GEOMORPHOLOGY
GEOMORPHOLOGIE

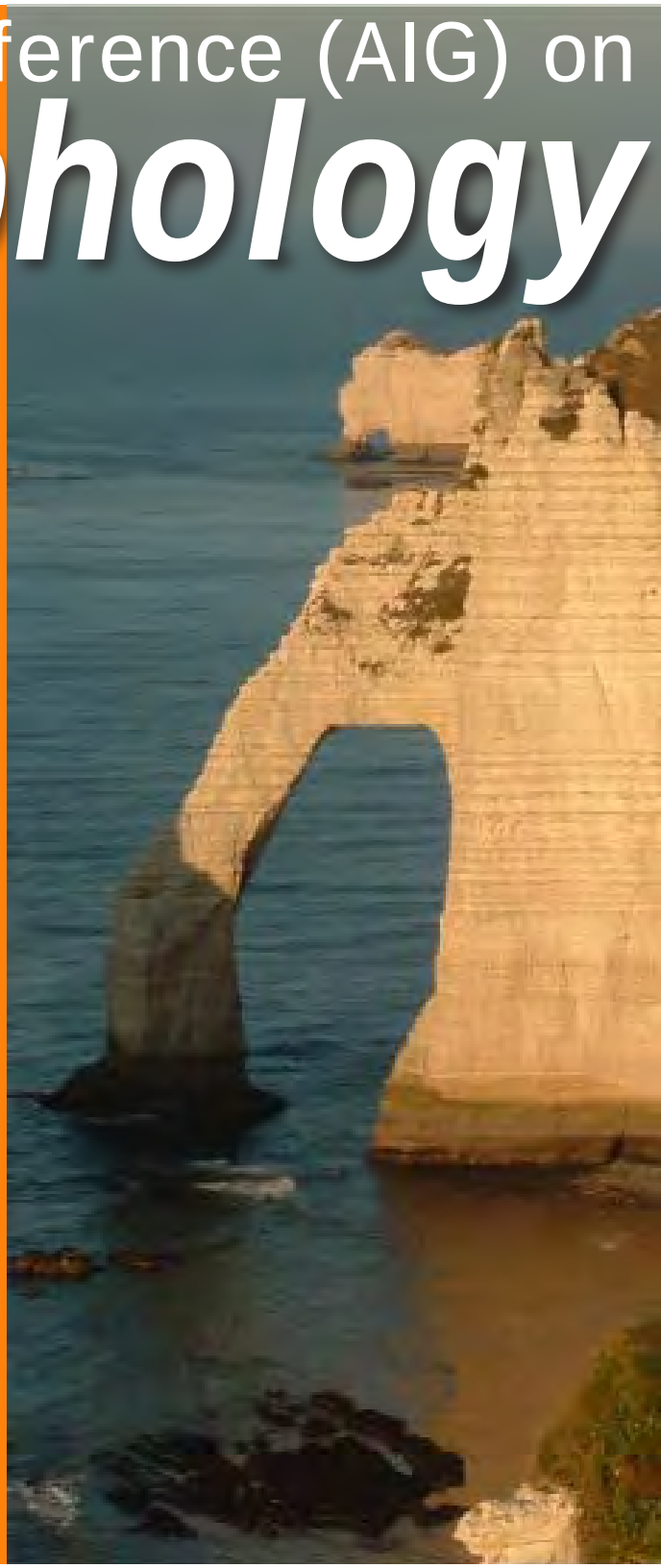
GFG

GEOMORPHOLOGY
PARIS – 2013

8th International conference (AIG) on

Geomorphology

ABSTRACTS VOLUME



PARIS - 2013

27-31 august

« Geomorphology and sustainability »

www.geomorphology-IAG-paris2013.com

ACKNOWLEDGEMENT

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PROLOGUE

Dear colleagues, dear friends,

This is a great pleasure to welcome you at the 8th International Conference on Geomorphology of the International Association of Geomorphologists (IAG), held in Paris (27-31 August 2013). This volume includes the 1936 abstracts accepted for oral (931) and poster (1005) presentations. These were dispatched within 27 sessions covering the majority of geomorphological topics. All abstracts have been reviewed by the 105 co-chairs of the sessions. In addition, five keynotes punctuate the Conference Programme: they will be delivered by Denys Brunsden, Vic Baker, Ana Luiza Coelho Netto, Asfawossen Asrat, Xiaoping Yang. Finally, 7 inter-conferences and 6 post-conference field trips have been organized by geomorphologists from more 17 French Universities, and 3 from abroad (Switzerland, Italy).

This Abstract volume, which provides an excellent overview of current research trends in geomorphology, is complemented by two books dealing with the Geomorphology of France: the first one, **"Géomorphologie de la France"** is coordinated by D. Mercier (Dunod), and the second one, **" Landscapes and Landforms of France "** edited by M. Fort and M.F. André, is the first of the new Springer series directed by P. Migón.

I would like to express my deep gratitude to the members of the Organizing committee for dedicating so much of their time to the organization of the conference: M. Fort, M.-F. André, E. Cossart, F. Bétard, Y. Le Drézen, N. Carcaud, D. Mercier, C. Le Coeur, L. Lespez, C. Giusti, N. Vanara, M. Ghilardi, Nicolas Jacob, G. Arnaud-Fassetta.

On behalf of the Organizing Committee, I wish to thank warmly the International Association of Geomorphologists (IAG) and its Executive Committee for putting their trust in the French community of geomorphologists.

Collectively, we are all very grateful to the Institutions: Marie de Paris, Conseil Régional d'Ile de France, CNRS, Ministère de la Recherche, and to all sponsors that have kindly provided financial and logistical support in a difficult economic period.

Stéphane Costa (University of Caen. LETG Géophen)
Chair of the Organizing Committee of the
8th International Conference on Geomorphology

PROGRAM OVERVIEW

Monday, August 26

14:30 - 18:30	Pre-registration
15:00 - 19:00	IAG meeting (Executive committee meeting of the outgoing EC)

Tuesday, August 27

8:00 -	Registration
9:30 - 11:00	1st IAG General Assembly
11:00 - 11:30	Opening Session
11:30 - 12:30	Keynote Lecture by Prof. Denys Brunsden
12:30 - 13:45	Break & Poster Session
13:45 - 16:30	Parallel Sessions
16:30 - 17:00	Coffee Break & Poster Session
17:00 - 18:00	Keynote Lecture by Prof. Victor Baker
19:00 - 21:00	Welcome Cocktail at Paris City Hall (Hôtel de Ville)

Wednesday, August 28

8:00 - 10:15	Parallel Sessions
10:15 - 10:45	Coffee Break & Poster Session
10:45 - 12:30	Parallel Sessions
12:30 - 13:45	Break & Poster Session
13:45 - 15:45	Parallel Sessions
15:45 - 16:15	Coffee Break & Poster Session
16:15 - 18:30	Parallel Sessions
18:30 - 19:30	Keynote Lecture by Prof. Ana Luiza Coelho Netto
19:30 - 20:30	Wine & Cheese

Thursday, August 29

One-day intercongress fieldtrips

Friday, August 30

8:00 - 10:30	Parallel Sessions
10:30 - 11:00	Coffee Break & Poster Session
11:00 - 12:45	Parallel Sessions
12:45 - 14:00	Break & Poster Session
14:00 - 16:00	Parallel Sessions
16:00 - 16:30	Coffee Break & Poster Session
16:30 - 18:15	Parallel Sessions
18:15 - 19:15	Keynote Lecture by Prof. Asfawossen Asrat
20:00 - 23:30	Gala Evening on the Seine River (Péniche “Le Boréas”)

Saturday, August 31

8:00 - 10:15	Parallel Sessions
10:15 - 10:45	Coffee Break & Poster Session
10:45 - 12:30	Parallel Sessions
12:30 - 13:45	Break & Poster Session
13:45 - 16:15	Parallel Sessions
16:15 - 16:45	Coffee Break & Poster Session
16:45 - 17:45	Keynote Lecture by Prof. Xiaoping Yang
17:45 - 18:45	2nd IAG General Assembly
18:45 - 19:15	Closing Session

Sunday, September 1

Beginning of:

- Post-Conference Excursions
- Intensive Course for Young Geomorphologists

GENERAL SCIENTIFIC PROGRAM (LIST OF SESSIONS)

Sessions		Convenors
S1	**History and epistemology of geomorphology**	Victor BAKER
S2	**Geomorphology and earth system science (IAG-WG)**	Nick CLIFFORD
S3	**Planetary geomorphology (IAG-WG)**	Mary BOURKE & Nicolas MANGOLD
S4	**Mega-geomorphology**	Jorge RABASSA & Clifford OLLIER
S5	**Tectonic geomorphology (including neotectonics and paleoseismology)**	Doug BURBANK & Francisco BEZERRA
S6	**Volcanic geomorphology: towards a quantitative assessment of volcanic landforms, processes and hazards**	Jean-Claude THOURET & Paola FREDI
S7	**Magnitude and frequency in geomorphology including:** S7A - Extreme events in geomorphology (IAG-WG)	Stuart LANE & Thomas GLADE Samuel ETIENNE & James P. TERRY
S8	**Geomorphic processes and long term landscape evolution**	Yanni GUNNELL & Leszek STARKEL
S9	**Rock control on geomorphic processes and landforms including:** S9A - Sandstone geomorphology (Danxia IAG WG), extended to quartzites S9B - Karstic geomorphology: from hydrological functioning to palaeoenvironmental reconstructions	Piotr MIGÓN Piotr MIGÓN Philippe AUDRA, Francisco GUTIÉRREZ & Jo DE WAELE
S10	**Quaternary geomorphology, including :** S10A - FLAG-GLOCOPH	Margot BÖSE Gerardo BENITO, David BRIDGLAND, Stéphane CORDIER & Thomas HOFFMANN
S11	**Geomorphology and global environmental change**	Olav SLAYMAKER
S12-16	**Anthropocene geomorphology** S12. Geoarchaeology (IAG-WG) S13. Human impacts on landscapes (IAG-WG) S14. Geomorphic hazards, risk management and climate change impact (IAG-WG) S15. Geoconservation, geotourism and education including: *S15A - Anthropogenic and climatic drivers of cultural stone deterioration and conservation* *S15B - Geomorphosites (IAG-WG) including geoparks and WHS* *S15C - Managing landscape dynamics in protected areas* *S15D - Teaching and disseminating geomorphology* S16. Forum francophone : la géomorphologie au service du développement durable	Andrew GOUDIE Kosmas PAVLOPOULOS & Vanessa HEYVAERT Asfawossen ASRAT, Andrew GOUDIE, Paul HUDSON, Denes LOCZY Irasema ALCÁNTARA AYALA, Sunil Kumar DE & Adriana NIZ Patricia WARKE & Stephen McCABE Emmanuel REYNARD, Paola CORATZA & Dominique SELLIER Maria Luisa RODRIGUES & Tim BADMAN David HIGGITT Jules ALONI, Jean-Louis BALLAIS, Mohamed Raouf KARRAY, André OZER, Mario PANIZZA, André ROY & PHAN TRONG Trinh

S17	**Geomorphology and the Critical Zone (including weathering, soils and biogeomorphology)**	Heather VILES & Junun SARTOHADI
S18	**Hillslope processes and mass movements** S18A - CERG Subsession: Methods for landslide hazard and risk assessment	Mauro SOLDATI, Mihai MICU & Jordi COROMINAS Jordi COROMINAS, Thomas GLADE, Jean-Philippe MALET
S19	**Fluvial geomorphology and river management including:** S19A - Large rivers (IAG-WG) S19B - Small catchments (IAG-WG) S19C - Sediment fluxes and morphodynamics of stream channels S19D - Other subsessions	Janet HOOKE & Gary BRIERLEY Avijit GUPTA & Zhongyuan CHEN Andrzej KOSTRZEWSKI Alain RECKING, John PITLICK, Mike CHURCH & Nicola SURIAN Janet HOOKE & Gary BRIERLEY
S20	**Sediment budgets (IAG-WG covering all environments)**	Achim A. BEYLICH & Armelle DECAULNE
S21	**Coastal geomorphology and management including:** S21A - Reef forms (IAG-WG) S21B - Rocky coasts (IAG-WG) S21C - Other subsessions	Edward ANTHONY & Julian ORFORD Chris PERRY, Paul KENCH & Scott SMITHERS David KENNEDY & Wayne STEPHENSON Edward ANTHONY & Julian ORFORD
S22	**Submarine geomorphology**	Klaus SCHWARZER & Sebastian KRASTEL
S23	**Aeolian systems and arid geomorphology (including subarid margins)**	Xiaoping YANG & Martin WILLIAMS
S24	**Tropical geomorphology** S24A - Tropical Rivers: Hydro-Physical Processes, Impacts, Hazards and Management (IGCP 582 and IAG Working Group on Tropical rivers)	Vishwas KALE, Robert WASSON Edgardo LATRUBESSE, Jose C. STEVAUX, Rajiv SINHA
S25	**Cold region geomorphology including:** S25A - Glacial and paraglacial geomorphology S25B - Permafrost and periglacial geomorphology (in coop. with IPA) S25C - Mountain geomorphology	 Jasper KNIGHT & Stephan HARRISON François COSTARD & Hugues LANTUIT Francesco BRARDINONI & Lothar SCHROTT
S26	**Methods in Geomorphology including:** S26A - Modelling in geomorphology S26B - Remote sensing (including laser scanning,applications of radar, etc.) S26C - DEMs, GIS and spatial analysis S26D - Statistics in geomorphology S26E - Dating methods (including cosmogenic nuclides) S26F - Applied geomorphological mapping (IAG-WG)	 John WAINWRIGHT Thomas DEWEZ & Dirk RIEKE-ZAPP Takashi OGUCHI & Christopher GOMEZ Ian EVANS & Delphine GRANCHER Andreas LANG & Susan IVY-OCHS Michael SMITH, Paolo PARON & Jim GRIFFITHS
S27	**Young Geomorphologists Session**	Etienne COSSART, Johnny DOUVINET & Stuart LANE

PROGRAM SCHEDULE

TUESDAY AUGUST 27

	Amphitheater Gaston Berger	Amphitheater Louis Armand Est	Amphitheater Louis Armand Ouest	Room 1	Room 2	Room 3	Room 4	Room AB	Room CD
9:30 11:00	**IAG General Assembly**	***IAG General Assembly****	***IAG General Assembly****						
11:00 11:30	**Opening Session**	***Opening Session****	***Opening Session****						
11:30 12:30	**Keynote lecture by Denys Brunsden**	***Keynote lecture by Denys Brunsden****	***Keynote lecture by Denys Brunsden****						
12:30 13:45	Break & Poster Session								
13:45 16:30	S21C	S19D	S14	S08	S12	S24	S15B	S25A	S22
16:30 17:00	Coffee Break & Poster Session								
17:00 18:00	**Keynote lecture by Victor Baker**	***Keynote lecture by Victor Baker****	***Keynote lecture by Victor Baker****						

WEDNESDAY AUGUST 28

	Amphitheater Gaston Berger	Amphitheater Louis Armand Est	Amphitheater Louis Armand Ouest	Room 1	Room 2	Room 3	Room 4	Room AB	Room CD
8:00 10:15	S21C	S19D	S14	S08	S12	S26C	S15B	S25A	S24A
10:15 10:45	Coffee Break & Poster Session								
10:45 12:30	S21C	S19D	S14	S08 S04	S12	S26C	S15B S15C	S26E	S24A
12:30 13:45	Break & Poster Session								
13:45 15:45	S21C	S19D	S14	S01	S5	S26C	S19A	S25B	S24A S16
15:45 16:15	Coffee Break & Poster Session								
16:15 18:30	S21C	S19D	S18	S21A	S5	S2	S19A	S25B	S16
18:30 19:30	**Keynote lecture by Ana Luiza Coelho Netto**	***Keynote lecture by Ana Luiza Coelho Netto****	***Keynote lecture by Ana Luiza Coelho Netto****						

FRIDAY AUGUST 30

	Amphitheater Gaston Berger	Amphitheater Louis Armand Est	Amphitheater Louis Armand Ouest	Room 1	Room 2	Room 3	Room 4	Room AB	Room CD
8:00 10:30	S21C	S19D	S18	S23	S5	S26A	S19A	S25C	S9B
10:30 11:00	Coffee Break & Poster Session								
11:00 12:45	S21C	S19C	S18	S23	S5	S26A	S7A	S25C	S9B
12:45 14:00	Break & Poster Session								
14:00 16:00	S13	S19C	S18	S23	S3	S26A	S10	S6	S9B S9
16:00 16:30	Coffee Break & Poster Session								
16:30 18:15	S13	S19C	S18	S23	S3	S26D	S10	S6	S9A
18:15 19:15	**Keynote lecture by Asfawossen Asrat**	***Keynote lecture by Asfawossen Asrat****	***Keynote lecture by Asfawossen Asrat****						

SATURDAY AUGUST 31

	Amphitheater Gaston Berger	Amphitheater Louis Armand Est	Amphitheater Louis Armand Ouest	Room 1	Room 2	Room 3	Room 4	Room AB	Room CD
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10:15 10:45	Coffee Break & Poster Session								
10:45 12:30	S13	S19C S19B	S18A	S21B	S20	S26B	S10A	S11	S17
12:30 13:45	Break & Poster Session								
13:45 16:15	S13	S19B	S18A	S21B	S20 S15A	S26F	S10A S15D	S11	S27
16:15 16:45	Coffee Break & Poster Session								
16:45 17:45	**Keynote lecture by Xiaoping Yang**	***Keynote lecture by Xiaoping Yang****	***Keynote lecture by Xiaoping Yang****						
17:45 18:45	**IAG General Assembly**	***IAG General Assembly****	***IAG General Assembly****						
18:45 19:15	**Closing Session**	***Closing Session****	***Closing Session****						

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Geoarchaeology of the ancient harbour of Ostia at the river mouth of the Tiber: chronology, stratigraphy and palaeoenvironmental reconstruction

CHABROL A., KAPSIMALIS V., FOUACHE E., LECOEUR C.
Human occupation and geomorphological evolution of the Corfu strait (NW Greece) during the Holocene: submarine seismic profiles and sedimentological proxies

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The geoarchaeology of the Talgar River alluvial fan and Iron Age history in the Semirech'ye region, Kazakhstan

BARTZ M., EIWANGER J., HILGERS A., MIKDAD A., BRUECKNER H.
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Mid-Holocene inundation of the Lower Danube Valley - Lake sediments reflecting changing environmental conditions and human impact

VANDARAKIS D., PAVLOPOULOS K., VOUVALIDIS K., FOUACHE E.
Lithostratigraphic evidence of the paleogeographic evolution of the Athenian basin during Holocene (6.000 YBP)

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Arsenic Exposure in Pre-Columbian Populations of Caleta Vitor, Northern Chile

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Holocene fluvial and coastal processes, landforms and human settlement: the case of the roman town of Sena Gallica (Marche, Italy)

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What does art can teach us about coastal geomorphological environment ?

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CHAUSSE C., SCHWENNINGER J.L., DEBENHAM N., BLASER F.
The Middle and Upper Pleistocene loess record and Acheulean-Mousterian industries of Saint-Illiers-la-Ville (78 - France)

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MOZZI P., ABBÀ T., FERRARESE F., FONTANA A., GAMBA M., NINFO A., PIOVAN S., ROSSATO S., ZANGRANDO D.
From point to surface. Reconstruction of a riverine urban settlement in Padova (NE Italy)

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Convenors: *Asfawossen ASRAT, Andrew GOUDIE, Paul HUDSON & Denes LOCZY*

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BEACH T., LUZZADDER-BEACH S., DUNNING N.
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KOTHIERINGER K., LAMBERS K.
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AUBAULT H., MCTAINSH G., STRONG C., LEYS J.
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GARCIA-RUIZ J.M., LANA-RENAULT N., NADAL-ROMERO E., SANJUAN Y., BEGUERIA S.
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LEIGH D.S., GRAGSON T.L., COUGHLAN M.R.
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BARTLEY R., CROKE J., THOMPSON C., FIFIELD K., TIMS S., WILKINSON S., KINSEY-HENDERSON A., HAWDON A.
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Anthropogenic Geomorphology of a highly urbanised fluvial plain: Pinheiros River, Sao Paulo, Brazil.

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RAMIREZ NUNEZ C., PARROT J.F.
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PASCHOAL L.G., CUNHA C.M.L.
Dynamics of land use and your interference in morphohydrographic system in aera of limestone mining: a case study in the inland of Sao Paulo, Brazil.

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GODLEWSKA A., RODZIK J., TERPILOWSKI S.
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NEUBERGOVA K., HYKS O.
Suburbanization of the village Cernosice depending on the geomorphology of the terrain and transport services

PATEAU M., FORT M., BEN MOUSSA A.
The "Tanger Med" harbor complex: impacts of its construction on its landslide prone hinterland (Rif Mountains, Morocco)

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Peri-urban growth in Mexico-City. A local evaluation of the landscape damage due to a massive house production

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5 millennia of Mediterranean mountain disturbance: soil erosion and vegetation dynamics recorded in Lake Petit (2200 m, South-Western Alps)

LANA-RENAULT N., GALILEA I., LLORENTE J.Á., NADAL-ROMERO E., SERRANO-MUELA M.P.
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Sustainable Land Management of the agro-pastoral plateaus, Atlantic Morocco

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PIJET-MIGON E.
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VALENZUELA P., DOMINGUEZ-CUESTA M.J., JIMENEZ-SANCHEZ M., MELÉNDEZ-ASENSIO M., SÁENZ DE SANTA MARÍA J.A.
Active collapse dolines: a geomorphological impact from a high-speed railway tunnel crossing the Cantabrian Mountains (NW Spain)

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S14. GEOMORPHIC HAZARDS, RISK MANAGEMENT AND CLIMATE CHANGE IMPACT (IAG-WG)

Convenors: *Irasema ALCÁNTARA AYALA, Sunil Kumar DE & Adriana NIZ*

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DAS A.K., HAZARIKA N., SAH R.K.
Changing nature of riverine hazards in Brahmaputra Valley, India

FURDADA G., MARQUES M.A., MASCAREñAS P.
Flood hazard maps of ephemeral streams (NE Spain): the Multibasin-Multifunction approach

BANDYOPADHYAY S., DE S.K.
A Proposed Method of Bank Erosion Hazard Zonation and Its Application on the River Haora, Tripura, India

WERREN G.
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NAGARALE V., MORE P.
Flood Risk Management - A Case Study of Savitri River Basin, Maharashtra (India)

UNDE M., JAWARE D.
Flood Recurrence Analysis of River Bhima at Pandharpur in Part of Maharashtra

SAHA F., TCHINDJANG M.
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Dynamics of Tsunami Flood related with Evacuation Behavior in the City Area Enclosed with Embankments - Analysis of 'the Tsunami Movie' recorded in Miyako City on 11 March 2011 -

LIN J.
Resilience of huge earthquake in Taiwan ---12 years after Chi-Chi Earthquake

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High- and low-frequency morphodynamic events and natural risks in mountain catchments of the semi-arid Brazilian 'Nordeste': Crato (Ceará)

RAVANEL L., DELINE P., LAMBIEL C.
Stability monitoring of high Alpine infrastructure by terrestrial laserscanning

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Predictive value of the geographical distribution of shrines undamaged by the 2011 Tohoku earthquake and tsunami: Identifying previous maximum disaster ranges from the distribution

OWCZAREK P., MALIK I., TIE Y.
Dendrochronological dating of debris flow activity in the Minya Konka massif (Sichuan, China)

VELLA S.
Climatic trend in Central Calabria (Italy) during the last 100 years

PAPATHOMA-KOEHLE M.
Validating an indicator-based vulnerability assessment methodology for debris flow hazards

PROMPER C., GASSNER C., GLADE T.
Spatial and temporal patterns of landslide risk - a case study in Lower Austria

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Alluvial fan flooding hazard in Southern Apennines: the state of knowledge

GAKI-PAPANASTASSIOU K., BATHRELLOS G., KARYMBALIS E., SKILODIMOU H.
Urban flood hazard assessment model using multi-criteria analysis: the case of Kifissos River (Athens, Greece)

TARRAGONI C., BELLOTTI P., DAVOLI L., LUPIA PALMIERI E.
Recent evolution of the Tiber River delta and future scenarios of coastal vulnerability

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Lake Nyos, a multirisk and vulnerability appraisal

DE LUIZ ROSITO LISTO F., VIEIRA B.C.
Analyze of shallow-landslide risk and susceptibility in São Paulo city, Brazil

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DE S., GHOSH G.K., ALCANTARA AYALA I., SENGUPTA A., JOSHI V.
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S15A - ANTHROPOGENIC DRIVERS OF CULTURAL STONE DETERIORATION AND CONSERVATION

Convenors: *Patricia WARKE & Stephen McCABE*

S15B - GEOMORPHOSITES (IAG-WG) INCLUDING GEOPARKS AND WHS

Convenors: *Emmanuel REYNARD, Paola CORATZA & Dominique SELLIER*

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CAPPADONIA C., AGNESI V., ANGILERI S.E., CORATZA P., COSTANZO D., DI PATTI C., SOLDATI M., TONELLI C.
Bridging Malta and Sicily through geoheritage exploitation: Identification and assessment of geosites for territorial enhancement

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HOBLEA F., JAILLET S., MAIRE R., MALARD A., MOREL L., FAGE L.H., MARBACH G., TOURTE B.
The geomorphosites of Madre de Dios island (Patagonia, Chile): "marble glaciers", painting caves and hydro-aeolian karst landforms. A singular heritage unique in the world

BUZJAK N., PAHERNIK M.
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Geoconservation of caves in Fiji: a case study from Volivoli Cave, SW Viti Levu Island

GAUCI R., CORATZA P., SCHEMBRI J.A., SOLDATI M., TONELLI C.
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OSORNO J., ALCÁNTARA-AYALA I., RAMOS S., COUTURIER S., GARNICA R., LOPEZ J.
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REYNARD E., BOLLATI I., CAYLA N., CORATZA P., GIUSTI C., HOBLÉA F., ILIES D., MARTIN S., MEGERLE H., PELFINI M., REGOLINI G., SELLIER D., ZORN M.
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PANIZZA V., CORATZA P.
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A large fluvial geomorphosite: the Seine River downstream Mantes-la-Jolie (France)

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PEREIRA P., PEREIRA D., CRISPIM J., NUNES J.C., BRUM DA SILVEIRA A.
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S15C. MANAGING LANDSCAPE DYNAMICS IN PROTECTED AREAS

Convenors: *Maria Luisa RODRIGUES & Tim BADMAN*

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S15D. TEACHING AND DISSEMINATING GEOMORPHOLOGY

Convenor: *David HIGGIT*

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S16. FORUM FRANCOPHONE : LA GEOMORPHOLOGIE AU SERVICE DU DEVELOPPEMENT DURABLE

Convenors: *Jules ALONI, Jean-Louis BALLAIS, Mohamed Raouf KARRAY, André OZER, Mario PANIZZA, André ROY & PHAN TRONG Trinh*

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S17. GEOMORPHOLOGY AND THE CRITICAL ZONE (INCLUDING WEATHERING, SOILS AND BIOGEOMORPHOLOGY)

Convenors: *Heather VILES & Junun SARTOHADI*

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S18. HILLSLOPE PROCESSES AND MASS MOVEMENTS

Convenors: *Mauro SOLDATI, Mihai MICU & Jordi COROMINAS*

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NG K.Y., MILLIS S.W.
Development of a geomorphological model for field instrumentation design, Tai O, Hong Kong

MICHELETTI N., LANE S.N.
Quantification of mass movement and sediment flux at the decadal scale for Alpine mountain basins: the critical role of sediment connectivity

SANDRIC I.(1), CHITU Z.(2)
Bayesian modeling of rainfall-triggered landslides using weather forecasting systems

WISTUBA M., MALIK I.
Relations between landslide activity and fluvial erosion: slope-channel coupling recorded in tree rings and relief (Western Carpathians and Eastern Sudetes, Czech Republic)

BOGAARD T.
Landslide hydrology: modelling the dynamic interactions between slope deformation, preferential flow and hydrology

VILLAÇA GOMES M., VIEIRA B.C.
Variations in soil hydraulic conductivity as triggering factors of shallow landslides in the Serra do Mar, Brazil

BAUZYS F., EGAS H.M.
Mass movements characterization in the disaster occurred in the Morro do Baú Complex, Santa Catarina, Brazil, in November, 2008

AMARAL C., SILVA A., LIMA I., RAMALHO J., VAREJÃO L., RODRIGUES J., LAGO L., CORREIA R., CORRÊA S., PORTOCARRERO H., MOTTA M., VARGAS JR. E., DE CAMPOS T., DOURADO F., SILVA L., ARAÚJO J., FERNANDES N.F., VIEIRA B.
The Catastrophic Landslide Event of January 2011 in Rio de Janeiro: Geomorpholocial and Geological Controls

CARDOSO-LANDA G.
Relation between the precipitation intensity and duration that originated the debris flows in Puebla, México

GORUM T., VAN WESTEN C., KORUP O., VAN DER MEIJDE M., FAN X., VAN DER MEER F.D.
The combined effect of complex rupture mechanism and topography in regional distribution pattern of the landslides triggered by the 12 January 2010 Haiti earthquake

CHELLI A., VESCOVI P., CARLINI M., CLEMENZI L., ARTONI A., TELLINI C., TORELLI L., BALESTRIERI M.L.
Relationships between large landslides and late orogenic antiforms in the Northern Apennines (N Italy): geomorphological, structural and thermochronological data

GONZALEZ-DIEZ A., FERNANDEZ-MAROTO G., DOUGHTY M.W., DIAZ DE TERAN J.R., REMONDO J., CARDENAL J.
The apply of digital photogrammetric techniques in the generation of landslide inventories of high temporal frequency for villafufre area (Cantabria, Spain)

EISANK C., HÖLBLING D., FRIEDL B., BLASCHKE T.
Defining digital signatures of landslide types for semi-automated landslide mapping
BELL R., PETSCHKO H., BRENNING A.
Age-dependent footprint of landslides in airborne laser scanning digital terrain models

DEVOTO S., FORTE E., MANTOVANI M., MOCNIK A., PASUTO A., PIACENTINI D., SOLDATI M.
Long-term monitoring of slow-moving landslides: examples from the Island of Malta (Central Mediterranean Sea)

BLAHUT J., KLIMES J., YEPES J., GALINDO I.
Monitoring of large mass movements on El Hierro, Canary Islands, Spain

VILIMEK V., KLIMES J.
Landslide monitoring, temporal analysis and susceptibility assessment at Machu Picchu, Peru

MBATCHOU MBATCHOU S., TCHINDJANG M., WAKPONOU A.
Landslides and erosion times on the Batchingou massive (West Cameroon)

AGNESI V., ARINGOLI D., BUCCOLINI M., COCO L., DEL MONTE M., GENTILI B., MATERAZZI M., PAMBIANCHI G., SCIARRA N.
Geomorphological evolution in some clayey small catchments of central and Island Italy during the last 15,000 years

COSSART E., MERCIER D., DECAULNE A., FEUILLET T., JONSSON H., SAEMUNDSSON Þ.
Impacts of post glacial rebound on landsliding at a regional scale in Northern Iceland (Skagafjörður): spatial distribution and mechanisms involved

HRADECKI J., PÁNEK T., SMOLKOVÁ V., ŠILHÁN K., LENART J.
Long-term slope instabilities of southern slopes of the Crimean Mountains (Ukraine), the role of karstification and slope-disequilibrium phases of the Late Quaternary

COROMINAS J., PLANAS X.
The 'El Forn' landslide, Principality of Andorra: a survivor of the late Pleistocene glacier activity

MICU M., JURCHESCU M., MICU D., BALTEANU D., ZAREA R., LEAU L.
The morphogenesis of deep-seated landslides in the Romanian Curvature Carpathians as a proxy in regional landslide hazard assessment

DELINE P., AKÇAR N., IVY-OCHS S., KUBIK P.W.
Repeated rock avalanches onto the Brenva Glacier (Mont Blanc massif, Italy) during the Holocene

PANEK T., HRADECKY J., MINAR J.
Giant landslides at Late Pleistocene highstands of the Caspian Sea

MAQUAIRE O., AFCHAIN P., COSTA S., DAVIDSON R., FRESSARD M., LETORTU P., LISSAK C., THIRARD G., THIERY Y.
Long term evolution of 'Les Vaches Noires' cliffs and spatio-temporal occurrence of landslides (Calvados, Basse-Normandie, France)

HURST M.D., ELLIS M.E., ROYSE K.R., LEE K.A., FREEBOROUGH K.
Magnitude-frequency scaling of a long-term inventory of landslides in Great Britain

ŠILHÁN K., PÁNEK T., HRADECKý J.
Tree-ring analysis in the reconstruction of slope instabilities associated with earthquakes and precipitation (the Crimean Mountains, Ukraine)

LIMA R., MARÇAL M.
Analysis of high magnitude mass movements on January 2011 rainstorm - Nova Friburgo, Brazil

RIEDLER R.A., FULLER I.C., GLADE T., BELL R., MARDEN M.
Spatio-temporal landslide dynamics and their contribution to the channel system from 1946 to 2011, Southern Ruahines, New Zealand

PARISE M., VENNARI C.
Slope movements shaping the landscape in the Daunia Apennines (Southern Italy), and their effects on the built-up environment

KACPRZAK A., MIGON P.
Constraining relative chronologies of mass movements using soil characteristics

LENART J., PÁNEK T.
Crevice-type rockslide caves and their relation to the slope deformations

RICHARDS K., BITHELL M.
Cliffs and screes: the Reverend Fisher, Bakker and Le Heux, Statham and Kirkby and DEM

SHRODER J., BISHOP M.
Geomorphometric assessment of large mass movements in Afghanistan and Pakistan

MARGOTTINI C., FIDOLINI F.
Geomorphological processes affecting the conservation of the Shahr-e Zohak archaeological site (Central Afghanistan)

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Storage coupling and sediment connectivity in a high-alpine cascading system (Val Müschauns, Swiss National Park)

S18A - CERG SUBSESSION: METHODS FOR LANDSLIDE HAZARD AND RISK ASSESSMENT

Convenors: *Jordi COROMINAS, Thomas GLADE & Jean-Philippe MALET*

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LISSAK C.(1), MAQUAIRE O.(1), MALET J.P.(2), BITRI A.(3), BOURDEAU C.(4), DAVIDSON R.(1), GRANDJEAN G.(3), REIFFSTECK P.(5)
Characterizing the complex morpho-structure of coastal landslides combining airborne and ground-based investigations

MOYA J., COROMINAS J., MAVROULI O.C.
A geomorphologic and probabilistic approach to the number and size of blocks of fragmental rockfalls

VAN ASCH T., XU Q.
A modelling approach of the large, rapid Yigong rockslide ' debris avalanche, Southeast Tibet

CARVALHO VIEIRA B., SOUZA FERREIRA F.
Physical and geotechnical properties of soils and shallow landslides, Serra Do Mar Moutain Range, Brazil

GHINOI A.
A reappraisal of field geomorphology in landslide hazard investigation

LOMBARDO L., CAMA M., CONOSCENTI C., HOCHSCHILD V., MÄRKER M., ROTIGLIANO E.
Comparing binary logistic regression and stochastic gradient boosting techniques in debris-flows susceptibility modelling: application in North-Eastern Sicily

ROTIGLIANO E., CAMA M.E., CONOSCENTI C., LOMBARDO L.
Landslide susceptibility modelling for extreme rainfall-triggered multiple landslides: a key study from the 2009 event in the Giampilieri Aera (Sicily, Italy)

PIACENTINI T., MICCADEI E., DI MICHELE R.
Assessment of rockfall susceptibility in different morphostructural frameworks, Abruzzo Region, Central Italy

MORITA K., ISOGAI N., ISHIZUKA T., UCHIDA T., OCHI H.
Assessing for deep-seated catastrophic landslide susceptibility of Japan: Application and verification for Kii mountain range, Japan

FERNANDES N., AMARAL C., BIERMAN P., SILVA L.M., ARAÚJO J.P., VARGAS JR. E., DE CAMPOS T., DOURADO F., LOPES M., PEIXOTO M.N., NUNES A.
Debris Flows in Rio de Janeiro: Mapping, Modeling and Dating

GRUNERT J., KRAUTER E., KUMCERICS C.
Accelerated landsliding due to climate warming? Modeling results from western Germany
OLIVEIRA S.C., ZÊZERE J.L.
Update of rainfall thresholds for landslide activity in the Lisbon area (Portugal)

FRESSARD M., THIERY Y., MAQUAIRE O.
Quantitative landslide hazard assessment in the hilly valleys of the Pays d'Auge plateau (Normandy, France)

PEREIRA S., SILVA M., GARCIA R.A.C., ZÊZERE J.L.
Quantitative Risk Analysis for shallow slides: the case of S. Marta de Penaguião (Douro Valley, Portugal)

CIUREAN R., HUSSIN H., FRIGERIO S., GLADE T.
Probabilistic modelling of uncertainties in vulnerability assessment - application to hydro-meteorological hazards in the municipality of Malborghetto-Valbruna, Italy

Evaluation of mitigation measures to reduce shallow-landslide hazard induced by extreme rainfall events: analysis of the road network in the Vernazza catchment (Cinque Terre, Italy)

NICULITA M., MARGARINT C.
Landslide susceptibility validation using multitemporal inventory of landslides in the Moldavian Plateau, Romania

VAN ASCH T., TANG C.
An integrated model to assess rain fall thresholds for critical run-out distances of debris flows in the Wenchuan Eartquake area, SW China

LIBERATOSCIOLI E., SOLDATI M., VAN WESTEN C.J.
Assessment of susceptibility for small landslides in the Secchia Basin (Modena Province - Italy) by means of statistical analysis

FERNANDES E., CESTARO L.A., PEREIRA V.H.C.
Dunes dynamics and potential risks of mass movements in Natal-RN City, Brazil

HECKMANN T., GEGG K., BECHT M.
Between spatial autocorrelation and representativity: Seeking the 'optimal' sample size for a statistical spatial prediction model of debris flow initiation

MALET J., BÉGUERIA-PORTUGUÈS S., PROMPER C., GLADE T., PUISSANT A., REMAÎTRE A.
ChangingRISKS: Assessment and communication on possible effects of global changes on landslide risks

PETSCHKO H., BELL R., GLADE T., GRANICA K., HEISS G., LEOPOLD P., BAUER C., PROSKE H., POMAROLI G., SCHWEIGL J.
Methods for landslide susceptibility assessment, concepts and applications for spatial planning in Lower Austria

SALVATORE M., BARONI C., CARLONI I., DELLA SETA M., DEL MONTE M., VERGARI F.
Debris flow susceptibility assessment in the avio valley (adamello-presanella massif, Central Alps) through multitemporal and conditional analysis

LI D., YIN K., CHEN L.
Deformation and prediction of landslides with step-like deformation in the Three Gorges Reservoir

NERY T., VIEIRA B.C.
Landslide Susceptibility Mapping Using SINMAP model, Serra do Mar, Brazil

ROTIGLIANO E., AGNESI V., ANGILERI S.E., ARNONE G., CALÌ M., CALVI F., CAMA M.E., CAPPADONIA C., CONOSCENTI C., COSTANZO D., LOMBARDO L.
Multi-scale regional landslide susceptibility assessment in Sicily (Italy): The Sufra Sicilia Project

MICCADEI E., MARSALA V., PIACENTINI T., ROCCA M., SCIARRA M.
Landslide susceptibility map of the Mauritius Island

CREMA S., CAVALLI M., MACCONI P., MARCHI L.
Regional-scale debris-flow modelization for hazard mapping in alpine basins using a high-resolution DTM and events geodatabase

BOSSI G., CAVALLI M., QUAN LUNA B., FRIGERIO S., MANTOVANI M., MARCATO G., SCHENATO L., PASUTO A
Multi temporal LiDAR-DTMs as a tool for modeling a complex landslide: a case study in the Small Dolomites (Rotolon catchment - Italy)

CHENG C., BAI S., WANG J., WEI Y.
Comprehensive Utilization of SAR and Optical Data for Landslides Investigation in the Bailongjiang Basin, China

CHHABRA N., ROY N.G.
Hydroelectric power generation, tropical river flood hazards and mitigation plan for better investment in Uttaranchal, India

BOGAARD T., WENKERS K.

How can fiber optic technology be used in early warning systems for natural hazards?

LISSAK C., MAQUAIRE O., MALET J.P.
Critical hydro-climatic thresholds for triggering slow-moving landslides along Normandy coasts (France)

S19A - LARGE RIVERS (IAG-WG)

Convenors: *Avijit GUPTA & Zhongyuan CHEN*

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AALTO R.
Sedimentary Processes in Large Source-to-Sink Systems Forced by ENSO

GUPTA A., LIEW S.C.
Climate change and large tropical rivers

GAUTIER E., FEDOROV A., COSTARD F., KONSTANTINOV P., BRUNSTEIN D.
Interactions between global warming, flooding and fluvial form adjustment on the Lena River, Central Siberia

BRUNIER G., ANTHONY E.J., PROVANSAL M., DUSSOUILLEZ P., GOICHOT M.
Recent changes in the morphology of river channels in the Mekong delta: natural or anthropogenic?

BALTHAZAR V., VANACKER V.
Regional scale analysis of natural vs. anthropogenic controls on sediment fluxes

BRONSTERT A., ARAÚJO J., BATALLA R., GÜNTNER A., FÖRSTER S., FRANCKE T., MÜLLER E., BROSINSKY A., DELGADO J., LÓPEZ-TARAZÓN J., SOMMERER E., VERICAT D., WERB S.
Quantification and Modeling of Runoff and Suspended Sediment Transfer Paths in Instrumented Mesoscale Catchments in Spain and Brazil

JOUBERT R., ROWNTREE K., ELLERY W.
Understanding recent change in river-floodplain connectivity in the Baviaans catchment, Eastern Cape: implications for floodplain restoration

FINLAYSON B., CHEN J., WU X., WEI T., LI M., CHEN Z., WEBBER M.
The Hydrology of the Yangtze (Changjiang) River, China

CHEN Z., YUAN W.H.
Post-dam assessment for change in riverbed and delta-coast morphology following impoundment of Three Gorges Dam of the Yangtze (Changjiang) River

YANG X.K., LU X.X.
Model of reservoir regulations and their impacts on river fragmentation in the Yangtze River Basin, China

SHAO L., LI C.(2), YUAN S.
Geochemical compositions of the late Cenozoic sediments in the Jianghan Basin: Implications for sediment source and evolution of the Yangtze River
HIGGITT D., ZHANG X.B., HE X.B.
Declining Sediment Yields in the Upper Yangtze: Dams, Degradation Control or Delivery?

YANG D.
Geomorphologic process of the first bend of the Yangtze River

YU G.A., HUANG H.Q., LIU X.F., NANSON G., FAN B.L., LIU T.H.
Characteristics and self-adjusting behavior of anabranching channel patterns along the middle and lower reaches of the Yangtze River

RAMOND S., ROBERT V., GAUTIER E., DEPRET T., MARLIN C., DURAND V., MONVOISIN G., NORET A., MASSAULT M.
Impacts of meander landforms evolution on hydrological fonctionning of a floodplain: the Loire Meander at Guilly (Central France)

Spatial organization of Pantanal lagoons in Matogrosso Do Sul, Brazil

YAN Y.
Similarity analysis of scale effects of specific sediment yield in the Yangtze River basin, China

SILVA J., RODRIGUES C., PEREIRA D.
Fluvial patterns and its use for the assesment of amazonian geodiversity, discussion and application ont the Xingu River Basin

YANG I.
Developmental History of the World's Longest Rivers

ATIF S., ARNAUD-FASSETTA G., FORT M.
The lower Indus Basin: an anthropogenically modified hydrosystem under the influence of extreme events

HENAFF Q., BELTRANDO G., ARNAUD-FASSETTA G.
Simulation of floods in the Rhône valley from Lidar DEM: Assessing impacts of hydraulic structures on the floodplain dynamics faced new regulation of 2014

DAVID M., CAROZZA J.M., VALETTE P.
A quantitative approach of the morphological changes in the Middle Garonne river (South-west France) during the last 300 years

S19B - SMALL CATCHMENTS (IAG-WG)

Convenor: *Andrzej KOSTRZEWSKI*

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KOSTRZEWSKI A.
The monitoring of small rivers catchments in various climatic zones - assumptions of methodological and methodical studies

JAKUBINSKY J.
Geomorphological features of small watercourses in a context of river landscape sustainability in the Czech Republic

AUGUSTIN C., CRUZ L., FABRIS J., ROCHA L.
Geochemical and physical loss from a small catchment area in the sub-humid 'tropics: contribution of gullies

MYKHNOVYCH A., KOVALCHUK I., KRAVCHUK Y., PYLYPOVYCH O., CHIKOVA I.
Extreme land-forming processes development and distribution in the Ukrainian Carpathians under natural and man-made factors

KARALIS S., KALOGEROPOULOS A., KARYMBALIS E., CHALKIAS C.
Assessment of the relationships among morphometric parameters and hydrologic indices

NAMDEO S.
Quantitative Morph metric Analysis of Machna River basin Management, M.P.(India)

SMOLSKA E.
Variability of soil erosion in the last-glacial areas on the example of NE Poland

NADAL ROMERO E., CORTESI N., GONZÁLEZ HIDALGO C.
Weather times and flood generation in the Araguás catchment (Central Spanish Pyrenees)

MAILLARD B., REYNARD E., THELER D.
Typology of torrential systems prone to debris flows occurence in the Hérens valley (Switerland)

SOUZA J., CORREA A.
Damming in semiarid, relation between landscape connectivity and effective catchment area on saco creek watershed brazilian semiarid

MASSELINK R., KEESSTRA S., GIMÉNEZ R., CASALÍ J., SEEGER M.
Determining catchment-scale connectivity using hysteresis analysis of discharge and suspended sediment

LAJCZAK A.
Contemporary functioning of peat catchments on a glaciofluvial fan. Case study: Orawska Basin, Polish Carpathians

S19C - SEDIMENT FLUXES AND MORPHODYNAMICS OF STREAM CHANNELS

Convenors: *Alain RECKING, John PITLICK, Mike CHURCH* & Nicola SURIAN

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Time scale analysis of bedload discharge over steep slopes: from intermittency to white noise

METTRA F., HEYMAN J., MA H., ANCEY C.
From bedform evolution to channel slope fluctuations in steep-slope streams

MOLNAR P., SALETTI M.
On grain blocking, step formation, sediment transport dynamics and self-organized criticality in steep streams

GALIA T., HRADECKÝ J.
Critical conditions for beginning of coarse sediment transport in headwater channels based in flysch rocks (Moravskoslezské Beskydy Mts., Western Carpathians)

LINDSAY O., JOHNSON J.P.L.
Evaluating bedload transport in coarse alluvial streams with RFID and motion tracers

LIEBAULT F., LARONNE J.B., KLOTZ S., JANTZI H., RAVANAT X., FAVARIO J.
Bedload transport monitoring in a small upland catchment

DEPRET T., GRANCHER D., GAUTIER E., HOOKE J.
Morphodynamic and bedload displacement on a meander loop (Cher River)

MARQUIS G.A., ROY A.G.
Linking process and form using a field data set: issues, challenges and prospects

SLATTERY M., MELCHIORS M.
The impact of impoundment on sediment transport and channel bar dynamics on the Brazos River, Texas

ROJAN E., DLUZEWSKI M., KRZEMIEN K., BIEJAT K.
Morphodynamics of small wadis on the southern slopes of High Atlas Mountains (on the example of upper Dades catchment, Morocco)

CHIODI F., ANDREOTTI B., CLAUDIN P.
Revisiting the river bar instability

ROUSSEAU Y., VAN DE WIEL M., BIRON P.
Combining Geotechnical and Hydro-Morphological Modelling to Investigate the Dynamics of Meandering Rivers

LEDUC P., RECKING A., NAAIM M.
An experimental study of the grain sorting effect on braided pattern

TAL M., GRAN K.
Riparian vegetation as a primary control on channel width: results and insights from the laboratory to the field

KLOESCH M., TRITTHART M., BLAMAUER B., HABERSACK H.
Effects of bedload input on channel widening in a restored section of the Drau River, Austria

ARNAUD F., BÉAL D., PIÉGAY H., ROLLET A.J., SCHMITT L.
Experimental sediment reintroduction into the Rhine River downstream the Kembs dam: feedbacks from repeated field measures and high resolution imagery

VATNE G.
Relationships between bank protection and forced pool characteristics in a low gradient flood prone river, Central Norway

HUGHES M.
Spatial and temporal patterns of channel change and bedload transport of the Wood River, Upper Klamath Basin, USA: implications for assessing river management and restoration

GROSPRETRE L., SCHMITT L., JACOB N., DELILE H., PRIVOLT G., PREUSSER F., COTTET M.
Contemporary channel adjustments in a periurban catchment in the frame of a long-term sediment cascade history (Yzeron, City of Lyon, France)

ZORRIASATEYN N., STEWARDSON M., VIETZ G., RUTHERFORD I., FLETCHER T.
What Impact Does Urbanisation Have on the Depth of Bedload Sediment in Streams?

GOB F., JACOB-ROUSSEAU N., LE DREZEN Y., HOUBRECHTS G.
Stream incision and sediment wave consecutive to three centuries of timber floating in the Morvan Massif (Central France)

LANDEMAINE V., GAY A., CERDAN O., SALVADOR-BLANES S., RODRIGUES S.
Recent morphological evolution of a headwater stream in agricultural context after channelization (Ligoire River, France)

TUNNICLIFFE J.
The post-glacial evolution of Cordilleran rivers in southwestern British Columbia: timescales, texture and topography

SRIDHAR A.
Aggradation and incision of the fluvial terraces in response to the change in the river regime and pattern during the Holocene in Gujarat Alluvial Plain, western India

NICOLL T., BRIERLEY G.
Quantifying the influence of landscape connectivity on alluvial sediment flux in the upper Yellow River

SLATER L.J., SINGER M.B.
Trends in alluvial channel geometry: an indicator of decadal fluctuations in regional sediment supply and local flood risk

ALCAYAGA SALDIAS H., BELLEUDY P.
A simple approach to understand the kinetics of the responses of the river beds to changes in the sediment supply and hydrological regimes at the watershed scale

RAMONELL C., MARCHETTI Z., PEREIRA S.
Within-channel levees: a new-recognized fluvial form in the floodplain of a large river (Paraná River, South America)

PARROT E., PIÉGAY H., TAL M.
A comprehensive analysis of bedform evolution on the Rhône River, France

HALLOT E., GUYON F., ZANGRE A., DABIRE F., DE THYSEBAERT D., PETIT F.
Establishment of a sedimentation monitoring system of irrigation dams in Burkina Faso: The PADI project

GUSAROV A.
Evaluation of genetic structure of erosion intensity in river basins according to the analysis of river suspended sediment flux

EGOZI R.
Anomaly suspended sediment loads and channel morphology changes in a Mediterranean catchment: the effects of land cover and land use changes

FRYIRS K., GORE D.

Sediment Dynamics and catchment connectivity at the catchment

MARQUIS G.A., VENDITTI J.G., CHURCH M., KOSTASCHUK R.A., ATTARD M.E., RENNIE C.D.
Intermittent suspension of sand from the bed in the Fraser River

PEREZ FILHO A., VALEZIO E.V., CARPI JUNIOR S.
Effects of human action on the transportation of Tucum Stream Channel in Sao Pedro, Brazil

DOWNS P., DUSTERHOFF S.
Event-scale sediment fluxes and morphodynamics of a semi-arid river: the influence of climate drivers and human actions in the Lower Santa Clara River, California, USA

LIRO M.
The changes in riverbed plant cover in two rivers upstream the dam reservoir. A case study of the Czorsztyn Reservoir in southern Poland

REDIN VESTENA L., KOBIYAMA M.
Analysis of the relationship between the dynamics of saturated areas and sediment transport in a basin in Southern Brazil

GILYAZOV A.
Theoretical and methodical basis of study of granulometry as an indicator of formation conditions of modern and ancient alluvial deposits

OLIVEIRA L., MAGALHÃES JÚNIOR A.
The fluvial dynamic influences on evolution of the relief in the Pomba River Depression, Southeastern Brazil

SATDAROV A.
Geomorphological analysis of longitudinal profiles of the river valleys in the Northern Hemisphere

BERTOLDI W., GARCIA LUGO G.A.
Experimental assessment of the effectiveness of sediment transport estimates from morphological changes

KIRKBY M., HOOKE J., SMITH M., BARBERA G., GARCIA-PINTADO J., BRACKEN L.
Hydrological impacts of floods in SE Spain, September 2012

SKARPICH V., HRADECKY J., DUSEK R.
Man activity affecting the river (dis)continuum system in the Moravskoslezské Beskydy Mts. and their forefield

SURIAN N., ZILIANI L.
Channel adjustments in a large gravel-bed river (Tagliamento River, Italy): what's the role of different sediment sources?

LE BOUTEILLER C., VENDITTI J.
Influence of bottom vegetation on sediment transport and morphodynamics

AMADEU P., CABRAL J., LUCAS C., MÕNICA M.
Sediment transfer assessment in Macaé River, Rio de Janeiro, Brazil

SASS O., STANGL J., SCHNEIDER J., HARB G.
Quantifying fluvial sediment transport in a mountain catchment in Upper Styria (Austria) using sediment impact sensors

BERTHET J., ASTRADE L., JAILLET S., PLOYON E.
Dynamic of sediments monitoring by terrestrial laserscanner, application to quantify sediment yield of four torrents in French Alps

OLIVEIRA F., HAAK L.
Suspended Sediment Yield in a Subtropical Watershed

KEESSTRA S., VAN MINNEN J., DE DIE L., KHAN S.A., WESTER F.
Sediment transport by tidal river management

PIMENTEL MARINHO T., FILIZOLA N., SANTOS A.L., NASCIMENTO A., JEAN-MICHEL M., COCHNEAU G.
Analysis of the flow of suspended sediments from the behavior of the variation of water stain in the region of the confluence of the Negro and Solimoes-Amazonas Rivers, Amazonia, Brazil

BILLI P., CIAMPALINI R.
Geomorphic analysis of the ephemeral stream distributary systems of the Kobo basin (northern Ethiopia)

LALLIAS-TACON S., LIEBAULT F., PIEGAY H.
Reach-scale morphological changes of a braided river following a 15-year flood with multidate airborne LiDAR

S19D. OTHER SUBSESSIONS

Convenors: *Janet HOOKE & Gary BRIERLEY*

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NANSON G., HUANG H.Q.
A philosophy of rivers

PETIT F., HALLOT E., PEETERS A., LEVECQ Y., HOUBRECHTS G.
Bedload dynamics in gravel bed rivers

SZABO T., FITYUS S., DOMOKOS G.
Measuring and modeling of basalt pebble abrasion in the Williams River, Australia

STEWARDSON M., RUTHERFURD I.
In-Channel Fine Sediment Retention and Dynamics: A Review

LANE S.N., BALIN D., LOVIS B., MICHELETTI N.
The impacts of climatically-driven hydrological change upon sediment flux in Alpine river basins

GAO P., NEARING M., HICKS M.
Quantifying spatial and temporal variations of specific event sediment yields in different climatic zones

KERMODE S.J., COHEN T.J., REINFELDS I.V., NANSON G.C., JONES B.G.
Modern depositional processes in a confined, flood prone setting: benches of the Shoalhaven River, NSW, Australia

SMITH-ADAO L., ROWNTREE K., NEL J.
Valley floor changes along and adjacent to the Baviaanskloof River, Eastern Cape Province, South Africa: Testing confinement

WAWRZYNIAK V., PIÉGAY H., ALLEMAND P., VAUDOR L., GRANDJEAN P.
Is braided river index only related to discharge and geomorphic activity? Feedbacks from thermal infrared remote sensing

CLARKE L., MCLELLAND S., COULTHARD T.
Experimental investigation into the impact of vegetation on fan morphology and flow

BÄTZ N., LANE S., VERRECCHIA E.
The Fluvial Critical Zone ' the co-evolution of a geomorphic-vegetation-soil system

WYZGA B., ZAWIEJSKA J., RADECKI-PAWLIK A.
Identifying channel incision and its hydraulic importance: examples from Polish Carpathian rivers

CHUDANICOVA M., HRADECKY J., PANEK T.
Anthropogenic intervention into the river pattern as a cause of the Ol'e River floodplain development change (with the use of magnetic susceptibility for the sedimentary record interpretation)

SLOWIK M.
Changes of channel planform within anastomosing river system transformed by hydro technical works (the Obra River, W Poland)

BELLETTI B., DUFOUR S., PIÉGAY H.
Spatial and temporal variability of braided river bio-geomorphic patterns at the regional scale, the case of the French Rhône basin

SCORPIO V., AUCELLI P., GIANO I., PISANO L., ROBUSTELLI G., ROSSKOPF C., SCHIATTARELLA M.
Recent channel adjustments of major rivers in southern Apennines (Italy): a contribution to the understanding of fluvial response to human impact and climate change

CAMPANA D., COMITI F., GIAMMARCHI F., TONON G.
Morphological degradation and restoration of the Ahr river (Italian Alps) and their effect on riparian vegetation

TURNER J.N., JONES A.F., HARVEY E.
Historical river channel change and stability in Irish catchments: implications for river management under the EU Water Framework Directive

TEOUGAM N., TCHAWA P., TCHINDJANG M.
Detecting the Fluvial Channel Mobility and the Erosion Process Development for a Sustainable Management of the Mayo Tsanaga (North Cameroon)

MARREN P., ZOLJAN S., SMITH H., TEO E.
Catchment-scale versus site-scale controls on flood impact: Flooding in northern Victoria, Australia in 2010 to 2012

HOOKE J.
Geomorphological impact and feedback effects of occurrence and sequences of flood events of differing characteristics

SEAR D., DEARING J., WHEATON J., BATES P., NEAL J.
Flooding from extreme rainfall: Geomorphological effectiveness as a vehicle for flood risk management and whole river restoration

RÄPPLE B., PIÉGAY H., MUTZ M., STELLA J.C., TRÉMÉLO M.L., WILCOX A.
Physical controls of vegetation recruitment patterns on the Drôme River (SE France): An analysis based on a chronosequence of high resolution aerial imagery

BOIVIN M., BUFFIN-BELANGER T., PIEGAY H.
Assessment of the annual dynamics of large woods along a 60 km semi-alluvial river section of the Gaspe Peninsula, Quebec, Canada, feedbacks from 3 year field surveys combined with airborne and ground images

CORENBLIT D., BORNETTE G., STEIGER J., DAVIES N.
Necessity of linking paleontological and contemporary approaches for understanding river dynamics

GOSWAMI U., ACHARJEE S.
Downstream channel changes of a tropical alluvial river due to construction of a dam: The example of the Subansiri in Assam, India

CASADO A., PEIRY J.L., CAMPO A.M.
Geomorphic changes of a dry-temperate meandering river highly disturbed by a large dam, Sauce Grande River, Argentina

MAGILLIGAN F., NISLOW K., RENSHAW C., GARTNER J.
Geomorphic Impacts of Riparian (Dis)Connectivity: Dams and Dam Removals as 'Natural' Geomorphic Experiments

WHITFIELD G., WHITFIELD E.
Geomorphological response to weir removal: the River Twymyn, mid Wales, UK

IBISATE A., ACÍN V., BALLARIN D., DIAZ E., GRANADO D., MORA D., OLLERO A.
Geomorphological monitoring after dam removal

JUGIE M., GOB F., SLAWSON D., LECOEUR C.
Hydromorphological adjustments and re-adjustments of low energy rivers in a sub-urban catchment following historical engineering and recent urbanization

REGAMEY B., LANE S.N., MICHELETTI N.
Long term impacts of flow abstraction upon basin scale sedimentation processes in an Alpine valley system

DEMERS S., OLSEN T., BUFFIN-BÉLANGER T., BIRON P.
On the use of floodplain landforms to generate flood risk maps

LESPEZ L., VIEL V., GERMAIN-VALLÉE C., ROLLET A.J., GERMAINE M.A., CADOR J.M., DELAHAYE D.
Inherited rivers. Anthropogenic changes in the low energy rivers in W France from 1500 BC and implications for their current management

PEIXOTO M., DEL POZO I.F.
Landscape Connectivity in Hilly Catchments on Middle Paraiba do Sul River Valley, Southeastern Brazilian Plateau

VAN DER WAAL B., ROWNTREE K.
Sediment connectivity in the upper Thina River, Eastern Cape, South Africa

GURNELL A.
Characterising Urban Rivers to support their Sustainable Management

GUSMAROLI G., CEDDIA M., SOGNI D., MANNUCCI G., DOTTI N., PARINI M.
Geomorphological assessment of urban river reaches: results and discussion of five case studies (North Italy)

COTTON G.
Reach-Scale Index for Sand-Bed Channels

BUFFIN-BELANGER T., BIRON P., LAROCQUE M.
Reflections on the application of the 'Freedom space' river management approach to help mitigate climate change impacts on three rivers of southern Québec, Canada

BRIERLEY G., FRYIRS K., TADAKI M.
Fluvial Geomorphology in Practice: Lessons learnt in the development and application of the River Styles framework

RINALDI M., SURIAN N., COMITI F., BUSSETTINI M.
A methodological framework for hydromorphological analysis of Italian streams (IDRAIM) aimed to an integrated management of fluvial hazard and river restoration

RUTHERFURD I.
Making space for geomorphic processes: the example of buffers for rivers

POLVI L.E., NILSSON C.
Potential and actual geomorphic complexity of restored streams in headwater streams of northern Sweden

DIXON S., SEAR D., ODONI N.
The effects of river restoration on flood risk and flood hydrology

STOUT J., RUTHERFURD I., WEBB A.
The role of geomorphic processes in the sustainability of large wood loads in rivers: A Bayesian approach

PEETERS A. VERNIERS G., DE LE COURT B., HALLOT E., HOUBRECHTS G., PETIT F.
Assessing the success of river restoration projects through Geomorphology

THOMMERET N., BILODEAU C., GOB F., BAUDOIN J.M., ALBERT M.B., BELLIARD J.
Morphological descriptors and typologies of French rivers as tools for managing river restoration

O'DONNELL J., FRYIRS K., LEISHMAN M.R.
Investigating the potential of seed banks as a regeneration niche in riparian systems: Implications for vegetation-based river rehabilitation

MELUN G., ARNAUD-FASSETTA G., FORT M., CHALAUX E., LUCAS E., FOUREL S., GUESDON L.
Hydromorphological impacts of hydrosedimentary and ecological continuity's restoration. Example of the Yerres RIV., seine catchment, France

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Regional scenario of Quaternary climatic oscillations: low river terraces and flood plains in the current context of Depressão Periférica Paulista

FACINCANI E.M., BACANI V.M., SANTOS R.M., PEREIRA W.
Quaternary Basin of the Pantanal Mato-Grossense, Brazil: fluvial Megafans

FACINCANI E.M., BACANI V.M., SANTOS R.M., QUIRINO P.B., CORDEIRO B.M., PEREIRA W.
Negro River: fluvial megafan. Southeastern border of the Pantanal Basin, Brazil

LEJEUNE Q., SCHMITT L., ZIMMERMANN A., ESCHBACH D.
Evaluating a functional hydromorphological restoration of a lateral channel of the Upper Rhine (France): first results and implications of the temporal trajectory to restoration sustainability

BESN_ P., IBISATE A.
Fluvial geomorphological adjustments to global change in Iberian Rivers

GAMBOA-ROCHA A., STEWARDSON M., RUTHERFURD I., FINLAYSON B.
Elucidating the level of influence of key factors on the spatial distribution of overbank deposition

WANG S., YAN Y., HE L., YAN M.
Variation trend of the sedimentation rate in the Yinchuan Plain of the upper Yellow River since 0.7 Ma B.P. and its main influencing factors

CHEN X., LIN M., LIN B.
Velocity distribution of turbulent open-channel flow over permeable rough bed

OGAMI T.
Knickpoint initiation and migration rate of bedrock rivers dissecting the Middle to Late Pleistocene marine terraces at North Sanriku coast, NE Japan

BATHRELLOS G., SKILODIMOU H., MAROUKIAN H., GAKI-PAPANASTASSIOU K.
Late Quaternary evolution of the lower reaches of Ziliana stream in south Mt. Olympus (Greece)

HOOKE J.
Spatial and temporal variability in cut-off sedimentation

BERA B.
The decay and related environment problems of the deltaic rivers in West Bengal, India

EKASSI ONDOUA L., TCHINDJANG M., WAKPONOU A.
Quaternary Paleolandforms at Sanaga-Mbam confluence between geography and historical palaeoenvironmental approach

DOUDJE K., TCHINDJANG M., MOUPENG B.
Current development of the bed and major Chari river bank at N'Djamena since Holocene

DOUDJE K., TCHINDJANG M., MOUPENG B.
Development of the Chari river bank from Mandjaffa to Milezi (1970 - 2008) at N'Djamena (Tchad)

PETERSEN C., JOVANOVIC N.
Linking land use, riparian vegetation and channel changes in two catchments in the Upper Olifants River, Mpumalanga Province, South Africa

RINALDI M., NARDI L.
Morphological effects of a large flood: the case study of the Magra River (Italy)

IOANA-TOROIMAC G., GRECU F.
Abandoned borrow pits from Buzau River's floodplain (Romania) - evolution and management

NUNES PATUCCI N., OLIVEIRA D.
Evaluation of morphometric and morphological variables: analyses of topographic, geological and partitioning maps of Guaratuba basin ' Boraceia ' São Paulo ' Brasil

DEGIOVANNI S., ANDREAZZINI J.

Morphodynamic and morphologic changes analysis in rivers of the Sierra de Comechingones piedemont, Cordoba province, Argentina, during the Late Holocene-present. Environmental implications

BERTOLDI W., MAO L., COMITI F., GURNELL A., MCLELLAND S., RAVAZZOLO D., TAL M., WELBER M., ZANELLA S.
The effect of input load on large wood dynamics in braided streams: preliminary results from physical modelling

CONESA-GARCÍA C., GARCÍA-LORENZO R.
Fluviomorphological hazards in roads crossing ephemeral channels on the South East coast of Spain

THAKRE D.
Geospatial Mapping Ancient Phad Irrigation System in Mousam Basin, Maharashtra (INDIA): A GIS Approach

WIEDERKEHR E., DUFOUR S., PIÉGAY H.
Contribution of geomatic for multiscale characterisation of river systems: application to the Rhone basin

NIKAM S.
Hypsometric Analysis for Prioritization and Conservation Planning of Sub Watersheds; a Case study of Arjunsagar Lake Catchment, North Maharashtra, India

GILES P., WHITEHOUSE B., KARYMBALIS E.
Examination of the morphological characteristics of alluvial fans modified by interactions with rivers in broad axial valleys in Yukon Territory, Canada, and Alaska, U.S.A.

SOUZA J., BARROS A.C.M., CORREA A.C.B.
Small catchment river styles® in Brazilian dryland, saco creek watershed

KARYMBALIS E., GILES P., PAPANASTASSIOU D., FERENTINOU M., GAKI-PAPANASTASSIOU K.
Analysis of relationships among alluvial fans and source basins in Lake Trichonis (Western Greece)

DINH Q., BIZZI S., BERNARDI D., PAVAN S., CASTELLETTI A., SCHIPPA L., SONCINI-SESSA R.
Integrating river geomorphic processes into optimal planning of reservoir operations
MCDOWELL P.
Sedge as an influence on channel form: case study of Carex nudata in gravel-bedded John Day River, Oregon, USA

NIKAM C.
Diversion of running water discharge from par river to girna river valley

PERŞOIU I., ROBU D.
Historical planform adjustments of rivers from the Eastern part of Pannonian Basin, as indicators of neotectonic features

S20. SEDIMENT BUDGETS (IAG-WG COVERING ALL ENVIRONMENTS)

Convenors: *Achim A. BEYLICH & Armelle DECAULNE*

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VALE S.
Development and application of a fingerprinting technique for quantitative source ascription of fine sediment in a large dynamic fluvial environment: Manawatu, New Zealand

VIEL V., DELAHAYE D., ROLLET A.J., LESPEZ L., REULIER R., CADOR J.M., DAVIDSON R.
The sediment budget: a tool to evaluate scale effect on sediment dynamics into a catchment

PELACANI S., MAERKER M., SCHMITT F.G.
Application of the physically based model, power spectral analyses and cross correlation analyses to estimate the sediment budget and the delay time for an impacted stream: case study of Italy

S21A - REEF FORMS (IAG-WG)

Convenors: *Chris PERRY, Paul KENCH & Scott SMITHERS*

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RIEGL B., PERRY C., SMITHERS S., KENCH P.
Biotic dynamics as a driver of coral reef geomorphology

SMITHERS S., PERRY C., ROCHE R.
Holocene growth of King Reef - the largest mainland fringing reef on Grfeat Barrier Reef, Australia

KAN H., URATA K., NAGAO M., HORI N., OHASHI T., NAKASHIMA Y., GOTO K., YOKOYAMA Y., SUZUKI A.
Discovery of submerged karst terrain in modern reef area by broadband multibeam bathymetric survey in the southern Ryukyu Islands, Japan

MORGAN K., KENCH P.
Calcium carbonate budget of a Maldivian reef platform

MANDLIER P., KENCH P.
Hydrodynamic process controls on reef platform sedimentation and island formation

KENCH P., PERRY C., SMITHERS S., YAMANO H., O'LEARY M.
Infill of Faro Lagoons: Size Thresholds and Controls on Island Formation in the Maldives

COSTA M., MACEDO E., SIEGLE E.
Morphological response of reef island on rocas atoll (South Atlantic Ocean) to Seasonal energetic wave conditions

JAVIER L., WOODROFFE C., PHINN S., HAMYLTON S.
A sediment budget for Lizard Island, northern Great Barrier Reef

MCLEAN R.
Atoll Island Geomorphology and Stability: Nukulaelae Atoll, Tuvalu, Central Pacific

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PERRY C., MURPHY G., KENCH P., SMITHERS S., EDINGER E., STENECK R., MUMBY P.
Quantifying the impacts of regional scale reef ecosystem decline on the geomorphic performance and growth potential of Caribbean coral reefs

SWITZER A., MELTZNER A.J., WU C.C., CHIANG H.W., SHEN C.C., GONG S.Y., SUWARGADI B.W., NATAWIDJAJA D.H., HORTON B.P.
Precise timing and elevation of the mid-Holocene highstand at Belitung Island, Indonesia, on the Sunda Shelf, from coral microatolls

S21B. ROCKY COASTS (IAG-WG)

Convenors: *David KENNEDY & Wayne STEPHENSON*

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STUIVER C., NICHOLLS R.J., RICHARDS D., BARTON M.
The influence of inter-tidal shore platforms on soft cliff recession rates and headland formation on the southwest coast of the Isle of Wight

NORMAN E., ROSSER N., BRAIN M., PETLEY D., WAUGH S.
Alongshore variations in hard rock coastal cliff erosion

ELINEAU S., DUPERRET A., MERRIEN-SOUKATCHOFF V.
Pluri-decadal evolution of cretaceaous coastal cliffs alonf the eastern English Channel in Upper-Normandy (NW France), as evidenced by aerial photographs and Lidar

LETORTU P., COSTA S., CADOR J.M., CANTAT O., MAQUAIRE O., BONNET E.
Fall of coastal chalk cliffs in Upper Normandy: Towards the determination of triggering factors

ROHMER J., DEWEZ T.
Analyzing the spatial structure of sea cliff instabilities through repeated high resolution terrestrial laser scanning surveys and point processes statistics

DICKSON M.
A new approach to coastal cliff landslide hazard assessment

SWIRAD Z., REES W.G.
Application of GNU Octave tools to analyse the shape of a rocky shoreline - an example from Hornsund area (SW Spitsbergen, Svalbard)

SAPOVAL B., BALDASSARRI A.
A feedback model relates rocky coast erosion to percolation theory, a new perspective on the statistics of erosion events

FICHAUT B., SUANEZ S.
Set up and evolution of cliff-top storm deposits on the western coast of Banneg island in the Molène archipelago, Brittany, France

MARINO A., CIUCCI M.
Geomorphic hazard along southern Abruzzo coast (central Italy)

MOTTERSHEAD D., BRAY M., FARRES P., SOAR P.
Geomorphological evidence of extreme wave events in the Maltese Islands

ABAZOVIC A., STEPHENSON W.J.
Evidence of storm wave induced shore platform boulder dynamics at Timaru, New Zealand

YOUNG A., GUZA R., DICKSON M., FLICK R., WILLIAM O.
Microseismic observations of coastal ground motion and geomorphic implications

MOSES C., ROBINSON D., WILLIAMS R.
Towards an improved understanding of tidal notch development: ten years of micro-erosion meter rates, Phang Nga Bay, Thailand

TRENHAILE A., PRESTANSKI K., PORTER N., GAGNON J.
Shore Platform and Cliff Notch Transitions along the La Paz Peninsula, Southern Baja, Mexico

GABRIEL S., OLIVEIRA S., HORTA J., MOURA D.
Rocky coast dynamics - comparison between shore platform and adjacent sandy beach

LIMBER P., MURRAY A.B., ADAMS P., GOLDSTEIN E.
Using beach and sea cliff dynamics to understand rocky coastline morphology, sea stacks, and headland amplitude

NUNES M., FERREIRA Ó., BAILY B., CALVÃO J.
Beach nourishment impact in receding soft rock coastal cliffs using remote sensing techniques (Forte Novo, south Portugal)

PEREZ-ALBERTI A.
Boulder mobility and shore platform erosion in southern Galicia, Northwestern Spain

PAPPALARDO M., CHELLI A., PANNACCIULLI F.G.
The role of biota in the weathering of microtidal shore platforms: first results from a new approach through case studies along the coast of NW Italy

STEPHENSON W., NAYLOR L., CHEN B.
Wave transformations across a macro-tidal shore platform

ROBINSON D., MOSES C.
Comparative rates of surface erosion of coastal engineering materials and of chalk and sandstone platforms, East Sussex, southeast England

S21C. OTHER SUBSESSIONS

Convenors: *Edward ANTHONY & Julian ORFORD*

STEPHAN P., SUANEZ S., FICHAUT B.
Long-, mid- and short-term morphological behaviours of gravel barriers: illustrations from the coast of Brittany (France)

BULTEAU T., BAILLS A., PETITJEAN L., GARCIN M., DE LA TORRE Y., PALANISAMY H., LE COZANNET G.
Potential and limitations of Bayesian networks for understanding shoreline mobility: an example in La Réunion island

MORISSETTE A., JOYAL G.
High resolution coastal evolution: dynamic profiles and geomorphological resilience beach index (GRBI)

MATIAS A., CARRASCO A.R., PACHECO A., LOUREIRO C., NUNES M., FERREIRA Ó., ARMAROLI C., MASSELINK G.
Longshore variation of overwash occurrence in a barrier island (Portugal)

GREEN A.N., COOPER J.A.G., SMITH A.M., SALZMANN L.
Longshore cell development in a boulder beach, Mission Rocks, South Africa

TILLMANN T., WUNDERLICH J.
Geomorphological development and sedimentary architecture and of two barrier islands (Sylt and Amrum/ German North Sea): Insights from ground-penetrating radar surveys and sedimentological data

MOORE L., DURAN O., WALTERS D., YOUNG D., FAGHERAZZI S., MARIOTTI G.
Ecomorphodynamic Feedbacks Determine Barrier Island Response to Climate Change

GIBEAUT J.
Projected Changes in Barrier-Island Wetland Distribution Caused by Sea-Level Rise

LIN T.Y., LOU J.Y., LIOU J.Y., HWUNG H.H.
Morphodynamics of barrier island evolution off SW Taiwan: An example from Wan-tzu-liao barrier, Tainan

HEQUETTE A., RUZ M.H., ANTHONY E.J., MARIN D.
Linking nearshore and coastal changes in the southwestern North Sea and Dover Strait: the role of tidal sand banks on coastline evolution

SHAH-HOSSEINI M., MORHANGE C., NADERI BENI A., ANTHONY E.
Study of strandplain evolution along the Iranian coast of Makran (north western Indian Ocean) with application of ground penetrating radar

CESCON A.L., COOPER J.A.G., JACKSON D.W.T.
Anegada Island, British Virgin Islands: a case study of beach ridges

FERNANDEZ G., BAPTISTA DA ROCHA T., RODRIGUES A.
Geomorphology and Internal Sedimentary Structure of Holocene Coastal Sandy Barriers along Rio de Janeiro Coast, Brazil

ZAGÓRSKI P., STRZELECKI M., SUPERSON J.
Post-Little Ice Age evolution of High Arctic paraglacial coasts in Svalbard

BRILL D., BRUECKNER H., JANKAEW K., KELLETAT D., SCHEFFERS A.
Morphogenesis of Phra Thong's beach-ridge plain (Thailand) ' the contribution of gradual processes and episodic events

VAN VLIET-LANOE B., HENAFF A., DELACOURT C., FERNANE A., GOSLIN J., HALLEGOUËT B., PENAUD A.
Middle to late holocene storminess record in western britany

MAY S.M., ENGEL M., BRÜCKNER H., PINT A., KELLETAT D., SCHEFFERS A., SQUIRE P.
Geomorphology, sedimentology and geochronology of cyclone-generated landforms and washover deposits along the coasts of NW Australia

VESPREMEANU-STROE A., TATUI F., CONSTANTINESCU S., PREOTEASA L., ZAINESCU F.
Storm Regime and Morphological Changes at Different Time Scales on the Romanian Black Sea Coast

PSUTY N., SCHMELZ W., SPAHN A., CHRISTIANO M.
Coastal Foredune Evolution Under Extreme Events: Superstorm Sandy

MASSELINK G.
New understanding and prediction of storm impacts on gravel beaches (NUPSIG project): roles of geomorphological investigation and numerical modelling

WINOWSKI M.
The impact of extreme and above average processes on morphodynamics of cliff slumps (Wolin Island - NW Poland)

EL TALIBI H., ZAGHLOUL M.N., ABOUMARIA K., WASSMER P., MERCIER J.L.
New insights on morphological and sedimentary evidences of high energy marine flooding along the Moroccan Atlantic coast

HART D.E.
Coastal multi-hazard cascades: how 12 seconds can reset baselines & trigger decades of coastal system adjustment

LEMCKERT C., COOPER A.
Extreme sea-level rise and adaptation options for coastal resort cities

FLOOD R., ORFORD J., TURNER J.
Holocene sedimentary processes in the West Bengal Sundarbans: facies dynamics in a peri-marine environment

ARISANTY D., SARTOHADI J., MARFAI M., SRI HADMOKO D.
The Influence of Tide for Suspended Sediment Transport in Barito River Delta, Southern Kalimantan, Indonesia

HUSEIN S.
Altération of delta morphology by channel abandonment processes at Mahakam delta, east Kalimantan, Indonesia

ZHANG Y.
Formation and evolution of the abandoned Yellow River delta

ANTHONY E.
Longshore drift and sand sequestering in river deltas

MAGDIEL LYDIA B.R., ORTIZ PEREZ M.A.
Temporal and spatial variability of coastal change on deltaic coast of Tabasco, Mexico

MASSUANGANHE E., WESTERBERG L.O., ACHIMO M.
Geomorphology and evolution of the Save River Delta plain, South-Centre Mozambique

GOSLIN J., VAN-VLIET LANOË B., HENAFF A., DELACOURT C., FERNANE A., HALLEGOUET B., PENAUD A., SUANEZ S.
A renewed Holocene relative sea-level envelope for Western Brittany (France): Global signal and local artefacts
RUZ M.H.
Incipient foredune development along macrotidal beaches, Northern France

LABUZ T.
Morphological types of foredunes in Poland as an indicator of coast trend changes

CHOI K.H., KIM Y.M., JUNG P.M.
Decrease of the supply of wind-blown sands in front of artificial pine forest in coastal dunes

PINHO J., GRANJA H., ALMEIDA E., HENRIQUE A., TEIXEIRA A., VIEIRA S.
Dune fences efficiency assessment on northern beaches of Portugal

CARTIER A., HÉQUETTE A., LARROUDE P.
The role of the inter-bar depressions in hydrodynamic and sediment transport processes of sandy macrotidal beaches

DAS MAJUMDAR D., PURKAIT B., PAUL A.K.

Dune Vulnerability and Management Strategy: A Case Study of West Bengal and Orissa Coasts, Bay of Bengal, India

SILINSKI A., HEUNER M., DAUWE S., PUIJALON S., TROCH P., BOUMA T.J., VAN BELZEN J., SCHÖDER U., FUCHS E., MEIRE P., TEMMERMAN S.
Interactions between waves, sediments and pioneer plants in tidal marshes: Results from a full scale flume experiment

BALKE T., JEUKEN M.C.J.L., HERMAN P.M.J., BOUMA T.J.
Biogeomorphic succession of mangroves: Basic knowledge to improve restoration and management of tropical mangrove coasts

JEANSON M., DOLIQUE F., ANTHONY E.
Mangrove evolution and morphodynamic processes in Mayotte Island (Indian Ocean)

WHITE A., HANLEY M.E., MASSELINK G., BLAKE W.H., HOGGART S.P.G.
A risky retreat: Fine-tuning projections of salt marsh development in managed realignment projects

ORFORD J.D., PETHICK J., KUMAR S.
Geomorphological responses of tidal islands and estuary channels to embankments: a paradox of sustainability and protection in the West Bengal Sundarbans

REGNAULD H., DAIRE M.Y., LOPEZ ROMERO E.
Evolution of the coastline of anthropised islands off Galicia and Brittany: Ons and Ushant

RANDAZZO G., LANZA S.
Shoreline evolution of Capo Peloro, the northernmost point of Sicily(Italy) : causes and temporary management

ARAÚJO M., MONGE SOARES A., CUNHA P.P., GOMES A., VIEIRA M.
Anthropic interference versus littoral dynamics: Aguda (Northern Portugal) breakwater, Holocene evolution and recent coastal erosion

TRAVALINI V., CUNHA C.M.L.D.
The relief cartography in coastal areas: a contribution to the environmental planning of Bertioga, Sao Paulo State, Southeastern Brazil

ETIENNE L., BOUAZIZ R., DAHECH S., DAOUD A., BELTRANDO G.
Coastline vulnerability in the Kerkennah archipelago between 1963 and 2010

DREJZA S., BERNATCHEZ P., DUGAS S.
Toward a prevention of coastal erosion in the Magdalen Islands, Quebec, Canada

OLLERHEAD J.
Geomorphic Changes at a Bay of Fundy Salt Marsh Restoration in New Brunswick, Canada

REED D.
Science in Support of Coastal Management: Developing Louisiana's 2012 Coastal Master Plan

CUROY J., MOSES C., ROBINSON D.
Influence of sediment recycling-recharging on mixed beach behaviour: a case study at Cayeux-sur-Mer, north France

JOLICOEUR S., BÉRUBÉ D., DESROSIERS M., O'CARROLL S.
Coastal squeeze: its assessment and integration within regional- and municipal-level planning tools

LOUREIRO C., FERREIRA Ó., COOPER A.
Embayed configuration and geological control on beach morphodynamics and management: an overview of contrasting responses in embayed beaches of southwestern Portugal

CARPENTER N., NICHOLLS R.J., DICKSON M.E.
Development of an Integrated Geomorphic Model of Soft Cliff Retreat: Investigating the effects of varying lithology in the vertical

GOMEZ-PUJOL L., ROIG-MUNAR F.X.

MONTREUIL A., BULLARD J., CHANDLER J.
Multi-temporal scale development of embryo dunes on an accreting macrotidal beach: North Linconshire, UK

TRINDADE J., RAMOS-PEREIRA A.
Predicting storm erosion impacts on exposed beaches

MARIE G., NEUMEIER U., LE ROUX A.
Influence of coastal geomorphology on boulder transport by ice in the St. Lawrence estuary (Quebec, Canada)

BISWAS B.
Changing Water Resources of West Bengal, India: A Micro level Study

ELMIMOUNI A., ANTHONY E., DAOUDI L.
Complex rotation of an embayed beach, Essaouira, Morocco

CLEMENTE SALAS L., MENANTEAU L., RODRÍGUEZ-RAMIREZ A.
Holocene evolution of coastal formations in the estuaries of the Guadalquivir and Tinto-Odiel (Gulf of Cadiz, SW Spain)

RAZAFIMBELO M.R., RATIARISON A.
Morondava, town in danger

SUANEZ S., FICHAUT B., COSTA S., DAVIDSON R., ARDHUIN F.
Morphological changes and dynamics of comet-tails in the Molène archipelago (Brittany, France)

LOCKOT G., HARTMANN K., WUENNEMANN B.
Quantifying disturbances of lake terraces at two lakes on the NE Tibetan Plateau

STEPHAN P., FICHAUT B., SUANEZ S.
Morphological evolution of the Sillon de Talbert gravel barrier spit (Brittany, France) since the 17e century: a challenge for coastal managment?

TATUI F., VESPREMEANU-STROE A.
Nearshore Sandbars Behavior on Danube Delta Coast

LYGIN A., MARUSIN K., LYGIN A., KHABIDOV A.
Prototype of the information system for coastal zone monitoring

NICOLAE LERMA A., THOMAS Y.F., ANDRADE C.A.
Water level modeling on micro-tidal beach, application of several wave breaking approaches

RUAULT R., REGNAULD H., TIERCELIN J.J., PROUST J.N., MOTTE E.
Geomorphological Evolution of the coastline in Baie d'Audierne (Western Brittany, France) and relation with changes in the land use

ALAM A.K.M., TALUKDAR A., AHSAN A.
Geological Exploration in the Coastal Zone of Bangladesh

CIAMPALINI A., FIDOLINI F., ANDREETTA A., CONSOLONI I., MORETTI S.
Evolution of quaternary coastal landscape in the Giglio Island (Tuscany, Italy)

PARK H.S., KWON M.S., JEON C.K.
Survey and analysis of coastal geomorphology using Terrestrial LIDAR in Kosrae, Federated States of Micronesia

FERNANDEZ G.
Morphological Evolution along the North Part of Paraíba do Sul River Delta, Rio de Janeiro Brazil

KARYMBALIS E., KOUGEMITROU E., GAKI-PAPANASTASSIOU K., TSANAKAS K., DRINIA H., ANTONARAKOU A., STATHOPOULOS V.
Geomorphic evolution of the Pinios River delta, in Central Greece, in the Late Holocene

DHORDE A., DHORDE A.

S22. SUBMARINE GEOMORPHOLOGY

Convenors: *Klaus SCHWARZER & Sebastian KRASTEL*

Oral presentations 923

S23. AEOLIAN SYSTEMS AND ARID GEOMORPHOLOGY (INCLUDING SUBARID MARGINS)

Convenors: *Xiaoping YANG & Martin WILLIAMS*

Oral presentations 937

ZHANG D., YANG X., NARTEAU C., ROZIER O.
Mean residence time in barchan dunes from numerical modelling

YAIR A.
Complex Geo-Ecological responses to climate change in dry-land areas: Northern Negev desert, Israel

DIETZE M., KLEBER A.
Dynamic stone pavements - insights from experiments and numeric modelling

HESSE P.
What makes Australian desert dunes so stable? Vegetation and sand transport response to variable rainfall

PERKINS J., FINNEGAN N.J., DE SILVA S.L.
The relative efficacy of wind and fluvial erosion of bedrock in northern Chile

BIEJAT K., DLUZEWSKI M.
Form-flow interaction of star dune arms

DLUZEWSKI M., BIEJAT K.
Sand bulk density as an indicator of form-flow interaction on barchan dunes

CAMMERAAT E., KAKEMBO V.
Vegetation change and geomorphological response of dryland hillsopes

BOURKE M., VILES H., CONWAY S., GOUDIE A.
Fog-induced slumping in a hyper-arid dunefield, Namibia

PAILLOU P.
The Kufrah paleodrainage system in Libya: Mapping the past from space

VEIT H., PREUSSER F.
The Southern Westerlies in Central Chile during the last glacial cycle as documented in coastal dunes and paleosols

WILLIAMS M., DULLER G., WILLIAMS F., MACKLIN M., WOODWARD J., EL TOM O., MUNRO N.
Causal links between Eastern Mediterranean sapropel formation, Nile floods and White Nile source-bordering dunes confirmed by OSL and radiocarbon dating.

FAUST D., WILLKOMMEN T., YANES Y., ZOELLER L., RICHTER D.
From dune accumulation to soil formation - Is climate change required?
KASSE C.
Climate change and sandy aeolian depositition during the Last Glacial Maximum and Late Glacial in northwest Europe with special reference to the Lutterzand type locality, eastern Netherlands

SEBE K., ROETZEL R., FIEBIG M., LÜTHGENS C.
Pleistocene cold-climate wind system in the foreland of the Pannonian Basin

LEHMKUHL F.
Timing and spatial distribution of loess-like sediments and late Quaternary alluvial fans in Mongolia and adjacent areas

PAIN C.
Landforms of the hyper-arid Northern Emirates, United Arab Emirates

BENAZZOUZ M., BOUREBOUNE L.
Morphoclimatic significance of eolian plugs on the northern margins of Sahara desert

SCUDERI L., WEISSMANN G., YANG X., KINDILIEN P.

YOON S.O., HWANG S., PARK C.S.
Geochemical properties of loess-paleosol sequence in the Haemi area, West Coast of South Korea

TIUMENTCEVA E.
Eolian denudation in the baikal region under conditions of climate aridity

ZHENG Y., WU Y., LI S.
Provenance analysis of aeolian sediments in the wide valleys of Middle Reaches of Yarlung Zangbo River in Tibet, China

YAN P., ZHENG S., GUO J., LI X.
Using a 3D laser scanner to monitor the wind erosion in wind tunnel test

LUZÓN A., RODRÍGUEZ-LÓPEZ J.P, PÉREZ A., SORIANO M.A., GIL H., POCOVÍ A.
Exceptional preservation of Pleistocene aeolian forms in an outwash plain. Central Ebro Basin (NE Spain)

ZOU X., WU X., ZHANG C., WANG R., ZHAO J.
The Effect of Wind Barriers on the Airflow Field in A Wind Tunnel

Active sand seas are a major source of desert loess
CROUVI O., AMIT R., ENZEL Y., GILLESPIE A.

CLAUDIN P., WIGGS G., ANDREOTTI B.
Field evidence for the upwind velocity shift at the crest of low dunes

MUNRO R.
Understanding the causes of increased sand influx at the Begrawiya (Meroe) pyramids archaeological site, Sudan: initial findings to support the implementation of a mitigation programme

ZHANG X., SUN T., XU J.
The Study of Relationship between Moving of the Farming-pastoral Boundary and Preaching of Catholic Church in Kalgan, Northern China

PAN M., WU Y., ZHENG Y.
Aeolian activity in DingJie area(southern Tibet, China)during Holocene

SRIJONO S., HENDRATNO A., HUSEIN S., FRESKY Y.
Recent development of coastal sand dunes, Parangtritis, Yogyakarta, Indonesia

GABARROU S., LE COZANNET G., PARTELI E., PEDREROS R., OLIVEROS C., BRIVOIS O., MULLER H., GUEBER E., MALLET C.
Modeling aeolian coastal dunes mobility in Aquitaine, South Western France

WIGGS G., WASHINGTON R., KING J., THOMAS D., WOODWARD S., ECKARDT F., HAUSTEIN K., BRYANT R., NIELD J., VICKERY K., MURRAY J., BRINDLEY H., JONES R.
Dust Observations for Models (DO4Models): Project Overview

VERSTRAETEN G., MOHAMED I., NOTEBAERT B.
More than 5000 years of interaction between aeolian, fluvial and anthropogenic systems in the central Egyptian Nile valley

MAMADOU I., GAUTIER E., BOUZOU-MOUSSA I., DESCROIX L.
Process and causes of neo-exoreism in Sahel: 'Koris' study case in the area of Niamey (Niger)

BRISTOW C., DULLER G.
The structure and development of a star dune, Lala Lallia, Erg Chebbi, Morocco

KATSUKI A.
Size distribution of barchan dunes with a cellular model

DE VET S., CAMMERAAT E.
Non-linear differentiation in fluid thresholds for wind-induced sediment mobilisation in low-pressure, high-altitude mountain environments

S24. TROPICAL GEOMORPHOLOGY

Convenors: *Vishwas KALE & Robert WASSON*

Oral presentations 969

Poster presentations 974

S24A. TROPICAL RIVERS: HYDRO-PHYSICAL PROCESSES, IMPACTS, HAZARDS AND MANAGEMENT (IGCP 582 AND IAG-WG)

Convenors: *Edgardo LATRUBESSE, Jose C. STEVAUX & Rajiv SINHA*

Oral presentations 983

S25A. GLACIAL AND PARAGLACIAL GEOMORPHOLOGY

Convenors: *Jasper KNIGHT & Stephan HARRISON*

Oral presentations 1005

KING E.
Contemporary sub-glacial landscapes: case studies from three Antarctic ice streams

KNIGHT J.
Subglacial processes and drumlin formation in west Connemara, Ireland

ITURRIZAGA L.
Last Glacial Maximum to Holocene glacial and paraglacial landscape reconstruction in the Cachapoal valley (Southern Central Andes, 34°22'S/70°05'W)

GALANIN A.
The age of the Last Glacial Maximum in the Asian North-East

GODLEWSKA A.
Differentiation of the younger saalian ice-sheet dynamics in the interfluve of the Krzna and Bug Rivers (E Poland))

BUSNELLI J.
The overlapping problem of paleoglacial and periglacial landforms under an evident scenario of global warming but a tectonic uplifting in the central Andes (Northwestern Argentina)

MARREN P., TOOMATH S.
Fluvial adjustments in response to glacier retreat: Skaftafellsjökull, Iceland

HIRSCH F., RAAB T.
Micromorphology and macrofabrics of Late Quaternary sediments in the Aragonese Pyrenees, Spain

GODON C., MUGNIER J.L., FALLOURD R., PAQUETTE J.L., POHL A., BUONCRISTIANI J.F.
The Glacier des Bossons protects Europe's summit from erosion

SANTOS-GONZALEZ J., REDONDO-VEGA J.M., GONZÁLEZ-GUTIÉRREZ R.B., GOMEZ-VILLAR A.
Determination of La Bana Lake (NW Iberian Peninsula) Origin using clast macro-fabric analysis

SANTOS-GONZALEZ J., SANTOS J., REDONDO-VEGA J.M., GONZÁLEZ-GUTIÉRREZ R.B., GÓMEZ-VILLAR A.
Till fabric and grain size analysis of glacial sequences in a complex paleoglacial system, the case study of the upper sil valley, cantabrian moutains, NW Spain

CARTURAN L., BARONI C., CARTON A., CAZORZI F., DALLA FONTANA G., DELPERO C., SALVATORE M.C., SEPPI R., ZANONER T.
Reconstruction of Late Holocene fluctuations of La Mare Glacier (Eastern Italian Alps): a combined approach

LEONELLI G., BOLLATI I., DIOLAIUTI G., MERLINI A., TROMBINO L., SMIRAGLIA C., ZERBONI A., PELFINI M.
The largest Italian valley glacier with little ice during the Sub-Boreal: evidences from a buried log in the Forni Glacier forefield

BATHRELLOS G., SKILODIMOU H., MAROUKIAN H.
The spatial distribution of cirques during Quaternary glaciations in Greece

BIERMAN P., CORBETT L., GRALY J., NEUMANN T., ROOD D., SHAKUN J., NELSON A.
The Greenland Ice Sheet erodes its bed some places but not in others

HAEMMIG C., KEUSEN H., HESS J., TOBLER D.
Early Warning of Glacial Lake Outburst Floods and Climate Change Monitoring in the Karakoram Mountains, P.R. China

HARRISON S.
The Glaciation of southwest England

ESKOLA T., PEURANIEMI V.
Glacial erosion in northern Ostrobothnia, Finlan

ESKOLA T., PEURANIEMI V.
Glaciomorphic depositional formations in northern Ostrobothnia, Finland

ROSSATO S., MOZZI P., MONEGATO G.
From minor to major: understanding the LGM Adige-Brenta-Astico glacial system in the eastern Southern Alps through the analysis of transfluence tongues

GEIGER A., FABEL D., GLASSER N.
Thickness constraints of the Patagonian Ice Sheet over the last glacial cycle using surface exposure dating

MALOWANY K., OSBORN G., MARTIN Y., MARSHALL S.
Modelling depth of river incision caused by meltwater discharge from the retreating Cordilleran Ice Sheet, Alberta, Canada

WANG J., KASSAB C., HARBOR J.M., CAFFEE M.W., CUI H., ZHANG G.
Cosmogenic nuclide constraints on Late Quaternary glacial chronology on the Dalijia Shan, northeastern Tibetan Plateau

YESILYURT S., DOGAN U., SENKUL C.
Glacier recession from 1955 to 2007 on Sat (Ikiyaka) Mountains, Southestern Anatolia, Turkey

RODRIGUEZ RODRIGUEZ L., JIMÉNEZ-SÁNCHEZ M., DOMÍNGUEZ-CUESTA M.J.
The Quaternary glacial maximum in the center of the Cantabrian Mountains (northern Iberian Peninsula): Aller-Nalón-Porma catchments

BERTHLING I., LANDSNES E., FREDIN O.
The Norwegian strandflat - glacial or periglacial erosion?

SAMYN D., GLASSER N.
Ice shelf structural and (geo-)statistical mapping: a case study using satellite imagery

GHEORGHIU D.M.
Surface exposure dating of rock slope failures in Northern Romania

S25B. PERMAFROST AND PERIGLACIAL GEOMORPHOLOGY (IN COOP. WITH IPA)

Convenors: *François COSTARD & Hugues LANTUIT*

Oral presentations 1031

KOKELJ S., TUNNICLIFFE J., LACELLE D., LANTZ T.
Assessing the factors that affect growth and propagation of 'mega-slumps' in Canada's Northwest Territories

LANTUIT H., FRITZ M., KRAUTBLATTER M., ANGELOPOULOS M., POLLARD W.
Retrogressive thaw slumps: structure, evolution and relevance to carbon cycle of the Arctic Ocean

SEJOURNE A., FEDOROV A., COSTARD F., GARGANI J., SKORVE J.
Important melting of ice-wedges and formation of thermocirques on slopes of thermokarst lakes in Central Yakutia (Siberia)

MORGENSTERN A., GROSSE G., ARCOS D.R., GÜNTHER F., OVERDUIN P.P., SCHIRRMEISTER L.
Thermo-erosional landforms in Siberian ice-rich permafrost

COSTARD F., GAUTIER E., FEDOROV A., KONSTANTINOV P., DUPEYRAT L.
A reassessment of the erosional potential of fluvial thermal process during ice breakups of the Lena river (Siberia)

GAGARIN L.
Features of suffosional processes in permafrost (Central Yakutia, Russia)

DWIGHT R., SCOTT D., MEIKLEJOHN I., MATCHER G., LEE J.
Thermal and Moisture Regimes in the Active Layer of Western Dronning Maud Land, Antarctica

ETZELMULLER B., LILLEOREN K.S.
Cold region geomorphology and Permafrost Evolution in the North-Atlantic region

Ice sheet - permafrost interactions inferred from landform and sedimentary structures, Weichselian Ice Sheet, Poland

VASILE M., VESPREMEANU-STROE A.
The influence of altitude, exposure and declivity on freeze-thaw processes in non-permafrost mountain areas: the Southern Carpathians, Romania

ANETAS G., BODIN X., SORUCO A.
Distribution and characteristics of mountain permafrost under the Tropics: insights from an inventory of rock glaciers on the Altiplano, Chile and Bolivia (20-22°S)

DEFIVE E., LE COEUR C., VIRMOUX C., PEIGNELIN C., POIRAUD A., GUNNELL Y.
Age and dynamics of blockstreams in the easthern velay highlands, Massif Central, France: preliminary findings

RAMAGE J., HUGELIUS G., PALMTAG J., LASHCHINSKIY N.
Phytomass and soil organic carbon inventories related to land cover classification and periglacial landscape features at Ari-Mas and Logata, Taimyr Peninsula

S25C. MOUNTAIN GEOMORPHOLOGY

Convenors: *Francesco BRARDINONI & Lothar SCHROTT*

Oral presentations 1049

KNIGHT J., GRAB S., MAYET N.
Lightning strikes and their influence on mountain geomorphology and sediment supply

SERRANO E., SANJOSÉ J.J., GONZÁLEZ-TRUEBA J.J.
Debris talus and cones dynamic in a calcareous Atlantic high mountain (Picos de Europa, Northern Spain)

GÖTZ J., SCHROTT L.
Holocene rockwall retreat in an inner-alpine headwater catchment (Gradenmoos Basin, Schober Mountains, Austrian Alps)

PAVLOVA I., ECKERT N., GRANCHER D., JOMELLI V., BRUNSTEIN D.
Geomorphological and climate context of debris flow regional occurrence in the Northern French Alps

GOLDIN B., CAVALLI M., BRARDINONI F., COMITI F., MARCHI L.
Geomorphic change detection using LiDAR DTMs in two small basins of the Italian Alps

COMITI F., DELL'AGNESE A., MAO L., ENGEL M., LUCÍA A., PENNA D., BERTOLDI G.
Temporal variations of bedload transport in a glacierized mountain basin

ROVERA G., CORONA C., LOPEZ SAEZ J., STOFFEL M.
Root-exposure: a new tool to quantify medium term erosion rates in gypsum areas (Massif de la Vanoise, France)

ANGEL I., CARCAILLET J., CARRILLO E., AUDEMARD F., BECK C.
Glacial chronology in the Mérida Andes, Venezuela, deduced from cosmogenic 10Be radionuclide dating

NISHII R., MATSUSHI Y., MATSUZAKI H.
Terrestrial cosmogenic nuclides dating of a sackung on a cirque in the Japanese Alps

PHARTIYAL B., SINGH R., NAG D., KOTHARI G.C.
Geomorphic landscape evolution along the river valleys in Ladakh region of NW Trans Himalayan range during Late Quaternary: implications to climate and tectonics

MORCHE D., BAEWERT H.
Consequences of a subglacial lake outburst flood for a proglacial fluvial system (Fagge River, Kaunertal, Austria)

The topographical factors in the formation of gully type debris flows in the upper reaches of Minjiang River

KLIMES J., VILIMEK V., EMMER A., COCHACHIN A.
Glacial lake outburst flood hazard assessment, example of the Palcacocha Lake, Cordillera Blanca, Peru

BOSSON J., UTZ S., LAMBIEL C.
Current evolution of high mountain glacier systems: the case of the Rognes and Pierre Ronde systems (St-Gervais, Mont-Blanc, France)

IKEDA A., ADACHI K., HATTANJI T.
Changes in hardness of rock surface as a result of weathering through the Holocene in an alpine area in Switzerland

SCAPOZZA C.
Evidence of paraglacial and periparaglacial crisis in the evolution of sediment transfer in the Southern Swiss Alps since the Last Glacial Maximum

STAUB B., DELALOYE R., LAMBIEL C.
Joint analysis of rock glacier kinematics and complementary permafrost monitoring elements observed in the Swiss Alps

ROJAN E., RACZKOWSKA Z., KALAFARSKI M., DLUGOSZ M., KACZKA R., GADEK B.
Avalanches in relation to relief of the Tatra Mountains

S26A. MODELLING IN GEOMORPHOLOGY

Convenor: *John WAINWRIGHT*

Oral presentations 1069

CHAPUIS M., DUFOUR S., PROVANSAL M., COUVERT B., DE LINARES M.
Coupling 3D hydraulic numerical modeling and field survey to assess morphodynamics of a wandering gravel bed river (Durance River, Southern French Alps)

CLAUDIN P., DURAN O., ANDREOTTI B.
Numerical simulation of turbulent sediment transport

ZHANG W., SCHNEIDER R., KOLB J.
Morphogenetic modelling of coastal foredunes

BURKOW M.
Numerical simulation of current driven sediment transport processes

RUIZ-VILLANUEVA V., DÍEZ-HERRERO A., BODOQUE J.M., BLADÉ E., SÁNCHEZ-JUNI M.
2D-Hydrodynamic modelling of large wood transport in rivers

CIAMPALINI R., FOLLAIN S., LE BISSONNAIS Y., DAVID M., COUTURIER A., WALTER C.
Modelling soil erosion on medium-term: the application of a landscape evolution model in a Mediterranean catchment

DOUVINET J., ESCUDIER A., DELAHAYE D., LANGLOIS P.
Flash floods susceptibility assessment through cellular automata modelling: a case study in northern France

BARKWITH A., WANG L., JACKSON C.R., HURST M., ELLIS M.
The dynamic cellular automata landscape evolution modelling platform CDP

CERDAN O., LE M., ROUSSEAU M., CORDIER S., LUCAS C.
Physically based modelling of soil erosion from the plot scale to the catchment scale

A. ALMODARESI S.A.
Space time substitution in geomorphology (modelling by rainfall)

CORREA E.A., PINTO S.D.A.F., MORAES I.C.
Analysis of methods of potential environmental fragility in a small sized watershed

ROUSSEAU M.(1), CERDAN O.(2), DELESTRE O.(3), DUPROS F.(2), CORDIER S.(4), JAMES F.(4)
Comparative study of overland flow modeling with different numerical resolutions

SILVA A., FERNANDES N.
Assessment of annual streamflow responses to different land use and land cover in a mountainous area of Rio de Janeiro, Brazil

BORYSIAK J., MAZUREK M., ZWOLINSKI Z.
Concept of sustainable management involves landscape geodiversity of hydrogeomorphological units: the Dębnica River, Poland

PINHEIRO L., CUNHA C.
The Importance of the USLE L Factor in Erosive Modeling: a Brazilian perspective

MERGILI M., GRUBER F.E., SCHNEIDER J.F.
A GRASS GIS model for high-mountain multihazard assessment at the regional scale

PASCULLI A., AUDISIO C., SCIARRA N.
Modelling river evolution: conceptual and numerical model on the river pellice (North-Western Italy)

DADSON S.
Estimates of river flows, floodplain inundation and land-atmosphere feedbacks in tropical African wetlands

MARCHESINI I., MERGILI M., SANTANGELO M., BUCCI F., CARDINALI M., ROSSI M., FELLIN W., GUZZETTI F.
A GRASS GIS-based deterministic model for the analysis of deep-seated slope stability in complex geology

ETTINGER S.
Using field data to evaluate modeling input parameters and attempt to include spatial distribution of flow bulking of lahars in three valleys at Cotopaxi volcano, Ecuador

WAINWRIGHT J., PARSONS A.J., COOPER J.R., LONG E.J., HARGRAVE G., KITCHENER B., HEWETT C., ONDA Y., FURUKAWA T., OBANA E., HAYASHI H., NOGUCHI T., PATIN J.
Innovative Modelling Techniques to Upscale Novel Field and Laboratory Estimates of Soil Erosion

MOHR C., ZIMMERMANN A., FRANCKE T., KORUP O., BRONSTERT A.
Robust interpolation techniques for estimating suspended sediment yields in logged catchments, south-central Chile

BRYSON L., HUGHES D.A., ROWNTREE K.M.
A Conceptual Understanding of Sedimentation in South African Catchments by a Sediment Flow Model

ANDERS N., SEIJMONSBERGEN H., BOUTEN W.
Evaluating landscape evolution models with object-based landform classifications

QUENEHERVE G., MÄRKER M., ZAKERINEJAD R.
Gully Development Assessment with Google Earth, GIS and Statistics

ROSCA S.M., PETREA D., IRIMUS I.A., SURDEANU V.
Methodological comparative assessment of the landslide susceptibility - case study: The Niraj River Basin (Transylvania depression, Romania)

FRANK F., MCARDELL B., DEUBELBEISS Y., HUGGEL C., KULL I.
Modeling debris flow erosion in Alpine Holocene debris fans: application to the Spreitgraben catchment, Switzerland

S26B. REMOTE SENSING (INCLUDING LASER SCANNING, APPLICATIONS OF RADAR, ETC.)

Convenors: *Thomas DEWEZ & Dirk RIEKE-ZAPP*

Oral presentations 1095

BARBOUX C., DELALOYE R., LAMBIEL C., STROZZI T., COLLET C., RAETZO H.
Differential SAR Interferometry in alpine geomorphology: Potential of this high precision technology for detecting and surveying landforms in mountain environment

GIULIANO J., DEWEZ T., GODARD V., LEBOURG T., MARCOT N.
Sea cliff erosion monitoring by boat-borne Laser-scanning

RAZAK K., QUAN LUNA B.
Airborne laser scanning of forested rock extraction: Airborne parameterizations, quality assessment, and rockfall modeling

TOBLER D., MEIER L., GRAF K.
Predicting Rock-Movements by Interferometric Radar Measurements

MOORMAN B., WHITEHEAD K., HUGENHOLTZ C.
The application of UAV's for high-precision glacial, periglacial and hydrological monitoring

ECHELARD T., KRYSIECKI J.M., SCHOENEICH P., GAY M.
Rockglacier movement detection by D-InSAR in French Alps using ERS archive data and TerraSAR-X data

DEWEZ T., MOSER S.
Time-lapse stereo-photogrammetric monitoring of volcanic slopes

GANCE J., MALET J.P., DEWEZ T., TRAVELLETTI J.
Continuous tracking of objects for characterizing landslide displacements from terrestrial images

BODIN X., DEROUX B., VACHER P., THIBERT E.
High-resolution quantification of mountain permafrost displacements: insights from Terrestrial Laser Scanning and image correlation techniques

ALHO P., KASVI E., VAAJA M., FLENER C., LOTSARI E., KUKKO A., KAARTINEN H., HYYPPÄ J., HYYPPÄ H.
Change detection of river channel utilising laser scanning, sonar survey and UAV-photogrammetry based bathymetric model

BENACCHIO V., PIEGAY H., MICHEL K., VAUDOR L.
Identification of factors disrupting remote bathymetry: experimental approach from ground imagery on the lower ain river (France)

SMITH M., PARON P.
Kite aerial photogrammety system for monitoring coastal change in the Netherlands

NINFO A., MOZZI P.
Integration of LiDAR and optical remote sensing for the study of fluvial and anthropogenic landforms in the Brenta-Bacchiglione alluvial plain (NE Italy)

DELGADO BLASCO J., MOHAMED I.L., VERSTRAETEN G., HANSSEN R.F.
The application of radar and optical remote sensing to analyse dune dynamics at the dune-field scale

QU_N_HERV_G., MÄRKER M., BACHOFER F.
Geophysics and Remote Sensing Data for the Detection of Soil Texture Distribution

DHORDE A., DHORDE A., KUMAR K.
Estimation of Surface Runoff for an Urbanized Watershed Using Satellite Data: A Case Study of Ramnadi Basin, Maharashtra, India

Poster presentations 1103

S26C - DEMs, GIS AND SPATIAL ANALYSIS

Convenors: *Takashi OGUCHI & Christopher GOMEZ*

Oral presentations 1117

GIS analysis as a tool for identification of preglacial large-scale landform assemblages and quantification of glacial erosional impact on northern shields

SAITO H., MURAKAMI W., DAIMARU H., OGUCHI T.
Effect of clear-cutting on landslide occurrences: Rainfall thresholds and topographic analysis at Mt. Ichifusa, Japan

GOMES R., MENKE A., GUIMARÃES R., CARVALHO JÚNIOR O.
Cluster analysis in watersheds using morphometric parameters in the state of Goiás, Brazil

HOŁUB B.
GIS application in morphometric-statistical analysis of relief in the upper Dniester River catchment (East Carpathian Foreland, Ukraine)

HART D.E., GOMEZ C., BEALING P.
Coastal Quakes: using global datasets to expose an underrated hazard

ETZELMULLER B., HJORT J., LILLEOREN K.S.
Landform prediction and environmental constraints ' examples and geomorphological implications

ASMARYAN S.
The ecological-geomorphological assessment of urban areas using GIS (a case study Yerevan)

VAN DE WIEL M., TEMME A.
Mass-Conservative Depression Removal from DEMs

LABUZ T., OSOCH P.
DTM models of coastal dune relief and dynamics as a tool for coast erosion and flooding prediction

ALEIXO C., RAMOS-PEREIRA A., TRINDADE J.
Dynamic effects of catchment morphology in the Alcabrichel estuary, Portuguese Estremadura

GOMEZ C., WASSMER P., STARHEIM C., HADMOKO D.S., LAVIGNE F.
Graph theory: the Ford and Fuklerson, and the Edmonds-Karp Algorithms to Model Dynamic Sedimentary Systems

NAUMENKO M.
Morphometric models of lake's bottom as necessary tool for limnological investigations

OCHIAI S., OGUCHI T., HAYAKAWA Y.S.
Morphometric analysis of alluvial fans and source basins for regions with different climates

HAEDKE H.
Multiscale Wavelet Analysis of ASTER DEM to detect geomorphologic and tectonic processes in the Gaxun Nur Basin, China

DOMINGUEZ-CUESTA M.J., JIMENEZ-SANCHEZ M., RODRIGUEZ-RODRIGUEZ L.
Visibility and optimal routes from the Roman Camp Site of Via Carisa, Cantabrian Mountains (Asturias, NW Spain)

SOUZA VALLADARES G., AQUINO R.P., CUNHA COELHO M.F.
Digital mapping of geomorphological features in a tropical semiarid climate of Ceará State, Brazil

MIGON P., KASPRZAK M.
Unexpected geomorphic features of a sandstone tableland revealed by LiDAR-derived DEM

PRASICEK G., KRAUS A., OTTO J.C., SCHROTT L.
Generation of morphometric semantics for automated mapping of geomorphological process domains

WLOSINSKA M., NIEDZIELSKI T., MIGON P.
A new method for estimating ocean reference depth

EISANK C., SMITH M., HILLIER J.
Supervised testing of segmentation for automated delimitation of landforms in DEMs

REULIER R., CAILLAULT S., DELAHAYE D., VIEL V.

Multi-agent modeling as a tool of spatial analysis for monitoring sediment fluxes

JAVIER L.(1), PHINN S.(2)
Measuring coral reef terrain roughness from a very-high resolution Digital Elevation Model (DEM) derived from Structure from Motion (SfM) Point Clouds

LAVARINI C., MAGALHÃES JR A.P., OLIVEIRA F.S.
Cluster Analysis of Watersheds as a Guideline for the Study and Sampling of Regoliths

GOMEZ-GUTIERREZ A., CONOSCENTI C., ANGILERI S.E., CARRASCO R.M.
Determining the optimal pixel size of topographical parameters for the prediction of hazardous geomorphological phenomenons of different magnitude: gullies and landslides

NINFO A., ZANONER T., GRUBER N., MASSIRONI M., CARTON A.
DSGSDs diagnostic landforms: a morphometric LiDAR based approach

MINGUEZ-MENENDEZ A., GARCIA-MELENDEZ E., MARTIN-SERRANO A., SUAREZ-RODRIGUEZ A., RODRIGUEZ-GARCIA A., RODRIGUEZ-FERNANDEZ R.
Study of the reference levels of erosional surfaces in the western Cantabrian Mountains and Montes de León (northwest Spain) through Digital Elevation Models

BYUN J., SEONG Y.B.
New Algorithm to Extract Longitudinal Stream Profiles (LSPs) based on unfilled DEMs

GHIRALDI L., BACENETTI M., MILLEMACI P., PEROTTI L., GIARDINO M.
Morphometric and morphotectonic indexes for quantitative geomorphology analysis of the Cannobino drainage basin (Piemonte, NW Italy)

AQUINO R.P., VALLADARES G.S., COELHO CUNHA M.F.
Geomorphological units and the risk of erosion in the central hinterland of Ceara, Brazil

DA SILVA SOUSA A., SOUSA A.
Fragility environmental analysis of River Basin Caulim - Sao Paulo/SP/Brazil

CARDOSO-LANDA G.
Application of a geographical information system to debris flows

S26D. STATISTICS IN GEOMORPHOLOGY

Convenors: *Ian EVANS & Delphine GRANCHER*

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UBER J.A., ZÊZERE J.L., SANTOS L.J.C.
Susceptibility analysis of landslide in the Bacia Do Marumbi (Morretes/PR) using bivariate and multivariate statistical methods

VERONESI F., HURNI L.
Automated geomorphological classification for the creation of rigorous shaded relief maps

VAUDOR L., PARROT E.
Interpreting wavelet-based decompositions of geomorphological features: the example of the Rhone river bathymetry

SCHMELTER M.
Accounting for uncertainty in fluvial geomorphology using Bayesian statistics

ECKERT N., LAVIGNE A., PAVLOVA I., THIBERT E., BEL L., GRANCHER D., PARENT E., JOMELLI V., NAVEAU P., BOREUX J.J.
Hierarchical Bayesian modelling for hydrological spatiotemporal mountain climate proxies

Poster presentations 1151

ROSSI M., MONDINI A.C., MARCHESINI I., SANTANGELO M., BUCCI F., GUZZETTI F.

Landslide morphometric signature

RAMOND S., GRANCHER D., GAUTIER E.
Statistical approach to analyze evolutions of statistical long-term hydrological data sets on the loire river (France)

DELUIGI N., LAMBIEL C., KANEVSKI M.
The discontinuous spatial distribution of Alpine Permafrost: an application of exploratory spatial data analysis

THOMMERET N., BAILLY J.S., BARDET J.M., KAISER B., PUECH C.
Robustness of fractal dimension estimators for vector talweg network characterization

DIETZE M., DIETZE E.
A flexible open-source toolbox for robust end-member modelling analysis - The R-package EMMAgeo

S26E - DATING METHODS (INCLUDING COSMOGENIC NUCLIDES)

Convenors: *Andreas LANG & Susan IVY-OCHS*

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AKCAR N., DELINE P., IVY-OCHS S., KUBIK P.W., SCHLÜCHTER C.
Surface exposure dating of rock avalanche deposits in the Ferret Valley (Mont Blanc massif, Italy)

MONGE SOARES A., CESÁRIO PORTELA P.J., MATOS MARTINS J.M., RAMOS PEREIRA A.
Age modelling of Mid-Holocene sedimentary sequences using a Bayesian approach

MUNYIKWA K., BROWN S., PLUMB E.
The utility of portable optically stimulated luminescence (OSL) readers in providing temporal contexts in clastic depositional systems: opportunities in geomorphology

SARIKAYA M., HIMMET H., ATTILA Ç.
Last Glacial Maximum glaciers on Akdağ, southwest Turkey, inferred from cosmogenic Cl-36 dating of moraines

SEONG Y.B., LEE S.Y., KIM D.E., CHOI K.H., YU B.Y.
A tragic flood but an invaluable opportunity to build a better model on catchment wide denudation rate (CWDR) using a pair of 10Be and 14C

WIRSIG C., IVY-OCHS S., ZASADNI J., AKCAR N., DELINE P., KOBER F., SCHLUCHTER C.
Timing of ice decay after the LGM in the high Alps

CORONA C., LOPEZ SAEZ J., STOFFEL M., BERGER F.
A continuous high-resolution 700-yr snow-avalanche chronology from the Queyras massif recorded from tree-ring and historical archives

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TILLMANN T., ZIEHE D., WUNDERLICH J.
Amino acid racemization analysis (AAR) as a successful tool for dating Holocene barrier island spit accretion: Examples of Southern Sylt (North Sea/ German Bight)

MAY S.M., BRÜCKNER H., HILGERS A., KELLETAT D., PÖTSCH S., RIXHON G., ZANDER A.
Investigations on anthropogenic shell accumulations in the Longotoma dune complex (central Chile) ' geochronological data and palaeoenvironmental context

CUNHA C., CONCEIÇÃO F.T.D., SIMON A.L.H., PEREZ FILHO A.
The land use interference on geomorphological aspects and sedimentation rates in the low course of the Piracicaba River basin, São Paulo State, Brazil

CLAUDE A., IVY-OCHS S., KOBER F., ANTOGNINI M., SALCHER B., KUBIK P.W.
Surface exposure dating of the Chironico landslide (Leventina valley, southern Swiss Alps)

CLAUDE A., AKÇAR N., IVY-OCHS S., GRAF H.R., KUBIK P., VOCKENHUBER C., DEHNERT A., MEINERT R., SCHLÜCHTER C.
Cosmogenic nuclide dating of Swiss Deckenschotter

REBER R., TIKHOMIROV D., AKÇAR N., YESILYURT S., YAVUZ V., KUBIK P.W., SCHLÜCHTER C.
Late Pleistocene Glacier advances in North Anatolia deduced from cosmogenic 10Be and 26Al

CSILLAG G., RUSZKICZAY-RÜDIGER Z., NOVOTHNY Á., THAMÓ-BOZSÓ E., FODOR L.I., BRAUCHER R.
Geochronology of Danube terraces in Hungary, using cosmogenic 10Be and luminescence dating

TSODOULOS I., STAMOULIS K., PAPACHRISTODOULOU C., IOANNIDES K., PAVLIDES S., CHATZIPETROS A., KOUKOUVELAS I.
Quantification of optically stimulated luminescence dating uncertainties based on the analysis of samples collected from a paleoseismological trench of an active fault in Central Greece

MESSERLI M., IVY-OCHS S., MAISCH M.
GIS-based geomorphological mapping, dating of selected landforms and landscape evolution during the Lateglacial and Holocene, in the region of Val Tuoi, Grisons, Switzerland

HUANG H., MAY J.H., FINK D., WRAY R., GU J.
Assessing processes and timescales of sandstone landscape formation in Zhangjiajie Geopark of China

GOLOSOV V., WALLING D., BELYAEV V.
Application of fallout radionuclides for investigating recent overbank sedimentation rates on river floodplains: potential and limitations

S26F - APPLIED GEOMORPHOLOGICAL MAPPING (IAG-WG)

Convenors*: Michael SMITH, Paolo PARON & Jim GRIFFITHS*

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SZEFLER K., TEGOWSKI J., NOWAK J.
Spectral properties of Southern Baltic bottom roughness

GRIFFITHS J.
Geomorphological mapping of an active landslide on the south-east coast of the Isle of Wight, U.K.

PANI P.
Geomorphological mapping of himalayan terrain using multi-sensor data: a case study of himachal pradesh, India

BUCCOLINI M., COCO L., ARINGOLI D., MATERAZZI M.
The influence of slope morphometry on erosion processes: the application of MSI (Morphometric Slope Index)

BOURENANE H., BOUHADAD Y.
Landslide susceptibility zonation using bivariate statistical analysis and GIS in Constantine city (North East of Algeria)

ISLAMI N.
Subsurface geomorphology of the North Kelantan Plain, as revealed by geoelectrical resistivity surveys

BARBOSA SOARES NETO G., SOUZA MARTINS É., VASCONCELOS V., LLACER ROIG H., B. J. MENEZES P.H.
Methodological procedures of digital geomorphological cartography in brazilian Central Plateau

NICULITA M.
Open Geomorphological Map. Romanian case study

Poster presentations 1173

BEN FRAJ T.

Geomorphological map of Northern Jeffara plain and North-eastern part of Matmata-Dahar plateau (Southeast Tunisia) 1/100 000

RAMOS A., CUNHA L., CUNHA P.
Geomorphological mapping applied to regional planning and geoheritage: study on Figueira da Foz Nazaré area (western central Portugal)

CUNHA E., BACANI V., FACINCANI E., SAKAMOTO A., LUCHIARI A.
Remote sensing and gis applied to geomorphological mapping of the watershed stream Indaia, MS, Brazil

BUZJAK N., PAHERNIK M., FAIVRE S., BOCIC N.
Geomorphological map of Croatia 1:100.000

MAILLARD B., REYNARD E., KUMMERT M., LAMBIEL C., THELER D.
The geomorphological map of the Hérens valley (Switzerland)

SCHOENEICH P., LAMBIEL C., BOSSON J.B.
Geomorphological map of the Diablerets massif - Swiss Alps

LAMBIEL C., MAILLARD B., MARTIN S., PELLITERO ONDICOL R., SCHOENEICH P., REYNARD E.
Adaptation of the geomorphological mapping system of the University of Lausanne for ArcGIS

MOEINI A., ALIZADE A., AHMADI H., ETEMAD V.
Survey the relationship between geomorphology and forest types (Case study: Kheirod forest, North of Iran)

DZIEDUSZYNSKA D., WACHECKA-KOTKOWSKA L.
The main geotouristic objects in the Lodz region (Central Poland)

Hydrogeomorphological mapping in hard-rock groundwater systems
TEIXEIRA J., FREITAS L., AFONSO M.J., ROCHA F., PEREIRA A.J.S.C., MARQUES J.M., CHAMINE H.I.

NGUYEN XUAN N.
Geomorphological analysis on the geological formations in downstream valley of the Da River, the Western Hanoi City, Vietnam

PARRY S.
Use the of engineering geomorphological mapping for landslide hazard assessments in Hong Kong

COMANESCU L., NEDELEA A., ZAHARIA L., SAFTOIU L.
Mapping flood vulnerability. Case study: Tecuci Town (Romania)

PIACENTINI T., MICCADEI E., DI MICHELE R., RANALLI O., SCIARRA M., URBANO T.
Multi-scale and multi-purpose Geomorphological Mapping for landscape evolution, geotourism, slope instabilities, and medical geology

PLATONOVA S.
Ecological-geomorphological features of transboundary interaction in the Irtysh river basin

GUITET S., RICHARD-HANSEN C., BRUNAUX O., CORNU J.F., CAROZZA J.M.
Geomorphology explains the regional beta-diversity of French Guiana rainforest and furnishes consistent maps to optimize forest management, regional planning and biodiversity conservation

REVELLINO P., GUERRIERO L., COE J.A., GRELLE G., GUADAGNO F.M.
Multi-temporal mapping of a large, slow-moving earth flow for kinematic interpretation

BINI M., BARONI C., RIBOLINI A., ANICHINI F., GATTIGLIA G., PARIBENI E.
A new interdisciplinary approach to build a geomorpho-archaeological map: the case study of the Versilia plain (NW Italy)

RODRIGUES S.C., MARTINS T.I.S.
Geomorphological Map of Piumhi Topographical Sheet (1:50.000) - Minas Gerais - Brazil

TERUGGI L.B., CHIAVERINI I., OSTUNI D., FARENGA M.
Database development for mapping fluvial channel variations: case study Cecina River (Central Italy)

BACENETTI M., PEROTTI L., GIARDINO M.

Using geospatial mobile applications and devices for geomorphological field data collection in mountain areas: a camparison test

EL GHACHI M., EL KHALKI YAHIA
Les inondations urbaines dans la ville de Khénifra (pied du Moyen Atlas occidental, Maroc) : caractérisation et cartographie

PEREIRA D., SANTOS L., PEREIRA P., SILVA J., HENRIQUES R.
Geomorphological units of Mainland Portugal: definition and mapping

TERUGGI L.B., MARIN E., CAPORALI E., VACCARO C., SALA S., KRISTENSEN M.J.
A GIS based interdisciplinary analysis of Río Quequén Grande watershed in Argentina

ZWOLINSKI Z.
Geomorphological mapping in Poland

KEESSTRA S., MARRUEDO ARRICIBITA A., LASSU T., SEEGER M.
Rainfall intensity, aggregate stability, shear stress resistance as parameters to evaluate soil erosion by water: an experimental study

S27. YOUNG GEOMORPHOLOGISTS SESSION

Convenors: *Etienne COSSART, Johnny DOUVINET & Stuart LANE*

Oral presentations 1189

LELEN M.
Morphometry of talus slopes in the high mountains methodological problems

PERRIER R., COSSART E., FORT M.
Thermal regime of ground surface in the French Southern Alps: a case study from the Clarée and Ubaye valleys

LOPEZ SAEZ J.
Recent contributions of dendrogeomorphology for the study of mass movements in an Alpine context

D'ARCY M., WHITTAKER A., RODA BOLUDA D., ALLEN P.
New constraints on landscape sensitivity to glacial-interglacial climate change: A detailed and quantitative record from debris flow deposits in Owens Valley, California

REULIER R., DELAHAYE D., VIEL V., CAILLAULT S., ABDELKRIM B., DAVIDSON R.
Study of the spatial interactions in the hydrosedimentary transfers on agricultural watershed

CARABALLO ARIAS N., CONOSCENTI C., DI STEFANO C., FERRO V.
Morphometric analysis of two calanchi areas in Sicily (Italy) by exploiting high resolution Digital Elevation Models

NURWIHASTUTI D., NURWIHASTUTI D.W., SARTOHADI J., MARDIATNO D., NEHREN U.
Spatial Correlation between Geomorphological and Subsurface Characteristics: A Case Study of Bantul, Yogyakarta, Indonesia

SAMSONOVA S.
Geomorphic mapping for environmental management in urban areas (case study of Moscow parks)

SEKARSARI P., GURNEL A.M., HENSHAW A.J., ZOLEZZI G.
Exploring geomorphic and vegetational features of low energy rivers using GoogleTM Earth

CREPY M., CALLOT Y.
Typology of eolian landforms of South Kharga oasis (Western Desert of Egypt): original evolution models and local specificities of Saharan loess deposits

Poster presentations 1194

MANDAL S., SARKAR S., BOSE P.K.
Tectonic sway on alluvial fan trilogy at Himalayan foothills

STARHEIM C., GOMEZ C., DAVIES T., OWENS I., HADMOKO D.S., WASSMER P., LAVIGNE F.
Identifying complex internal architecture in debris flow and lahar deposits using ground penetrating radar

MAKANZU IMWANGANA F., MOEYERSONS J., NTOMBI M.
The use of a rain simulator as an infiltrometer at Kinshasa (D.R. Congo)

CESCON A.L., COOPER J.A.G., JACKSON D.W.T.
Spatial distribution of beach ridges in the Intra-Americas Seas islands: a supervised manual investigation using Google Earth

ZOUVA C., GAKI-PAPANASTASSIOU K.
A methodological framework for the spatial decision support of the management of coastal wetlands

GIL H., SORIANO M.A., LUZÓN A., PÉREZ A., POCOVÍ A.
Interaction of tectonic, karstic and sedimentary processes in Early Pleistocene deposits (central Ebro Basin, NE Spain)

BRISSET E., MIRAMONT C., GUITER F., TROUSSIER T., ANTHONY E., ARNAUD F.
Lake Allos: a 12,000 year reference record of past climate-Human-environment interactions in the Mediterranean French Alps

HAQUE N., SHAMSUZZAMAN .., RAHMAN M.A., EKRAM A.R., UDDIN N., HASAN F.
Geomorphology of Sylhet City, Bangladesh - for Sustainable Urban Planning

ADAM A.
Assessing the impact of the pipeline on the swamp geosystems

WERB S., DELGADO J.M., BRONSTERT A.
Modelling sediment transport: Evaluating the effects of spatially refined input data

GO A., TANAKA Y., KASHIMA K.
Sedimentary environment of Hwajinpo lake using diatom analysis

SANDER L., KABUTH A.K.
I just can't put my finger on it! Understanding coastal lagoon systems from remotely sensed data - A case-study comparison from Denmark and Argentina

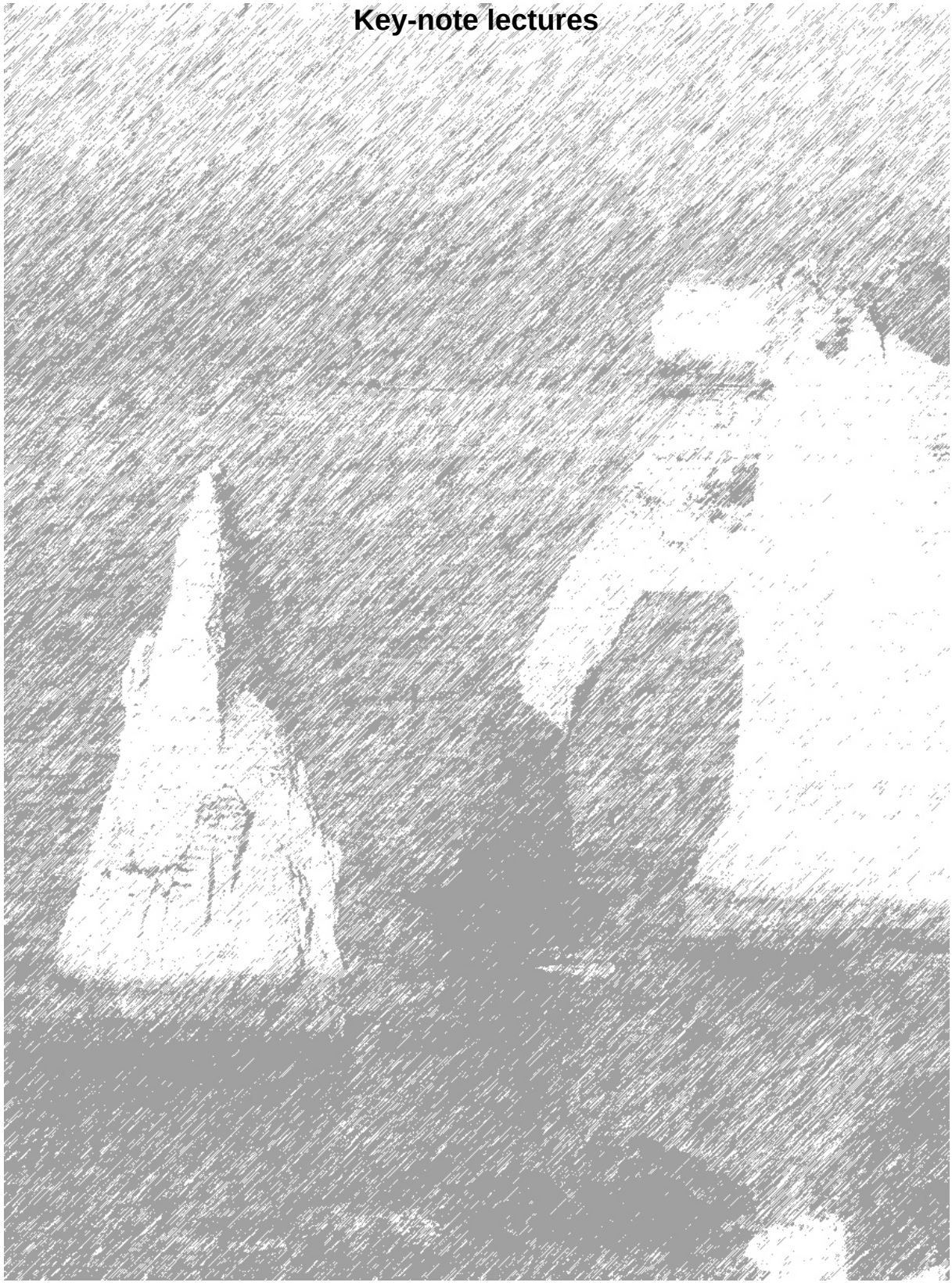
CHMIELOWSKA D.
Characteristcs of loam deposits as indicators of their sedimentary environment in the Late Glacial, example from Nowy Targ-Orava Basin, southern Poland

LINOIR D., THOMACHOT-SCHNEIDER C., FRONTEAU G., MALAM ISSA O., BARBIN V.
Hydric properties of carbonates accumulation horizons in Chalky Champagne (NE of Paris Basin, France)

MAJEWSKI K.
Application of terrestrial digital photography and free computer software in generating digital terrain models and geomorphological analysis

LI S., ZHANG K.
Research on the relationship between alluvial fans and the mountain uplift in Northwestern China based on GIS technique

Key-note lectures



Geomorphology of Ethiopia and Human Origins

ASFAWOSSEN ASRAT
SCHOOL OF EARTH SCIENCES, ADDIS ABABA UNIVERSITY, P. O. BOX 1176, ADDIS ABABA, ETHIOPIA (asfawossen.asrat@aau.edu.et; asfawossena@gmail.com)

Ethiopia is endowed with unique geomorphologic setting where the great East African Rift bisects the uplifted Ethiopian highlands, leading to diverse geomorphologic processes resulting in equally diverse landforms. Ethiopia has also proved to be the true “cradle of humanity” where more than 90% of the Australopithecus afarensis sp. discovered so far (including the famous A. Afarensis, “Lucy”) are from Ethiopia. Furthermore, the earliest fossil remains of H. sapiens have been found in Ethiopia dating back to 195 ka, and to between 160 and 154 ka suggesting that East Africa was the likely region of the origin of our species. Many archaeological, palaeontological and geological evidences also suggest that Early Modern Humans expanded their geographical range throughout the rest of the world starting from eastern Africa as of ca. 125 Ka. However, the environmental context of these discoveries has not been fully assessed. This paper postulates and shows that the geomorphological setting of Ethiopia played a significant role in human origins and dispersal by modulating the environmental (ecological) setting and local climatic conditions. Geological, Geomorphologic, palaeoanthropological and archaeological data from all over eastern Africa are reviewed and presented. High resolution palaeoclimatic data from lake and speleothem archives are used to interpret the environmental context of human origins and dispersal. This paper further shows that geomorphology of the country, i.e., the isolation of the northwestern highlands (where the political centers of the country have been located) from the external world by the harsh Afar depression close to the sea, determined the route of Ethiopian civilization and history.

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La Géomorphologie de l’Éthiopie et les Origines de l’Homme

ASFAWOSSEN ASRAT
SCHOOL OF EARTH SCIENCES, ADDIS ABABA UNIVERSITY, P. O. BOX 1176, ADDIS ABABA, ETHIOPIA (asfawossen.asrat@aau.edu.et; asfawossena@gmail.com)

L'Ethiopie bénéficie d’un contexte géomorphologique exceptionnel. À cheval sur le grand Rift Est Africain qui scinde en deux les hauts plateaux éthiopiens soulevés, cette situation induit des processus géomorphologiques divers, se traduisant par des formes de relief tout aussi diverses. Il est désormais acquis que l'Ethiopie est le véritable «berceau de l'humanité", où plus de 90% des Australopithecus afarensis sp. ont été découverts à ce jour (y compris la célèbre «Lucy», A. afarensis). De plus, les premiers restes fossiles de Homo sapiens trouvés en Ethiopie remontent à 195 ka, d’autres sont d’âge compris entre 160 et 154 ka, ce qui laisse à penser que l'Afrique de l’Est est probablement bien la région d’apparition de notre espèce. De nombreux témoignages archéologiques, paléontologiques et géologiques suggèrent également que les premiers hommes modernes ont, à partir de ca. 125 ka, élargi leur emprise spatiale depuis l'Afrique orientale à travers le reste du monde. Toutefois, le contexte environnemental de ces découvertes n'a pas été pleinement évalué. Cette présentation émet l’hypothèse et montre comment le cadre géomorphologique de l'Ethiopie a joué un rôle important dans les origines de l'Homme et de sa dispersion, en offrant des conditions écologiques modulées par l’étagement des milieux et des conditions climatiques locales favorables. Les données géologiques, géomorphologiques, paléoanthropologiques et archéologiques de toute l'Afrique de l'Est sont examinées et présentées. Le recours aux archives paléoclimatiques de haute résolution telles que les sédiments lacustres et les spéléothèmes permet d’interpréter le contexte environnemental des origines de l'Homme et de sa dissémination. Cette présentation montre en outre comment la géomorphologie du pays, notamment l’existence en bordure de mer de la dépression de l'Afar, quasi inhabitable, a conduit à l'isolement du reste du monde de la région montagneuse du nord-ouest –là où se trouvent les centres politiques du pays-, déterminant ainsi la voie de la civilisation éthiopienne et de son histoire.

Tales from the deep

BRUNSDEN DENYS
KING'S COLLEGE, LONDON
(brunsden@chideock.co.uk)

A conference entitled 'Seismic Geomorphology,' held in Houston, Texas in 2009, was organized by the geophysical profession, the petroleum industry and the Geological Society of London. It was advertised with the words:-

"We are poised to embark on a new era of discovery in the study of geomorphology. The discipline has a long and illustrious history, but in recent years an entirely new way of studying landscapes and seascapes has been developed."

This paper discusses this significant challenge to our discipline from outside our area of expertise. The central point is that we probably know more about the surface of the Moon or Mars than we do about the ocean floor. Of course we have an excellent general picture at a large scale but only where there are industrial, conservation or oceanographic imperatives have specifically commissioned detailed studies been carried out. Perhaps only < 2% of the sea floor is known at high resolution.

Yet, the sea floor occupies 71% of the Earth's surface, some 361,419,000 km2. It is truly the last geomorphological frontier. This paper attempts the to describe some of the problems we face as we attempt to describe, in detail, this huge area, it's landforms and processes for the first time.

Geomorphology is now routinely included in sea floor surveys but the work is mainly carried out by oceanographers, geophysicists, geologists, sedimentologists, geomechanics or geo-chronological experts. Few geomorphologists have the software or interpretation skills required.

Primary interests for geomorphological inputs are planning data acquisition programs, site characterization, interpreting ground conditions, sediment transfer systems, geohazards identification and risk evaluation all set within the frameworks of palaeo-oceanography and contemporary met-ocean research.

The lecture cannot cover all of these fields or indeed 71% of the planet. It therefore concentrates the morphological aspects that can be contributed to the inter-disciplinary teams. Any specialist will know that many spectacular technical advances are not discussed. Instead the lecture concentrates on geomorphological problems, grand visions and conceptual developments.

Brief examples of ocean floor discovery and current technical capability are followed by outlines of environmental, structural, tectonic controls of ocean landforms and sediment transfer systems; the nature of onshore-offshore connections, environmental change and biodiversity. Emphasis is placed on geomorphological mapping of the sea floor.

Critical discussions include:

- The types, distribution and scales of ocean floor processes.
- The process controls, causative factors, triggers and recurrence intervals of events.
- The nature of landform inheritance and multi-cyclicity.
- The influence depth of sea level change.
- The nature of high energy events, new benthic storm processes.
- Event calibration and
- The sea floor as a record of the continents.

World- wide examples are used in illustration.

The paper also outlines eight primary tasks for offshore process geomorphology.

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Histoires des profondeurs

BRUNSDEN DENYS
KING'S COLLEGE, LONDON
(brunsden@chideock.co.uk)

La conférence intitulée «Géomorphologie sismique", qui s'est tenue à Houston (Texas) en 2009, avait été organisée par les géophysiciens professionnels, l'industrie pétrolière et la Société Géologique de Londres. On en avait fait la publicité en ces termes: "Nous sommes prêts à nous engager dans une nouvelle ère de découvertes grâce aux études de géomorphologie. Cette discipline a non seulement une histoire longue et illustre, mais elle a aussi, au cours des dernières années, développé une toute nouvelle façon d'appréhender les paysages terrestres et marins. "

Cet exposé aborde ce grand défi pour notre discipline, dans un champ jusque là en dehors de notre domaine d'expertise. Le point central est que nous en savons probablement plus sur la surface de la Lune ou de Mars que sur le plancher océanique. Certes, nous avons une excellente connaissance générale à petite échelle, mais seulement là où les impératifs industriels, océanographiques ou de conservation ont spécifiquement requis la réalisation d'études détaillées. Peut-être <2% seulement de la surface de la mer sont connus avec une haute résolution. Et pourtant, le fond des mers occupe 71% de la surface de la Terre, soit 361.419.000 km2, et c'est pourquoi il constitue vraiment la dernière frontière géomorphologique. Cette présentation vise à décrire quelques-uns des problèmes auxquels nous, en tant que géomorphologues, sommes confrontés alors que nous tentons de décrire, en détail et pour la première fois, ce vaste espace, ses reliefs et ses processus.

La géomorphologie est désormais systématiquement incluse dans les recherches sur le plancher océanique, mais le travail est principalement effectué par des experts océanographes, géophysiciens, géologues, sédimentologues, géomécaniciens ou géo-chronologistes. Rares sont les géomorphologues qui ont les compétences requises en terme de logiciels ou d'interprétation.

Dans le cadre de recherches contemporaines menées en paléo-océanographie et sur les relations météorologie-océanographie, les apports majeurs de la géomorphologique sont les suivants : la planification des programmes d'acquisition de données, la caractérisation du site, l'interprétation des conditions au sol, les systèmes de transfert des sédiments, l'identification des risques géologiques et l'évaluation des risques.

Cette conférence ne peut couvrir tous ces domaines, ni 71% de la planète. Elle se concentrera donc sur les aspects morphologiques qui peuvent contribuer de façon importante aux équipes interdisciplinaires. On ne discutera pas des nombreux progrès techniques spectaculaires réalisés. On insistera en revanche sur les problèmes géomorphologiques posés, les visions d'ensemble et les développements conceptuels.

Après l'exposé rapide d'exemples de découvertes actuelles du plancher océanique et des capacités techniques en cours, on présentera les facteurs environnementaux, structuraux et tectoniques qui conditionnent les reliefs océaniques, ainsi que les systèmes de transfert des sédiments, la nature des connexions continent-océan, les changements environnementaux et la biodiversité. L'accent sera mis sur la cartographie géomorphologique des fonds marins.

Plusieurs éléments de discussion critique porteront sur :

- Les types, la distribution et les échelles de processus agissant au niveau du plancher océanique.
- Les facteurs de contrôle des processus, les facteurs de déclenchement, et les intervalles de récurrence des événements.
- La nature des héritages géomorphologiques et de la multi-cyclicité.
- La profondeur de l'influence de la variation du niveau marin.
- La nature des événements à haute énergie et des nouveaux processus de tempêtes benthiques.
- L'étalonnage de l'événement et
- Le fond de la mer comme enregistrement de tous les continents.

La conférence sera illustrée par des exemples choisis dans le monde entier.

On terminera par la définition des huit principales tâches à mettre en œuvre pour une géomorphologie des processus sous-marins.

Spatially non-uniform landscape evolution and process-operations around the Tropic of Capricorn: the role of extreme rainfall events.

COELHO-NETTO ANA-LUIZA
LABORATORIO DE GEO-HIDROECOLOGIA, INSTITUTO DE GEOCIENCIAS, DEPARTAMENTO DE GEOGRAFIA,
UFRJ-UNIVERSIDADE FEDERAL DO RIO DE JANEIRO JANEIRO, BRAZIL
(ananetto@acd.ufrj.br)

Classical geomorphology valued the relationships between bio-climatic zoning and the dominant morphogenetic evolutionary pattern. Humid Tropical landscapes were seen as related to slow and progressive chemical denudation to form the so-called etchplanation. Long term field studies in SE-Brazil, however, provide evidences of highly discontinuous processes operations and evolutionary patterns both on space and time. At middle Paraiba do Sul river valley, i.e., stratigraphic data and absolute dating together with hillslope morphological characteristics and weathering-transport relationships, point out the dominance of mechanical denudation (by gullying due to delayed responses of seepage erosion relative to regional rainfall inputs and consequent landslides) over chemical denudation in some major tributary basins draining serra do Mar, but not at all major tributary basins draining serra da Mantiqueira where chemical denudation landforms still prevail. The underlying bedrock and inherited tectonic structures, together with basin relief seems to explain such variations in the hilly lowlands. In contrast, all mountainous compartments are quite vulnerable to mechanical denudation especially related to gravitational transport (mass movements). Wet seasons and extreme rainfalls are usually associated with fast movements by shallow landslides, rock fall and debris flows that may cause disasters. The very extreme landslide disaster from January 2011 spread over large areas of the mountainous domain in Rio de Janeiro state causing more that 1,500 deaths and intense social, environmental and economic losses. Facing the magnitude of landscape changes in response to this climatic event, one might consider the relevance of very extreme rainfall inputs on landscape evolution in mountainous areas but not necessarily in the complex hilly lowlands as it will be discussed in this lecture.

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Evolution de paysage spatialement non-uniforme et action des processus autour du Tropique du Capricorne : le rôle des événements pluviométriques extrêmes.

COELHO-NETTO ANA-LUIZA
LABORATORIO DE GEO-HIDROECOLOGIA, INSTITUTO DE GEOCIENCIAS, DEPARTAMENTO DE GEOGRAFIA,
UFRJ-UNIVERSIDADE FEDERAL DO RIO DE JANEIRO JANEIRO, BRAZIL
(ananetto@acd.ufrj.br)

La géomorphologie classique insiste sur les relations entre les zones bio-climatiques et le modèle dominant de l'évolution morphogénétique. Les paysages tropicaux humides ont été considérés comme étant le produit d'une dénudation chimique lente et progressive, ce que l'on a appelé "etchplanation". Des études de terrain sur le long terme, menées dans le SE-Brésil, ont cependant apporté la preuve qu'il existe des actions discontinues, dans l'espace et le temps, des processus et des séquences d'évolution. Dans la moyenne vallée du Paraiba do Sul, à partir des données stratigraphiques et de datations absolues, combinées aux caractéristiques morphologiques des versants et aux relations météorisation-transport, on a pu mettre en évidence la prédominance de la dénudation mécanique sur la dénudation chimique : érosion par ravinement, liée aux actions de soutirage différé par rapport aux entrées pluviométriques régionales, et érosion par glissements de terrain. Ceci a été observé dans certains bassins tributaires majeurs qui drainent la Serra do Mar, mais en revanche pas dans tous les grands bassins tributaires de la Serra da Mantiqueira, où la dénudation chimique l'emporte encore. Le socle rocheux sous-jacent et les structures tectoniques héritées, en même temps que l'amplitude topographique des bassins, semblent expliquer de telles variations dans les bas plateaux vallonnés. En revanche, tous les secteurs de montagne sont très vulnérables à la dénudation mécanique, en particulier au transport gravitaire (mouvements de masse). La saison des pluies et les précipitations extrêmes vont généralement de pair avec le développement de glissements de terrain rapides et superficiels, d'éboulements et de coulées de débris qui peuvent engendrer de vrais désastres. Tel fut le cas en Janvier 2011, où se produisit une catastrophe extrême caractérisée par des mouvements de terrain qui ont affecté de vastes zones du domaine montagneux de l'Etat de Rio de Janeiro, et ont causé plus de 1.500 morts ainsi que d'immenses pertes socio-économiques et environnementales. Face à l'ampleur des changements engendrés dans le paysage en réponse à cet événement climatique, on doit s'interroger sur le rôle des apports pluviométriques extrêmes sur l'évolution du paysage dans les zones de montagne, rôle pas nécessairement aussi important dans les bas plateaux vallonnés complexes, comme il sera discuté dans cette conférence.

Geomorphology of earth-like planetary surfaces

BAKER VICTOR R.
DEPARTMENT OF PLANETARY SCIENCES, THE UNIVERSITY OF ARIZONA, TUCSON, ARIZONA, 85721, USA
(baker@email.arizona.edu)

Recent advances in astronomy hold the prospect for the discovery of a great many Earth-like planets, rich in both water and possible habitats for life. Nevertheless, until it proves possible to do the geomorphology for these potential exo-Earths, we can greatly advance the science of Earth-like planetary surfaces through studies in our own solar system. Recent discoveries from Mars missions reveal the extensive role of water in shaping ancient Martian landscapes, including the formation of channels and valleys, alluvial fans and deltas, aqueous weathering products (clay minerals and sulfates), glacial and periglacial features, paleolakes, and even a probable, though transient ancient ocean. The surface of Saturn's moon Titan has extensive networks of fluvial features, but the responsible fluid is methane, which seems to be cycled on Titan in much the same way that water is on Earth. Venus has a spectacular variety of volcanic features, including some that mimic aspects of fluvial landscapes. Such discoveries are leading to the recognition of the importance for Earth itself of processes, features and relationships that are better displayed on other planetary surfaces, including important roles for impact cratering, large-scale volcanism, and megaflooding.

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Géomorphologie des surfaces planétaires telluriques

BAKER VICTOR R.
DEPARTMENT OF PLANETARY SCIENCES, THE UNIVERSITY OF ARIZONA, TUCSON, ARIZONA, 85721, USA
(baker@email.arizona.edu)

Les progrès récents de l'astronomie entretiennent la perspective de découverte d'un grand nombre planètes telluriques, riches en eau et recelant des habitats de vie possibles. Néanmoins, avant qu'il ne s'avère possible d'étudier la géomorphologie de ces exo-Terres potentielles, nous pouvons faire beaucoup progresser la planétologie à partir d'études dans notre propre système solaire. Les découvertes issues des récentes missions sur Mars révèlent le rôle important de l'eau dans le façonnement des paysages martiens anciens, avec notamment la formation de chenaux et de vallées, de cônes alluviaux et de deltas, de produits de météorisation hydratés (minéraux argileux et sulfates), des traces de façonnements glaciaires et périglaciaires, de paléo-lacs, et même un probable, bien qu'éphémère océan antique. La surface de Titan, lune de Saturne, possède de vastes réseaux de systèmes fluviaux, mais le fluide responsable en est le méthane, qui semble sur Titan être recyclé pour une large part de la même manière que l'eau l'est sur Terre. Venus présente une variété impressionnante de formes volcaniques, dont certaines prennent même les apparences de paysages fluviaux. Ces découvertes amènent à prendre en considération, pour la Terre elle-même, des processus, des formes et des interactions qui sont mieux mis en évidence sur d'autres surfaces planétaires, ceci afin de mieux comprendre en particulier leur rôle dans la formation des cratères d'impact, du volcanisme à grande échelle, et des crues géantes terrestres.

Geomorphology and palaeoenvironmental changes in arid Asia

XIAOPING YANG
INSTITUTE OF GEOLOGY AND GEOPHYSICS, CHINESE ACADEMY OF SCIENCES, P.O. BOX 9825, BEIJING 100029, CHINA.
(xpyang@mail.igcas.ac.cn)

Located in the interior of the largest continent, Eurasia, the arid regions of Asia are distributed in a wide range of tectonic settings, from 155 m below sea level to more than 5000 m above sea level. Under dynamic fluvial, aeolian, lacustrine processes and the interactions between those, a great diversity of landforms occurs in these arid regions, with a high percentage of active sand seas in the desert landscape. This lecture reviews our current understanding of formation and Quaternary changes of these desert landscapes, a key portion of the middle-latitude drylands on Earth. Combining earlier studies with our recent work, we aim to offer a comprehensive picture of the formation of the diverse desert landforms and their Quaternary changes and identify knowledge gaps. Here we focus on two aspects: formation of megadunes and late Quaternary environmental changes in the deserts of northern China. Our field sites refer mainly to the Tarim Basin of southern Xinjiang, the Alashan Plateau of western Inner Mongolia and the Hunshandake Sandy Land of eastern Inner Mongolia, all characterized by occurrences of sand dunes at present time. Our geophysical investigation of dune bodies in the Badain Jaran Desert of western Inner Mongolia reveals that the height of dunes is highly sensitive to local geology and interactions between changing climate conditions, both of these aspects have been neglected in the studies of the dune formation so far. Our recent palaeoenvironmental investigations confirm that great geomorphological, climatic and hydrological changes have taken place in these regions during the Late Quaternary, and the extent and intensity of human activities in these drylands during some periods of the Holocene were surprisingly greater than previously assumed. The acute risk of some potentially unsustainable land management practices in these drylands will be briefly discussed also.

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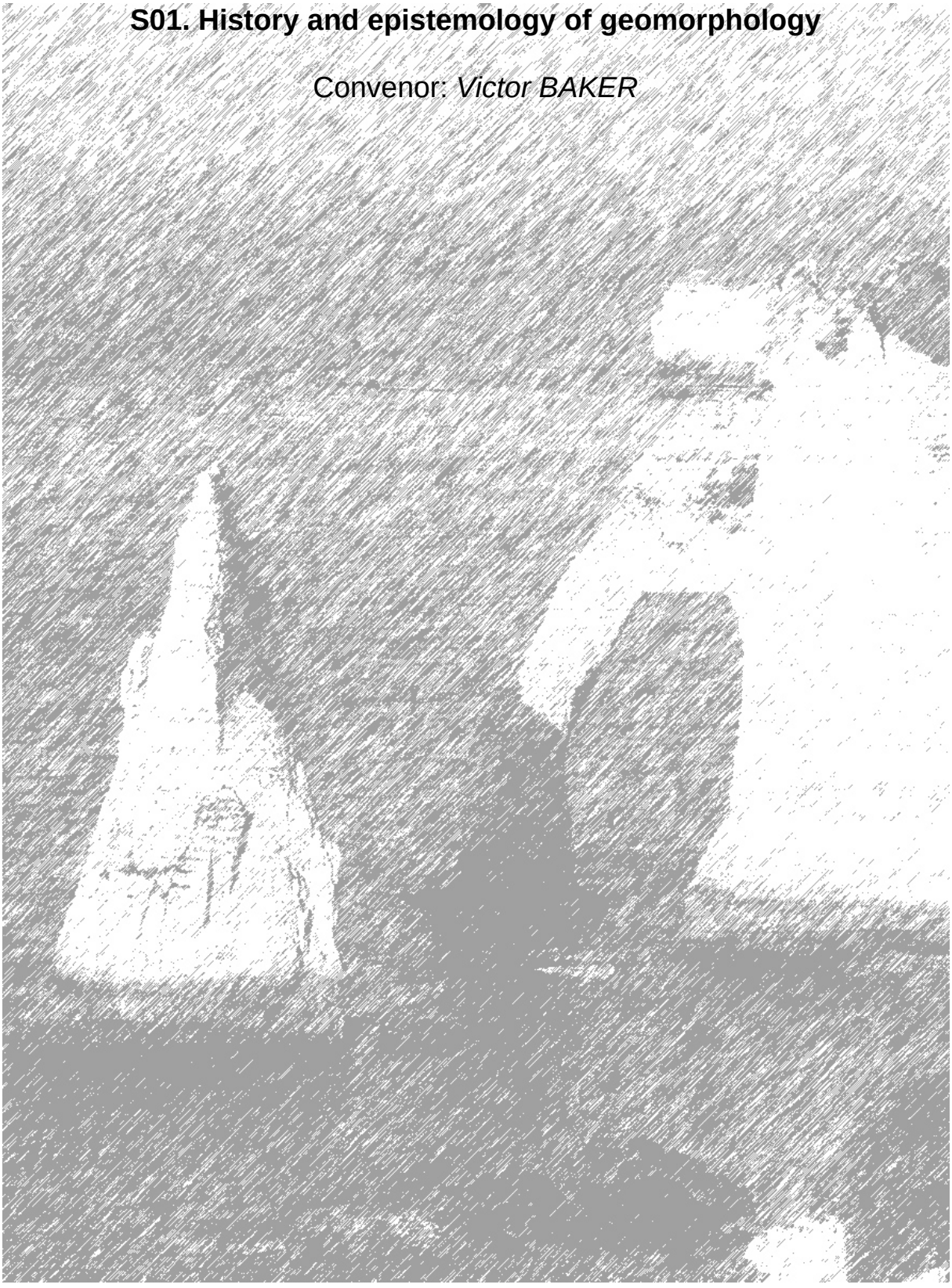
Géomorphologie et changements paléo-environnementaux dans l'Asie aride

XIAOPING YANG
INSTITUTE OF GEOLOGY AND GEOPHYSICS, CHINESE ACADEMY OF SCIENCES, P.O. BOX 9825, BEIJING 100029, CHINA.
(xpyang@mail.igcas.ac.cn)

Situées au milieu du plus grand continent, l'Eurasie, les régions arides de l'Asie couvrent un large éventail de contextes tectoniques, depuis -155 m en dessous du niveau de la mer à plus de 5000 m d'altitude. Grâce aux processus dynamiques fluviaux, lacustres, ou éoliens, ainsi qu'aux interactions de ces différents processus entre eux, des formes de relief très diverses ont pu se développer dans ces régions arides, avec notamment un pourcentage élevé de mers de sable actives. Cette conférence fait l'état de l'art de notre compréhension actuelle de la formation et des changements quaternaires de ces paysages désertiques, éléments clés des terres arides des latitudes moyennes sur Terre. Partant des études antérieures et de nos travaux récents, notre objectif est de présenter une synthèse globale de la formation des reliefs désertiques et leurs divers changements au cours du Quaternaire afin d'identifier les lacunes dans les connaissances. Nous nous concentrerons ici sur deux aspects : la formation des méga-dunes et les changements environnementaux quaternaire dans les déserts du nord de la Chine. Nos sites sur le terrain concernent principalement le bassin du Tarim au sud du Xinjiang, le Plateau d'Alashan à l'ouest de la Mongolie intérieure, et le Pays Sableux de Hunshandake de l'est de la Mongolie intérieure, tous ces sites étant actuellement caractérisés par la présence de dunes de sable. Nos recherches géophysiques sur les ensembles dunaires dans le désert de l'ouest de Badain Jaran en Mongolie intérieure révèlent que la hauteur des dunes est très sensible à la géologie locale et aux interactions entre des conditions climatiques changeantes, ces deux aspects ayant été négligés jusqu'à présent dans les études sur la formation des dunes. Nos dernières recherches de terrain confirment que de grands changements paléo-environnementaux, géomorphologiques, climatiques et hydrologiques, se sont produits dans ces régions au cours du Quaternaire tardif et que, au cours de certaines périodes de l'Holocène, les activités humaines ont eu dans ces terres arides une emprise et une intensité étonnamment plus grandes qu'on ne le pensait jusqu'à présent. Le risque aigu de certaines pratiques potentiellement non durables de gestion des terres dans ces régions arides sera également brièvement discuté.

S01. History and epistemology of geomorphology

Convenor: *Victor BAKER*



Oral presentations:

The relationship between art and the consolidation of american geomorphology during the nineteenth century

FERRAZ M., VITTE A.
UNICAMP, CAMPINAS, BRAZIL

This essay intends to establish the relationships between the consolidation of North American geomorphology and the arts, especially landscape painting of the XIX Century. Currently, modern science is going through a revision of its paradigms, and the historic fragmentation of science is also being affected. This makes it possible for new perspectives, which are also interdisiciplinary, to be adopted.

The concept of landscape art permits dialogue between geography and the arts because it was a fundamental concept for the systemization of the science of geography as well as the study of geomorphology. Landscape art was the artistic genre of greatest significance in the United States during this period.

The XIX Century was marked by deep changes in North American society and science.During that time a national identify was being sought, and since there were no great historic precedents, they exalted nature through landscape painting. This expanded and stabilized the scientific community. The same effect occurred with geomorphology.

The expeditions to explore the American West were made by explorers who relied on the help of artists to depict the “new” artistic landscaping, artists who adopted a new vision for the representation of landscapes, based on natural history and sciences, producing a new vision of nature. Likewise, the westward expeditions also contributed to the unfolding of new theories of geomorphology.

Some artists would collect patterns of rocks, fossils and ores. They also read scientific theories and incorporated concepts of geomorphology into their works. As some examples, we have Thomas Cole, Sanford Robinson Gifford and Albert Bierstadt. Robinson and Bierstadt participated in expeditions to the West.

In conclusion, the landscape art movement of the XIX Century integrates concepts of nature and culture.

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The glacial trough - an attempt at theoretical geomorphology

SCHOENEICH P.
Institut de Géographie Alpine - PACTE/Territoires, Université Joseph Fourier, GRENOBLE, FRANCE

In the late 19th century, geomorphology was part of geology and an almost empirical science. It is the theoretical synthesis of the « normal » erosion system by Davis which both established geomorphology as an independent science and separated it from the still empirical geology. Davis’ erosional cycle theory provided not only an explicative framework, but also a predictive model, allowing geomorphological predictions to be searched in the field. In its beginning, geomorphology was a theoretically based science! If the history and fate of Davis’ theories are well known, the most excessive tentative of theoretical approach in geomorphology remains largely unknown, mainly because it was almost confined to German-speaking geography: the glacial trough theory. Its main propagator was Hans Hess with his paper *Der Taltrog* in 1903. According to this theory, successive glaciations carve narrower and deeper troughs, which leave remnants in the form of embedded glacial troughs. In the early 20th century many geomorphologists searched for benches and examined slope profiles in order to find embedded troughs, four of them if possible, corresponding to the four Alpine glaciations defined by Penck and Brückner. Other authors tried to define troughs corresponding to the last deglaciation phases. Associated concepts like tongue basins and stepped glacial cirques were also used and led sometimes to opposite interpretations of the same features. Almost all studies based only on a topographical analysis – the most excessive relied even only on analysis of maps, without any field work. Criticisms arose from the beginning and developed in the 1920’s. The interest for glacial troughs, and debate around it, disappeared after the 1930’s. Today with the development of cosmonuclide exposure dating, the question whether glacial troughs, like trimlines, could enjoy a revival arises.

We will expose a brief history of the concepts, and develop some examples mainly from the Swiss Alps.

Is the present the key to the future?

FURLANI S.(1), NINFO A.(2), CANDELA A.(3)
(1) Dept. of Mathematics and Geosciences, University of Trieste, TRIESTE, ITALY ; (2) Dept. of Geosciences, University of Padua, PADUA, ITALY ; (3) Dept. Of Theoretical and Applied Sciences, University of Insubria, VARESE, ITALY

Earth sciences are largely based on the concept of the uniformitarianism, the assumption that the same natural laws and processes that operate today have always operated in the universe in the past. It summarizes and includes the gradualistic concept. Modern earth scientists do not apply this concept in the same way as in the past, since the present may not be long enough to study the past and geologic processes may had been active at different rates. Thus the forecast of future natural events is partly related to the knowledge of present-day processes.

Even the debate concerning the relations between the past, the present and the future in geomorphology has not been discussed as regarding an approach inside the theoretical philosophy, despite its importance for geomorphic models.

The concept that “the present is the key of the past” implies that we know the present, at least enough to be able to extend our knowledge back in time or forward to focus on the future. Therefore, even if future remains always unknowable, the accumulation of new data will anyway allow a deeper knowledge. Prediction is realized by the improvement of theoretical models which are able to forecast the future trends. The abstraction of theoretical models occupies a largest space rather than the empirism of measured data, since it is the sum of the space of actualism (measured data) and the space of possibility (the future).

A considerable number of studies in epistemology shows that natural systems fall into the category of complex phenomena within which it is very difficult to forecast future conditions. Recent rates of global deglaciation shows we are actual in a overscale discontinuity moment and present-day measures are probably not representative of past and future trends. It is therefore required a deep rethinking of the category of reductionist scientific determinism that should consider also out-of-scale events.

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Philosophical Reflections on Computational Geomorphology

VAN DE WIEL M., DESJARDINS E., MARTEL T., ROUSSEAU Y., ASHMORE P.
University of Western Ontario, LONDON, ONTARIO, CANADA

Like many other scientific disciplines, geomorphology has over the last two decades witnessed a phenomenal rise in the use of computational modelling as a tool for predicting changes, testing hypotheses and generating new knowledge. This turn marks an especially important shift for geomorphology, which has traditionally employed empirical and observation-based methods of inquiry. Although promising for many of us, the rise of computational geomorphology raises several epistemological issues that need to be debated if the knowledge gained from this new tool is to be considered admissible. This paper focuses on two lines of inquiry. First, and most importantly, we compare the nature and value of the knowledge established through computational modelling with that obtained through more “traditional” empirical methods used in geomorphology. More specifically, we discuss if these methods generate knowledge of the same value, or if computationally-derived knowledge is subservient to empirical observation. We contend that computational modelling can indeed provide understanding of the causal structure of the world, and that it can improve our capacity to recognize and deal with the inherent complexity of geomorphological phenomena. Second, we highlight and reflect on two different modes of modelling, *i.e.* predictive and exploratory. The former is characterized by instances where the functioning of the modelled geomorphic system is well-understood and where specific state changes in that system are predicted, whereas the latter uses modelling to test hypotheses or to improve our understanding of the functioning of the modelled geomorphic system. These two types of modelling have different underlying epistemologies, and thus offer different challenges and opportunities in characterizing the complexity of geomorphological systems.

What's the point of fieldwork?

RICHARDS K.
University of Cambridge, CAMBRIDGE, UNITED KINGDOM

This paper will explore questions about the changing role and epistemological status of "the field" in geomorphology. If field locations are an environmental scientist's equivalent of the physical scientist's laboratory, what does this mean for experiments and experimental design, and for explanation and understanding, in geomorphology (and indeed, in different areas of geomorphology)? If numerical models and remote sensing can today generate "data" at a rate unimaginable for field measurement, what does this mean for the epistemological status of the "field"? Does adherence to an image of fieldwork imply that it has a more social than a scientific purpose (although being no less important for that)? And do the epistemological peculiarities of field enquiry, surprisingly, gradually serve to undermine the autonomy of environmental science disciplines (including geomorphology), and to threaten their independent status?

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A river runs through It: Conceptual Models in fluvial geomorphology

GRANT G.(1), O'CONNOR J.(2), WOLMAN M.G.(3)
(1) USDA Forest Service, Pacific Northwest Research Station, CORVALLIS, OR, UNITED STATES ; (2) US Geological Survey, PORTLAND, OR, UNITED STATES ; (3) Johns Hopkins University, BALTIMORE, MD, UNITED STATES

Fluvial geomorphology has a rich history of conceptual models to explain how rivers change and evolve. These models provide a framework for analysis, and the choice of models and the manner of their application will fundamentally affect the outcome of any geomorphologic study. Underlying the models themselves is a scaffolding of ideas and concepts that draws from Newtonian physics, and fundamental geological and geomorphic principles dating back to Playfair and before. The history of modern conceptual models in fluvial geomorphology can be viewed as a braided river of ideas that begins with a bifurcation in thinking between G.K. Gilbert’s concept of landscape processes reflecting a balance among pertinent forces, and W.M. Davis’s concept of the geographic cycle. Many of the conceptual models that have been developed subsequently are primarily fed by one or the other of these two master braids, although some of the most exciting ideas have emerged from cross-currents in thinking. Concepts such as the graded river, hydraulic geometry, dynamic equilibrium, geomorphic thresholds, magnitude and frequency of geomorphic processes, landscape and channel classification, and landscape evolution all find their places in this river of ideas. Conceptual models both reveal and conceal fundamental aspects of the fluvial system, and care should be taken to choose wisely and not follow blindly.

What's in a name? Unravelling the inosculate definitions of multichannel river networks

CARLING P.(1), JANSEN J.(2), MESHKOVA L.(1)
(1) University of Southampton, SOUTHAMPTON, UNITED KINGDOM ; (2) Stockholme University, STOCKHOLME, SWEDEN

The etymology and historic usage of such terms as ‘anabranching’, ‘anastamosing’ and ‘braiding’ within river science are reviewed. Despite several decades of modern research to define river channel typologies inclusive of single channels and multiple channel networks, typologies remain ill-conditioned and consequently ill-defined: the history of usage of terms, in part, has conditioned the modern philosophical approach to defining channel typologies rather than the latter being physics-based. Conventionally employed quantitative planform characteristics of river networks possibly cannot be used alone to define channel types, yet the planform remains a central part of all modern classification schemes, supplemented by sedimentological and other qualitative channel characteristics. Planform characteristics largely have been defined using non-standardised metrics describing individual network components, such as link lengths, braiding-intensity and bifurcation angles; which data often fail to separate visually-different networks of channels. We find that existing typologies remain pragmatically utilitarian rather than fundamentally physics-based and too often fail to discriminate between two distinctive and important processes integral to new channel initiation and flow-splitting: i) in-channel bar accretion, and ii) channel avulsion and floodplain excision. It is suggested that, firstly, if channel planform is to remain central to river typologies, then more rigorous quantitative approaches to the analysis of extended integral channel networks at reach scales (rather than network components) are required to correctly determine whether ‘visually-different’ channel patterns can be discriminated consistently; and, secondly, if such visually-different styles do in fact differ in their governing processes of formation and maintenance.

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Geosemiosis of planetary surfaces

BAKER V.
University of Arizona, TUCSON, UNITED STATES

Geosemiosis (Baker, 1999, Geol. Soc. America Bull., v. 111, p. 633-645) involves the continuous interpretive flow of signs (semiosis) from the Earth to our thoughts about Earth. For geomorphology this flow of signs that leads to a fruitful course of hypothesis generation in regard to the causes of landforms and landscapes. The invention of geomorphological hypotheses involves both inductive inferences of the type G.K. Gilbert termed “empiric classification” and abductive inferences of a logical form made famous by the 19th century American logician Charles Sanders Peirce. The testing and corroboration of such geomorphological hypotheses relies less on the correspondence logic of theoretical/ experimental sciences, like physics, and more on the logic of consistency, coherence, and consilience that characterizes the investigative/historical sciences of interpretation exemplified by geological geomorphology. Geosemiosis focuses on what Earth says to us, thereby providing a complement to the accelerating mode of science that is focused on what we can say about Earth. While the latter uses mathematics to provide knowledge that aspires to be universal, necessary, and certain, the science of what Earth says to us focuses all the messy and uncertain realities of the nature’s particulars. The science of what Earth says to us is more concerned with what actually does happen or has happened, as opposed to making a law-based, prediction of what should happen. This approach to science may well have more affinity with the commonsense view of the nonscientists who influence policy decisions. Human action seems to be more influenced by beliefs attached to experience of particulars than by adherence to abstract generalities.

Poster presentations:

Rise of the Theory of Diluvial Morpholithogenesis in Russia: Opposition to the Recognition of late Pleistocene megaflooding in northern Eurasia

RUDOY A.
Tomsk State University, TOMSK, RUSSIAN FEDERATION

Cataclysmic flooding theories for the late Pleistocene landscapes of the northwestern United States were long regarded as unique and restricted to that region. However, beginning in the 1980s discoveries by the author and others identified the systematic effects of immense breakout floods from late Pleistocene ice-dammed lakes that filled intermountain depressions in the Gorny Altai region of central Asia, including the Chuya, Katun, Tchulishman, and Bashkaus valleys. Subsequent studies documented evidence for late Pleistocene cataclysmic flooding associated with depressions in the northern Mongolian region, and further work extended the recognition of possible great late Pleistocene floods in the Transbaikal and the Cisbaikal regions. Despite these discoveries, what is now known to be relief features and related sediments formed and emplaced by cataclysmic flood phenomena continued to be explained by many investigators in terms of very different and occasionally conflicting mechanisms. The lack of a general unifying theory for the phenomena meant that explanations that seemed to be more or less plausible for a particular valley are ineffective for explaining similar features in an adjacent valley, and of no use at all for explaining features on the drainage divides between valleys. Nevertheless, the new cataclysmic flooding theories will become more widely accepted when the investigative community comes to realize the insufficiency of previous explanations. The appearance of puzzling anomalies means that paradigms established by previously successful theories will be found to be lacking. As this lack of success is reinforced by the collection of new data, the stage will be set for theory change, whereby new explanatory theories successfully encompass both the phenomena that marked explanatory successes for the old theories, and also the discoveries that proved anomalous in regard to systems posed by the old theories.

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On Postmodern Geomorphology

NEVSKY V.
Pacific Geographical Institute FEB RAS, VLADIVOSTOK, RUSSIAN FEDERATION

Thematic structure of publications for the last 20 years shows that geomorphology enters a period of semantic reorganization. Its status could be characterized as the entry in a modern cultural (and scientific) reality, i.e. Postmodern. It will be expected that the technological analytic mainstream of geomorphology will produce less and less new semantic information. The themes of all the scientific publications could be led to a limited number of principal patterns, such as “quantitative estimate of some exogenous geomorphic process“, “regional DEM and its application” and so on. Geomorphic information is becoming more specific and additional. New meanings are mainly formed in border scientific branches, such as ecological geomorphology and aesthetic geomorphology. The first fate feature of postmodern geomorphology is decrease in historical aspect, which has been given to paleogeography and geology. The second feature is a tendency to depletion of our visual object, i.e. the earth surface. Geomorphology is gradually depriving of endlessness and eternity, whereas the latter are the very main opponents of Postmodern. Thus, geomorphology is coming back to geology from which it singled out a century ago. It is a normal process, neither bad nor good. To keep independence, geomorphology should return itself historicity and evolutionism (according to W.M. Davis’s ideas). Geomorphology must take part in interdisciplinary project that has a general name “Evolutionism: synergetic approach”. If one follows the nomogenesis principle, then relief development will be involved (as well as climate development) into the framework of biological and human evolution. The contour of new geomorphologic paradigm will become evident in the field of interaction between geography, biology and social-human sciences.

From the Physical Geography, through Dynamic Geology, towards the Geomorphology. An historical itinerary, bridging the XIX and the XX century, of the Italian naturalists's contribute

LAURETI L.
Univ. di Pavia, Dipart. di Scienze della Terra e dell'Ambiente, PAVIA, ITALY

The aim of this paper is to retrace the initial stages of the historical evolution (both from the content and the methodology) turning, from the early descriptions of the physical surface of the Earth, towards the achievement of the Geomorphology as peculiar scientific discipline putting in evidence the contribute provided by the Italian geographers and geologists.

Surely under the influence of scientists such Lyell or Humboldt (whose works had in Europe a large reputation) together with the Kantian "Physische Geographie" (1801), the Italian text-books, for the use of both secondary schools and universities, revealed a mainly ripetitive and descriptive character during all the first half of the XIX century. It is in this time that we see become stronger the dichotomy between the Physical Geography and the so-called Political Geography, peculiar in the Galanti's or Balbi's works. In this regard it is very symptomatic the great diffusion of the Italian translation of the Somerville's "Physical Geography" (1853).Luckily, during the second half of the XIX century, the rapid spread of the studies and researches in Italy, thanks to eminent scientists as Stoppani, Capellini, Taramelli and others, gave a strong support to the evolution and renewal of the Physical Geography, particularly by the development of the Dynamic Geology (to which is dedicated the first of the three volumes of the Stoppani's "Corso di Geologia", 1871).

As known, the word "Geomorphology" was used firstly at the end of the XIX century, probably by an American geologist (McGee 1891). After few years, also by an Italian geologist (Rovereto), entitling a work about the morphology of the Ligurian coasts (1902-03), followed, after twenty years, by a great treatise in two volumes: "Trattato di geologia morfologica (Geomorfologia)" (1924-25), again today a useful reference work.

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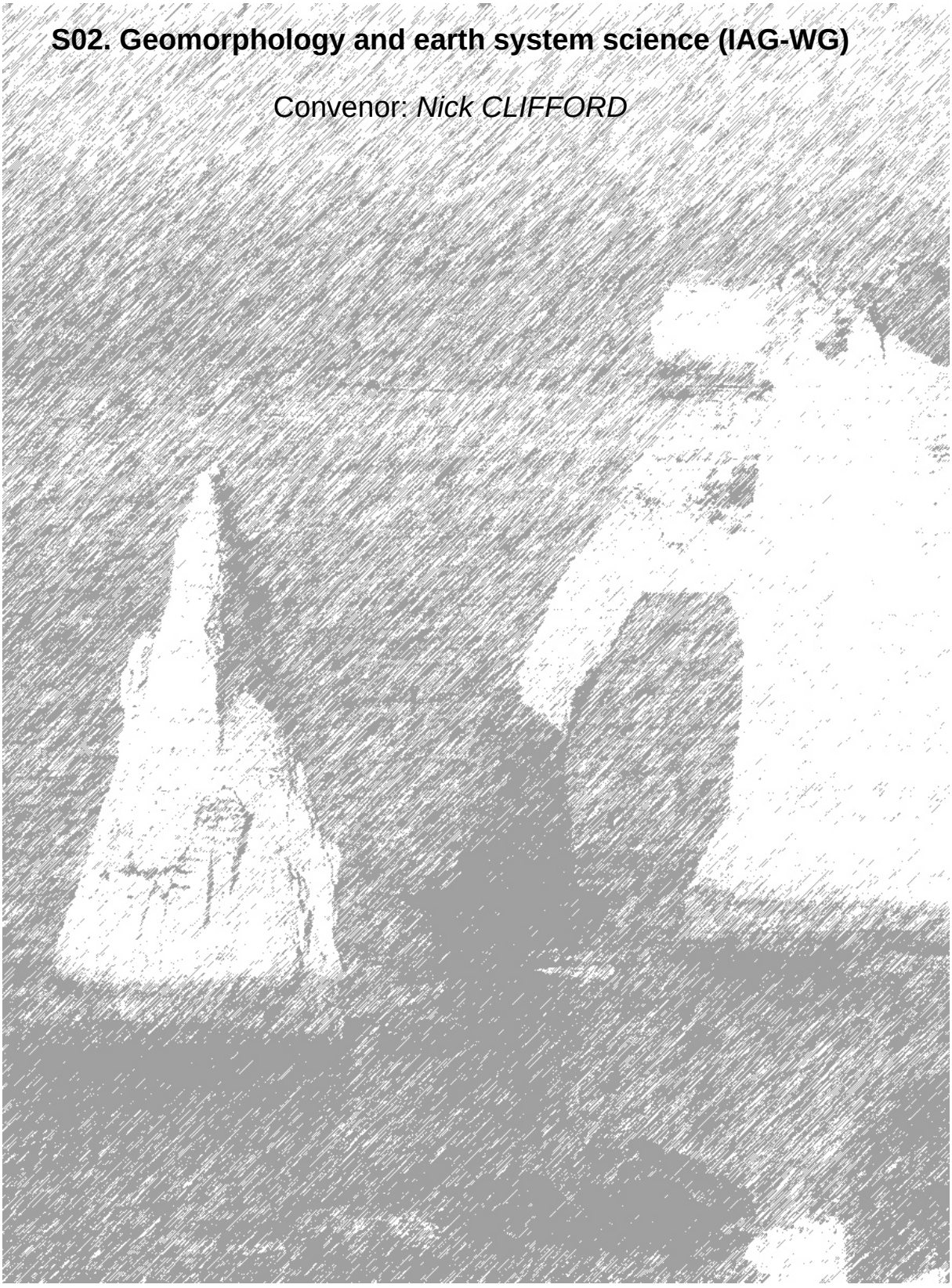
The Primacy of Fieldwork

INKPEN R.
University of Portsmouth, PORTSMOUTH, UNITED KINGDOM

The practice of 'fieldwork' remains essential to the nature of geomorphology. Using examples from stone decay this presentation illustrates how fieldwork is the primary driver of conceptual and methodological developments. The term 'fieldwork' is explored and defined in relation to the practices undertaken by geomorpholgists in this field. Likewise, the role of this expanded view of fieldwork in generating wonder and intrigue (or enchantment as others have suggested), essential and often under-rated stimuli to investigation, are discussed. Overall, this primacy of practice provides geomorphology with a particular conceptual and philosophical view of the physical environment within the sciences.

S02. Geomorphology and earth system science (IAG-WG)

Convenor: *Nick CLIFFORD*



Oral presentations:

Geomorphology and Earth System Science: some thoughts on scale, place and method

CLIFFORD N.
King's College London, LONDON, UNITED KINGDOM

Views on the relations between Geomorhology and ESS are varied, and span a range from very positive to very negative. The spectrum of views relates both to the epistemology of the two subject areas, and to disciplinary security and identity in a fast-changing academy and a fast-changing world.

Epistemologically, scientific investigation is marked by new technologies for information gathering, processing and sharing; by new means of simulation and modelling and potentially, synthesis; and environmental science is increasingly addressing questions which are hybrid between differing physical systems, and between these and social and political considerations. Beyond the science process, thare are rapidly changing expectations in student experience and higher education; and there is questioning of the place of scientific research in social and political decision-making, especially relating to issues with inherently large uncertainties.

This paper offers some comment on the relations between Geomorphology and ESS, first, through considerations of 'conceptual contingency' (historical explanation) and place-based understanding of form-process interactions, and then through the methodologies which are adopted in these circumstances. It is argued that both a more contingent, local method and conceptualisation is characteristic of many forms of Geomorphology, past and present, which can be counterposed against more totalising approaches characteristic of ESS.

Geomorphological and ESS approaches are then reviewed against changing science-society relations. Here, the argument presents Geomorphology as one means of reducing uncertainty and 'downscaling' ESS to levels more suitable for practical policy uptake and to facilitate greater social and political acceptance of science input in key environmental questions.

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Ethnogeomorphology

WILCOCK D.(1), BRIERLEY G.(2)
(1) Victoria University, MELBOURNE, AUSTRALIA ; (2) University of Auckland, AUCKLAND, NEW ZEALAND

Geomorphology offers an effective entry point into wider debates across geography and the sciences, framing understandings of landscapes as physical manifestations of complex and emergent relationships that can be used as a platform to support conversations among multiple and diverse worldviews. Physical geographers have much to contribute in moving beyond monological (one only) views of landscapes. This paper draws upon concepts of emergence, connectivity, and space-time relationality to develop an ‘ethnogeomorphic’ outlook upon biophysical-and-cultural ('living') landscapes. This perspective is grounded through ethnographic case studies with Indigenous [1] communities in Australia and Canada that examine knowledge production and concerns for environmental negotiation and decision-making. Extending beyond a traditional approach to ethnosciences, ethnogeomorphology seeks to move beyond crossdisciplinary scientific disciplines (and their associated epistemologies) towards a shared (if contested) platform of knowledge transfer and communication that reflects multiple ways of connecting to landscapes. Convergent perspectives upon landscape understandings are highlighted from Indigenous knowledges and emerging, relational approaches to geomorphic analysis. Ethnogeomorphology presents a situated, non-relativist response to people-landscape connections that reflects and advocates sentient relationships to place. Potential applications of ethnogeomorphology as an integrating theme of geographic enquiry are explored, highlighting important tensions in the knowledge production process.

[1] Indigenous’ is deliberately capitalised, following discussion by Johnson et al. (2007) of decolonising discourse around Indigenous rights in the global context.

'But what do you measure?' Contextualising geomorphic understandings of the upper Yellow River

BLUE B., BRIERLEY G.
The University of Auckland, AUCKLAND, NEW ZEALAND

As new technologies, measurement techniques and sources of information become available to geomorphologists, the importance of contextualising our expanding volume of information becomes ever greater. Geomorphic understandings are products of their specific physical, scientific and human contexts: local morphologies, controls and histories; the methods, scales and purposes of enquiry; and the philosophies, skills and background of the practitioner are all reflected in the knowledge produced by geomorphological research. These contextual factors exert a critical influence upon the application of geomorphic knowledge to new places and timescales, by other people, calling into question the development and communication of geomorphological knowledge both in terms of primary research and practical applications. Geomorphic classification provides a means of knowledge production and transfer, however it also has the potential to render that knowledge irrelevant or misleading if applied uncritically. Concerns for the role of spatial and temporal context, the ramifications of 'disciplining' unruly continua of form and process into 'simple' categories, and the selection of appropriate descriptors of form and process are central to the effectiveness of morphological classification: not all measures are relevant for all morphologies in all places. Using examples from the upper Yellow River, this paper explores the role of what, where, how and why we measure in shaping our understandings of the forms, processes and controls of riverine systems.

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Representing Geomorphology in Models of the Earth System

DADSON S.
School of Geography and the Environment, University of Oxford, OXFORD, UNITED KINGDOM

Understanding the competing pressures on land and water resources requires detailed knowledge of the future climate and water balance under uncertain environmental change. For many years, Earth system models have represented land-surface processes including surface and subsurface hydrology, because they exert important influence on fluxes of water and energy between the land and the atmosphere. However, improvements in model resolution, and detailed research showing that land-surface heterogeneities can strongly influence land-atmosphere feedbacks has motivated a renewed interest in the representation of Earth surface processes in models of the Earth system. In practice, these representations may vary from the representation of finer-detailed orography for use in atmospheric models, to more sophisticated representations of sub-grid-scale features of the geomorphic environment in ways that interact dynamically with other Earth system components.

These challenges have invigorated debate around the representation of surface processes in simple models and have contributed to resurgence in the use of reduced-complexity models. This paper examines the role that land-surface models can play in providing a robust scientific basis for making resource management decisions against a background of environmental change, including climate and land-cover change. Some perspectives are given on Earth system models which represent hydrological and geomorphological systems, in particular: (i) the representation of surface, subsurface and floodplain hydrology in models, particularly at the scales relevant to land-surface modelling, (ii) the representation of human interventions such as dams and irrigation, and (iii) the role of geomorphic systems in the carbon cycle.

Geomorphology 6.0: a framework for complexity elicitation

MASSON E.(1), KEILER M.(2)
(1) University Lille 1 Sciences and Technologies, VILLENEUVE ASCQ, FRANCE ; (2) Geographisches Institut Universität Bern, BERN, SWITZERLAND

Earth surface landforms are emerging from complex environmental systems. The observed pattern and structure may result by self-organisation, linear as well as nonlinear interactions and feedbacks between the elements in the systems. Studying geomorphic features and the processes dynamics, the relation and connectivity to other component parts in the Earth systems and to the human sphere become evident and are increasingly addressed. Both, Earth systems and geomorphological systems, are denoted as complex systems. However, in many fields the terms of complexity and complex systems are used as catchwords or in a general linguistic usage. Furthermore, the terms are equated with descriptions of geomorphological research without considering and/or defining the theoretical background. This situation hinders cooperation within geomorphology and especially trans-disciplinary approaches in Earth system sciences.

In contrast to highlighting the importance of more theoretical discussion we propose as a first step a framework for deconstructing complexity to make more explicit which part in a complex system is addressed and which part is missing in geomorphological studies. This framework should help to define boundary limits of the studied system complexity by describing and analysing following six dimensions: structures, functions, connections, phases, scales and adaptations.This six dimensions conceptual basis can be combined in a second step for a more detailed analysis.

To illustrate this theoretical framework, a case study considering the analysis of main influencing factors on sediment discharge in steep alpine catchments will be discussed. Moreover, this theoretical contribution and its case study will foster the discussion on trans-disciplinary approaches into geomorphological studies. Our proposition is indeed a framework for thinking and analysing complex catchment issues within Earth System Sciences.

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Geomorphologic fundamentals of system geologic and geographic studies

LASTOCHKIN A., ZHIROV A.
St. Petersburg State University, ST. PETERSBURG, RUSSIAN FEDERATION

Numerous versions of system theories in natural science are based on morphological approach. In the Earth sciences which are closely tied to the Earth surface this approach is widely used when geotopological and structural geographic studies are involved.

Composition of the Earth surface is determined by means of tracing *structural lines* of 25 types. These lines connect points of extremum and zero points originating from the analysis of main geomorphic functions: altitude (depth), inclination, vertical and horizontal curvature. Intersections of structural lines present *characteristic points* of 20 types. Both structural lines and characteristic points serve as the borders of *elementary surfaces* of 52 types. Elementary surfaces fix definite locations (geotops, biotops, etc.), each with a number of exposures (gravitational, insolational, circulating, anthropogenic) that determine distinctive features such as physical, chemical, biological, environmental, etc. They can be mapped in different scales.

Structure of the Earth surface is studied through the reduction of topological models to mere structural networks, which patterns conform to the classical and dynamic symmetry. Measures of elements and symmetrical patterns reflect the aggregate result of day-surface material and energy flows since the relief acts as a distributor and concentrator of them, thus, influencing biota and mankind. The main ideas of this approach are stated in the monograph "General theory of geosystems" (SPb, publishing house Lema,2011) published with support of the grant of the Russian government (№ 11.G34.31.00025).

Conceptualising and formalising the structure of coupled estuary-coast-offshore systems

FRENCH J., BURNINGHAM H.
University College London, LONDON, UNITED KINGDOM

The concept of the coastal cell has endured for 50 years as an essentially geomorphological framework for coastal engineering and management. Cells are readily defined for coasts dominated by alongshore transport of beach-grade material, but struggle to accommodate longer range suspended sediment fluxes. Moreover, the challenges of predicting, understanding and mitigating climate change impacts at the coast demand a richer conceptualisation that embraces the connectedness of open coasts with estuaries and the offshore at broader scales and also acknowledges the extent of anthropogenic control. Accordingly, we present a new approach that re-engages with formal systems analysis and, importantly, restores a geomorphological focus to problems that have latterly become the preserve of the engineering community. At the heart of this approach is an ontology of landforms and interventions that is partly inspired by the coastal tract concept and its temporal hierarchy of sediment sharing systems, but which places more emphasis on a spatial hierarchy in scale, from coastal shelf, through landform complexes, to landforms and engineering interventions. A formal protocol specifies the mapping of important landform components and structural and non-structural constraints thereon, and their grouping into estuarine and coastal landform complexes. The complex web of interactions is represented through an influence network, which contains a sub-set of mass transfer pathways that define the sediment budget. This process constitutes a form of knowledge formalisation in which disparate sources of information (published research, data etc) are generalised into usable knowledge. System maps then act as a catalyst for structured discussion of geomorphic system behaviour and its implications for climate change impacts and their management. They also provide both a framework and a repository for more quantitative analyses and system-level modelling at the scales that really matter.

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Fractal dimension of drainage network geometry of some Mediterranean-type river basins in California, Spain and Italy: a geomorphologic key to interpretation

DONADIO C.(1), MAGDALENO F.(2), KONDOLF G.M.(3), MAZZARELLA A.(1)
(1) Department of Earth Sciences, Environment & Resources, University of Naples Federico II, NAPOLI, ITALY ; (2) CEDEX, Ministry of Public Works - Ministry of Agriculture, Food and Environment - Alfonso XII, 3, MADRID, SPAIN ; (3) Department of Landscape Architecture and Environmental Planning, University of California, BERKELEY, UNITED STATES

By applying fractal geometry analysis to the drainage network of three large river basins in America and Europe, 2D- and 3D-fractal dimensions through the correlation integral have been calculated. Preliminary results have been compared with classical geomorphic-quantitative indexes to highlight fluvial dynamics. The basins of Russian River in northern California, Ebro River in northeastern Spain and Volturno River in southern Italy, in present-day Mediterranean climate and with different geologic history and tectonic styles, have been analyzed. Preliminary results show an average fractal dimension slightly above unity. This suggest that basins have experienced concurrent overlay of secondary modeling processes, resulting from morphoselective erosion in a climate different from the present, on the primary tectonic processes, responsible for both the current structuration of inherited landscapes and degree of structural control. Tectogenesis was intense in the Plio-Pleistocene, although currently very active in some of these basins, while morphogenesis mainly occurred in the Late Quaternary and its effects are well preserved. The different fractal degree would indicate river basin evolution at certain periods was controlled by glacial fluctuations, at others by intense effects related to Plio-Quaternary tectonics and locally to Pleisto-Holocene volcano-tectonic activity. Finally, in historical times such phenomena appear to have been overlain by fluvial dynamics.

References: D'Alessandro L., De Pippo T., Donadio C., Mazzarella A. &. Miccadei E. 2006: *Fractal dimension in Italy: a geomorphological key to interpretation.* Z. Geomorph. N.F., 50, 4, 479-499.

Kondolf G.M. & Piégay H. 2003: (Eds.) Tools in Fluvial Geomorphology. Wiley, UK, 688p.

Magdaleno F., Fernández J.A., Merino S. 2012: The Ebro River in the 20th century or the ecomorphological transformation of a large and dynamic Mediterranean channel. Earth Surf. Proc. Landf. 37, 5, 486-498.

Preliminary study of the coupled control of tectonic uplift and the glaciations in the Tibetan Plateau

ZHIJIU c.(1), ZHANG W.(2), LIU G.(1), LI C.(1)
(1) Peking University, BEIJING, CHINA ; (2) Liaoning Normal University, DALIAN, GHANA

It has been noticed that the youngest glaciations in high Asia and the surrounding mountains occurred later than the high latitudes and polar region. The Kunlun-Huanghe tectonic movement around 1.1-0.7-0.6 Ma M.P. induced the Tibetan plateau and the bordering mountains extensively uplift to the height about 4000 m. The orbital configuration was also changed towards the dominance of the 100 ka cycle at around the same time, which led to further cooling of the Earth and resulted in the development of glaciers.The oldest glaciation, Kunlun Glacaiton (0.71-0.78 Ma.B.P.), occurred in the Tibetan Plateau and the bordering mountains.Definitely glacial remains of the last glacial cycle (0.05-0.01 Ma B.P.) are preserved in the Siguniang Shan (6250 m)and the Xuebaoding Shan (5588 m)of the eastern Tibetan Plateau. However, complete glacial sequence including the penultimate, last glacial cycle and the glaciation in the middle stage of the Pleistocene occurred in the Queer Shan and Nianbaoyuze located in the inner part of the Tibetan Plateau, which is lower than the Siguniang Shan and Xubaoding Shan in the same latitude , although the moisture is not benefit for the Queer Shan and Nianbaoyuze Shan. This may be the result of the extensive tectonic uplift because the uplift rate is about 2 mm/ yr during the middle and late Pleistocene in the Siguniang Shan and Xuebaoding Shan.Only glacial remains in the last glacial cycle are preserved in seventeen mountains with the altitude of 3500-400 m in the east margin of the Tibetan Plateau. Most absolute ages of the glacial remains are 0.03-0.01 Ma B.P. The glacial sequence in these mountains may be induced by three reasons, that is, first, the direction of the uplift of the Tibetan Plateau is form west to the east margin, second, the climate became cold and lead to the snowline decrease, and finally, the coupled control of the tectonic uplift in these regions and the cold climate.

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Poster presentations:

Groundwater investigations using optical and microwave remote sensing data in Solani watershed, India

BENNIA A.(1), SRIVASTAV S.K.(2), CHATTERJEE R.S.(2)
(1) Centre for spatial techniques CTS, ORAN, ALGERIA ; (2) Indian Institute of remote sensing, DAHRADUN, INDIA

This article describes general hydro-geological set for the Solani watershed. Satellite imagery obtained from Landsat-7ETM+ has been analysed to prepare the groundwater prospects map. By using SAR interferometry techniques, paleo-channels, geomorphic units, lineaments, could be identified and delineated at a reasonable level of accuracy.

In this study the following aspects have been covered: drainage map, geology, geomorphology, depth of water table map, water table contour map, EC (electric conductivity) distribution map etc. From these thematic maps ground water prospects map, has been prepared. As seen in these maps, the depth of water table in this area ranges from 2m from ground level to more than 100m; the EC of ground water varies from 284µS/cm to 2000µS/cm. Five different prospect zones: excellent, good, moderate, low and runoff zone are identified according to the integration of thematic maps.

Hydrogeologic prospection in the basin of Tindouf. Contribution of the satellite images in the characterization of the fracturation

SAAD A.Z.E., KEBIR L., ZEBBAR Z.E., MAHI H., BENNIA A., DIF A., DJAAFAR Y.
Centre des Techniques Spatiales, ARZEW, ALGERIA

The study belongs to the sub watershed Saoura and is included in the large Saharan platform, and belongs to the North African craton. This platform includes a Saharan Precambrian basement on which rests unconformably overlain by a thick sedimentary Paleozoic structured into several basins separated by high zones, including the Tindouf Basin to the west. This Basin is characterized by the endoreic. It is a great a closed basin with a large east-west extension in oval shape. Its main outlet is the sabkha Tindouf, it is fed by a river system developed only in the northern part of the basin. The main stream el Maa, which is composed of two major tributaries that drain the northern part of the basin along the border with Morocco.

Hydrogeological prospecting area is mainly based on the structural aspect. For its characterization, we use the image data.

Areas of intersection of lineaments involve a large reserve of water. The intersection is the most favorable to drill to optimal production.

The study area is composed of faults and folds with a large radius of curvature. Lineaments are characterized different directions. Characterized most generally NE-SW to NNE-SSW. According to some authors, the allocation of this direction is to order Hercynian

This study represents a contribution to the understanding of the hydrogeological behavior of some of the Tindouf Basin, and offers a menu of potential groundwater. The overall results are a contribution to a better hydrogeological exploration in the region.

Keywords: Tindouf, hydrogeological, fracturation, satellite images

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Analysis of environmental fragility - Letter from Santa Maria da Vitoria - Bahia

GUIMARAES S., FRANCO B., GOMEZ T.
Universidade Federal da Bahia, BARREIRAS-BA, BRAZIL

Motivated by the need to understand the existing processes contained in the spaces occupied by humans, they are sourced from environmental and social phenomena, the study was conducted, the result was achieved by performing analysis of the physical and socioeconomic aspects of the area between the Geographic coordinates: 13 °, 13 ° 30 'South Latitude and 44 º, 44 º 30' West Longitude. This part which includes the municipalities of Baianópolis, Canápolis Coribe, Correntina, Jaborandi, Santa Maria da Vitória Santana and São Felix do Coribe. Those that are located in the Far West Mesoregion Baiano. The study had as main objective the acquisition and interpretation of results in making maps, making it possible to do an analysis relating the physical limitations and confronting -the form in which man has occupied this space. Thus from these reviews was possible to obtain a map of environmental vulnerability of the same.

Keywords: Santa Maria da Vitoria, Environmental Fragility, West of Bahia, interpretation

The Progress and Prospect of Daigu Landform Research

XU S.
College of Resource and Environment,Linyi University, Shandong Province, China, LINYI , CHINA

In August 2007, Professor Cui Zhijiu and other six geomorphologists, identified Daigu Landform as China's fifth modelling landform after Karst landform, Danxia landform, Zhangjiajie landform and Zhangshiyan landform in the academic conference held in Mengyin county of Shandong province.

In the landform classification system, Gu is a type of mesa landforms, which is known as Gu in Yimeng Mountainous area in Shandong. Gu is an elevated area of land with a flat top and steep cliffs under the mountain top. The cliffs have a gentle slope near the foot of the mountain. There is a total of over 180 Gu in Yimeng Mountainous area. The formation of Daigu landform requires three conditions: the soft-hard interbedding gentle stratum, long-term gradual tectonic uplift and strong external erosion. The formation of Daigu landform in this region is due to the effect of erosion and corrosion of water flow and gravity collapse on large-area and gently sloping limestone and sand-shale layer of Cambrian system under long-term and gradual tectonic uplift in the context of local fault structure. Daigu landform, developed in the Cambrian neritic deposit marine sediment of dating back to about 500 million years ago, is attracting more and more attention with its structural typicality, type diversity, clustered concentrated distribution.

At present, there is still a lack of profound and systematic research into the formation and evolution pattern of Daigu landform. Therefore, the key topics of academic research is its distribution, morphological characteristics, evolution trend, etc. The research on Daigu landform can reverse current situation of weak mesa research in geomorphology field and enrich the research on continental weathering and terrestrial carbon cycle. Furthermore, it can provide scientific support for applying for National Geoparkof Chinaandthe World Natural Heritage.

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Using Google Earth to map and understand gully development

FRANKL A.(1), NYSSEN J.(1), POESEN J.(2), ZWERTVAEGHER A.(3)
(1) Geography Department, Ghent University, GHENT, BELGIUM ; (2) Department of Earth and Environmental Sciences, KU Leuven, HEVERLEE, BELGIUM ; (3) Department of Geology an Soil Science, Ghent University, GHENT, BELGIUM

High-resolution images available on Google Earth are increasingly being consulted in geographic studies. However, most studies limit themselves to visualizations or on-screen measurements. Google Earth allows users to create points, lines and polygons on-screen, which can be saved as KML files. Here, the use of R statistics freeware is proposed to easily convert these files to the shapefile format [or '.shp file format'], which can be loaded into GIS-software (ESRI ArcGIS 9 in our example). The geospatial data integration in GIS strongly increases the analysis possibilities. We highlight our methodology and its accuracy by an applied study on gully network and volume development in the second half of the 20th century in the Northern Ethiopian Highlands.

Reference: Frankl, A., Zwertvaegher, A., Poesen, J., Nyssen, J., 2012. Transferring Google Earth observations to GIS-software: Example from gully erosion study. International Journal of Digital Earth. In press.

Applications of analytical geomorphologic maps in geography and geoecology

ZHIROV A., LASTOCHKIN A.
St. Petersburg State University, ST. PETERSBURG, RUSSIAN FEDERATION

Initial creation of analytical geomorphologic maps by tracing of structural lines of five principal types (convex crests, convex bends, concave bends, concave keels, morphoisographs) gives a morphological basis for the further studies and mapping, not only geomorphologic ones. Suggested by A. Lastochkin in the eighties, the system-morphological approach with its thorough, parametric and correlated, systematization of points, linear and areal relief elements makes it possible to do a precise map fixing of the morphological structure of any kind of surfaces: from day to subaquatic and subglacial ones and even to various interfaces. The analytical geomorphologic map presents all the elementary surfaces, each corresponding to one geotop, or location. Geotops house elementary landscapes and other geo-units: elementary soil areas, biocenoses, etc.

Analytically mapped relief represents a complete set of geotops (locations) which can be used as a fine basis for various applications. SPbU researchers and other Lastochkin' disciples have built a lot of analytical geomorphologic maps covering landscapes and soils, biocenoses and forests, some issues dedicated to forecasts of geomorphologic and geologic risks, natural distribution of anthropogenic pollution, including that of water-bearing strata, ferromanganese nodules at the ocean floor and many others. The most fruitful applications of the system-morphological approach can be found in the monograph "Applied geomorphology based on the general theory of geosystems" (SPbU, 2008) and in the "Geomorphologic Atlas of Antarctica" (SPb, publishing house Map, 2011) created by SPbU geomorphologistsunder the leadership of Prof. Lastochkin and granted by the Russian government (№11.G34.31.00025).

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On the new geomorphologic studies of Polar Regions

BOLTRAMOVICH S., LASTOCHKIN A., ZHIROV A.
St. Petersburg State University, ST. PETERSBURG, RUSSIAN FEDERATION

"Geomorphologic Atlas of Antarctica" can be estimated as a unique issue dedicated to the relief of a single continent. It has been created by the team of researchers from R&D institutions of St. Petersburg (Russia) under the leadership of Prof. Alexander Lastochkin and granted by the Russian government (№11.G34.31.00025). The Atlas presents an integrated model of day-surface, subglacial and subaquatic relief of Antarctica.

The Atlas is based on the new morphological approach worked up by A. Lastochkin from the Department of Geomorphology at SPbU. This approach embraces Earth surface division into defined elements – 20 points, 25 linear and 52 areal – and their networks that serve as functioning geo-systems of different levels. Data are mined from various Russian and international sources: geophysical, geographic, geologic, etc. Application of new morphological approach has made it possible to detail the Antarctic subglacial-and-subaquatic surface and to get new information concerning dynamics of different structural stages of the ice continent.

The mapping of Antarctica is carried out both for the entire continent and its separate, well studied regions: Vostok Lake and Lambert Graben. A set of maps comprises analytical (element's), orographic and other geomorphologic models as well as morphometric and morphotectonic maps that allow to assess neotectonic and glacioisostatic movements. Glaciodynamic studies have revealed the strong correlation between ice movements and day-surface and subglacial relief. Relief forming processes of the present and pre-glacial epoch as well as detailed studies of coastal areas are also represented in the Atlas.

Now, the research team is in the process of creation of a similar "Geomorphologic Atlas of the Arctic", which will cover the territories and water areas up to latitude 65°north. New morphological approach will also serve as integration base for the data obtained by various Earth sciences.

Half a century of glacier changes by analysing different data sources: The 1954-2007 glacier variations in the ortles-cevedale group(Stelvio National Park, Lombardy, Italian Alps)

D'AGATA C.(1), MARAGNO D.(1), SMIRAGLIA C.(1), BOCCHIOLA D.(2), DIOLAIUTI G.(1)
(1) Universita milano, MILANO, ITALY ; (2) Politecnico, MILANO, ITALY

By analysing aerial photos, orthophotos and digital elevation models (DEMs) and by colleting and analysing field data (glaciological and geomorphological evidence) we reconstructed and described the recent evolution of a representative subset of Alpine glaciers (i.e.: 43 glaciers located in the Ortles Cevedale Group, Stelvio National Park, Italy). Our data cover half a century of Alpine glacier history (from 1954 to 2007) thus permitting to describe glacier changes on a long and representative time window. The analysis led to a quantification of glacier changes and a description of the occurring geomorphological processes.

We found a glacier surface area change of**-19.43 km^2,** ca. -40%, from 1954 to 2007. Small glaciers proved to contribute strongly to total area loss. The area change rate accelerated in the later period, with surface reduction between 2003 and 2007 amounting to ca. 8.7 %, equal to a mean area loss of ca. 0.693 km^2/year; the mean yearly loss over the previous periods (1954-1981, 1981-1990 and 1990-2003) were found equal to **0.242**km^2/year, **0.436**km^2/year and **0.476**km^2/year, respectively.The glacier volume change was evaluated in the time frame 1981-2007 and it resulted equal to – 766 x 10^^{6} m^3 which corresponds to a mean thickness change of – 18 m (-0.7 m/year). This value is in good agreement with glaciological data (mass balance evaluations) measured on the field in the same period on some selected glacier in the Ortles Cevedale Group and with geomorphological evidence like the youngest moraine ridges abandoned by the Ortles Cevedale glaciers since the end of the 1980s. From a geodynamical perspective Ortles Cevedale group is now experiencing transition from a glacial system to a paraglacial one. The areas where most recently the main shaping and driving factors were glaciers are now subject to the action of melting water, slope evolution, and dynamics and periglacial processes.

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The ratio between river-bed erosion and river-basin denudation in natural and natural-anthropogenic landscapes on plains of Northern Eurasia according to suspended sediment runoff of the rivers

KAZHOKINA V.
Kazan Federal University, KAZAN, RUSSIAN FEDERATION

Studies of suspended sediment load of rivers lead to the conclusion that it formed due to ero-sion of the river-bed and its banks (river-bed component) and the various processes of mechanical denudation on the surface of the river basin (basin component). Different researchers at different times have been proposed numerous methods of partitioning of suspended sediment runoff in the river-bed and river-basin components. All of these methods vary in methodology, source data, and accuracy.

For estimation of the ratio between intensity of river-bed erosion and denudation of river basins 350 basins have been selected. All basins are located in various landscapes on the plains of Northern Eurasia. This area is provided with published materials of observations in the hydrological stations. Studies show that in natural conditions river-bed washouts play the most important role in the for-mation of sediment load in the forest zone (river-bed component equals 61 – 76 % of total sediment volume). Closed vegetation cover of this zone prevents any manifestations of mechanical denudation on river basins where erosion is inactive. As area of forests reduces, the part of basin component in-creases to the north and south of the forest zone. Basin component reaches maximum in the semi-desert zone, where its part in sediment load achieves up to 81 – 89 %.

Denudation processes intensify on the surface of the river basins that strongly disturbed by hu-man activities. The total value of suspended sediment load and part of basin component in such basins always increase. In forest zone the part of river-bed component may be reduced in 20 – 30 times (up to 2 – 5 %). Human activity in the treeless natural zones reduces the part of river-bed component in 1.5 – 2.5 times.

Mechanisms of urban flood and surface runoff genesis in Oued Koriche catchment (Massif of Bouzaréah, western part of Grand Algiers, Algeria)

MENAD W.(1), ARNAUD-FASSETTA G.(2), DOUVINET J.(3), BELTRANDO G.(2)
(1) 8586 (PRODIG) du CNRS à Université Paris-Diderot (Paris 7), CHOISY LE ROI, FRANCE ; (2) UMR 8586 (PRODIG) du CNRS ? Université Paris-Diderot (Paris 7), 5, RUE THOMAS MANN '? 75205 PARIS CEDEX 13, FRANCE ; (3) UMR 7300 (ESPACE) du CNRS, Equipe d?Avignon ? Université d?Avignon et des Pays du Vaucluse, 74, RUE LOUIS PASTEUR, CASE 19 '? 84029 AVIGNON CEDEX 1, FRANCE

Oued Koriche catchment is one of hydrographic units which constitute Massif of Bouzaréah (western part of Grand Algiers). In November 9-10th, 2001, the Massif of Bouzaréah and especially Oued Koriche catchment experienced one of the most catastrophic hydrometeorological events in the history of the Mediterranean. Historical analysis of climatic events of the Mediterranean shows that the meteorological scenario that triggered this event was unexceptional (Argence, 2008; Menad *et al*., 2012), and the level of damages observed cannot be just explained through this factor. The mechanisms of the genesis and development of the hydrological response of Oued Koriche catchment are the key factors of disaster. Therefore, we made recourse to the numerical simulation tools (cellular automaton *RuiCells*). Our analysis strategy covers the following points. Several catchment parameters (meteorology, geomorphology, and anthropogenic actions) were progressivelyintroduced in order to evaluate the hydromorphological effectiveness of Oued Koriche hydrosystem. The impact (in space and time) of urban pressure on the hydrological response of the 9-10th November event was quantified. This research clarifies how the urban pressure induces a polygenic hydrological response in Mediterranean, anthropised catchment.

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A Micromorphological Assessment of Anthropogenic Features in Pre-Columbian Archaeological Layers: First Results for Crowned Mountains Sites in French Guiana

BRANCIER J.
Universite Paris I, PARIS, FRANCE

CrownedMountain sites are typical pre-Columbian settlements under rainforest, on hilltops, most often characterised by the presence of circular U-shape ditches. Such sites may have had a defensive or a symbolic role for necropolis. About forty sites were identified in Brazil, Suriname and in French Guiana. In most cases, 14C dates indicate that ditches were built around 1st cAD, but pottery remains reveal that different ethnic groups or cultures may have existed. In French Guiana, there is very few data on ancient human settlements on Crowned Mountain sites as only three of them were recently prospected and excavated by INRAP: MC 87 and MC 88 (near Regina) and Yaou (near Maripasoula). Applying a geoarchaeological approach combining stratigraphy and micromorphology, the objective of the present study is to identify anthropogenic features in the archaeological record. The aim is to distinguish between agricultural, habitation or necropolis activity areas in order to better understand site formation processes. Micromorphological study shows that archaeological layers are enriched in organic particle, charcoals and fine organic matter likely related to human occupation(s). In ditch infilling, rhythms of accumulation help to differentiate formation processes such as collapse or intentional backfill. In the enclosed area, both in ditch infilling and soils, yellowish unburnt oxic B horizon aggregates together with anthropogenic features related to fire such as charcoals and burnt soil fragments (rubefied and dark brown aggregates) stress that lateritic soil acted as support (i) for activities in the enclosure, and (ii) as reworked material in the ditch. These components may result from clearance for settlement, agricultural management and cultivation, or domestic activities. Locally, the presence of crescent clay coatings and infillings may indicate intentional fires (charcoals and ashes inputs) or bone inputs. Micro-laminated coatings could also suggest land clearance.

Hydrogeomorphic features and improvement strategies of some Mediterranean rivers in California, Spain and Italy: a comparison between the Russian, Ebro and Volturno rivers

DONADIO C.(1), MAGDALENO F.(2), KONDOLF G.M.(3)
(1) Department of Earth Sciences, Environment & Resources, University of Naples Federico II, NAPOLI, ITALY ; (2) 2CEDEX, Ministry of Public Works - Ministry of Agriculture, Food and Environment, MADRID, SPAIN ; (3) 3Department of Landscape Architecture and Environmental Planning, University of California, BERKELEY, UNITED STATES

The application of an interdisciplinary approach to river management in some fluvial environments is presented. Three large rivers in Mediterranean climate have been studied: Russian River in northern California (drainage area of 3,846 km2), Ebro River in northeastern Spain (85,530 km2) and Volturno River (5,550 km2) in southern Italy. The aim is to compare hydrological and geomorphic features to highlight natural and human-based evolution, considering climatic crises and river basin management in the last decades. Moreover, improvement strategies held in the last years to increase their ecological status and to reduce pressures on hydromorphological attributes are analyzed. These rivers have been facing increasing changes in hydrogeomorphic aspects, mainly due to river damming, coastal retreat and floodplain occupation. These changes have deeply altered the fluvial dynamics, modifying aquatic and riparian habitats and imposing large alterations in their ecomorphological connectivity. However, they are being actively managed nowadays to improve their ecohydrological status: habitat restoration for protected species and amelioration of flow regime in Russian River, improvement of river connectivity and reduction of hydrologic alteration in Ebro River, river banks and mouth recovery to reduce erosion in Volturno River are some of those strategies. Application of these tools shows that an integrated, adaptive approach suitable for Mediterranean rivers improves their ecological status restoring natural processes.

References: De Pippo T., Donadio C., Guida M., Petrosino C. 2006: The case of Sarno River (southern Italy). Effects of geomorphology on the environmental impacts. Environ. Sc. Pollut. Res.,13, 3, 184-191.

Kondolf G.M. & Piégay H. 2003: (Eds.) Tools in Fluvial Geomorphology. Wiley, UK, 688p.

Magdaleno F. 2011: Manual de técnicas de restauración fluvial (2nd ed.). Monogr. M-100, Secretaría General Técnica, Centro de Publicaciones, Min. de Fomento, Madrid, 300p.

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Variation of confluences of some large rivers in Brahmaputra basin, Assam, India

SARMA J.N., ACHARJEE S.
DIBRUGARH UNIVERSITY, DIBRUGARH, INDIA

Confluences of the three large rivers, viz. Dihang, Dibang and Lohit, which constitute the mighty Brahmaputra River in Assam, India, have shown dynamic character for a period spanning 87 years (1924–2011). The Lohit River was flowing westerly along regional slope of the area. Both the Dihang and the Dibang, flowing southerly joined the Lohit near Kobo and their combined flow flowed westerly as the Brahmaputra. The study indicates that although the channel patterns of these three large rivers remained same, their confluence points have moved both upstream and downstream since 1950. During 1924-1972 the confluences between the Dibang and the Lohit migrated 7.2 km eastward and that of the Lohit and Dihang 20 km southwestward. By 2001 the Lohit avulsed diverting its flow south-westward to meet the Dihang at about 40 km west of its earlier confluence. Since 2005 the Dibang got separated from the Lohit and flowed independently in south-westerly direction to meet the Dihang near Kobo. The processes that have controlled the confluence movements include river capture, avulsion and neotectonic activity. River captures of streams the Dangori and the Dibru by the Lohit occurred through lateral bank erosion. Both the Dibang and the Lohit avulsed to flow from south to south-west and west to south-west, respectively. The diversion of the flow of the Lohit to the south-west is also correlated to a neotectonic fault, which created the 85 km long Oakland-Guijan-Laina topographic scarp and the rivers Dangori and Dibru were flowing along the base of the same. Recent activity along this fault might have diverted the Lohit towards the base of the scarp to capture those two small rivers, thereby shifting its confluence point with the Dihang by 40 km.

Keywords: Brahmaputra, Confluence, River capture, Avulsion, Neotectonics.

Geomorphological and environmental studies of high Moulouya watershed by ArcGis and ASTER Imaging

BENYASSINE E.M.(1), DEKAYIR A.(1), DESRUELLES S.(2)
(1) UR- Geoexploration & Geotechnics, Faculty of Sciences, ZITOUN, MEKNES, MOROCCO ; (2) Université de Picardie Jules Verne, AMIENS, FRANCE

The use of GIS and remote sensing tools permit to display, to acquire and to manage all spatial reference informations, in order to model spatial and temporal phenomena. These new merely computer techniques became asked more and more concerning the studies of the impact on the environment. The morphogenesis survey of the the High Moulouya watershed is the product of a methodological approach based on the advanced geomatics. It allowed us to show at the same time the grounds deterioration as a consequence of several conjugated factors acting together, leading to a deterioration of this non renewable capital.

The objective of this work is to explain of the morphohydrographical and morphostructural variations of the high Moulouya watershed in regard to its geomorphological and geological characteristics. It is mainly founded on the combination of a surface numerical analysis and a traditional synthetic approach. The use of GIS on the basis of the topographic maps 1/50000 allowed us to get a digitized model by the river system of the studied zone for purpose to make a spatial distribution of the geochemical data of various environmental component of the Zeïda mining area.

The geomorphological study of the spatial analysis was made on the basis of SRTM data, especially to create a morphological maps such: the slope, ground digital model as well as the river system maps (built by the assembly of the flow accumulation and the flow direction) of the aforesaid zone.

The use of the spatial remote detection in the analysis of the ASTER 15m images using ENVI 4.7 software, allowed us to detect clayey formations which exist near the studied area, and the creation of the clays distribution map. Recognized their high potential to capture heavy metals, the spatial localization of clays is crucial to limit at least the most polluted zones.

Key words: GIS, ASTER 15m images, Zeïda mining area, High Moulouya watershed

Topic: Environnement, Gestion des Ressources en Eau

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Relationships between land cover, land use change and erosion-sedimentation processes at the watershed level: A multitemporal study in the Cointzio watershed, Mexico

MENDOZA M.E.(1), GRATIOT N.(2), LÓPEZ-GRANADOS E.(3), ARNAUD F.(4), MAGAND O.(5), PRAT C.(6), STEVES M.(2)
(1) UNAM, MORELIA, MEXICO ; (2) IRD, GRENOBLE, FRANCE ; (3) UMSNH, MORELIA, MEXICO ; (4) EDYTEM, LE BOURGET DU LAC, FRANCE ; (5) LGGE, GRENOBLE, FRANCE ; (6) IRD, MARSEILLE, FRANCE

Changes in land cover and land use (LCLU) have a relevant role in current local and global change processes which are directly linked with water and soil quality, runoff and sedimentation rates. Soil erosion and sedimentation have been extensively studied at the experimental watershed or plot level, whereas in larger areas further research is needed for evaluating similar relationships. This paper aims to investigate LCLU change processes within the Cointzio watershed (Central Mexico) and its relationship to soil erosion and sediment transport processes. The analysis covers a 28-year time period from 1975 to 2003. LCLU changes were derived from a multitemporal remote sensing analysis (1975, 1986, 1996, 2000 and 2003) while long-term soil erosion was reconstructed based on lake sediment deposition data. We found that 46 % all of the LCLU changes occurred between 1986 and 1996. Sedimentation discharge remained stable over the 1975-2003 period (1.4±0.6 $g.cm^{-2}.y^{-1}$), with the exception of two peaks (1975-1977 and 1991-1994; 3.1±0.6 and 2.6±0.6 $g.cm^{-2}.y^{-1}$, respectively) caused by exceptional rainfall events. The processes did not lead to changes in soil erosion and sediment transport rate likely due to the simultaneous positive (forest transition and scrubland increase) and negative changes (deforestation and forest degradation). We concluded that the poor correlation of LCLU changes to sediment discharge can be explained by a balance between negative changes that promote land degradation processes (e.g., erosion, mass wasting) and positive ones that reduce these kind of processes.

Improvement of Chang'E-1 Orbit Determination Accuracy by Space VLBI

YAN W.(1), WEI E.(2), LIU J.(3), LI C.(1), LIU J.(1), FENG J.(1)
(1) National Astronomical Observatories, Chinese Academy of Sciences, BEIJING, CHINA ; (2) School of Geodesy and Geomatics, Wuhan University, WUHAN, CHINA ; (3) GNSS Center, Wuhan University, WUHAN, CHINA

Chang'E-1 (CE-1) is China's first lunar probe and has been provided abundant information for China's lunar exploration (Ouyang et al.,2010). Precise orbit determination of CE-1 is crucial to lunar exploration because it is directly related to the implementation of various scientific researches such as determining lunar gravity field. However, the orbit determination accuracy of CE-1 can't meet the demand of high-precision applications like geodesy currently (Li et al.,2009, Cheng et al.,2011). How to improve probe orbit determination accuracy has become the main challenge of China's Lunar Exploration Program.

According to this background, Earth Orientation Parameters (EOP) and relativistic effect corrections are introduced into the orbit determination of CE-1 by a derived differential very long baseline interferometry (⊿VLBI) time delay model (Yan et al.,2011 and 2012). The calculation results show that the accuracy of CE-1 orbit parameters and EOP can be improved obviously compared with their predicted values. However, more precise results can't be obtained because of the restriction of relatively low accuracy and poor geometrical structure of ⊿VLBI time delay observations under current monitoring conditions. New strategies are required to overcome these problems.

Space VLBI (SVLBI) is an extension of ground based VLBI to space, which has many advantages such as improving the accuracy and geometrical structure of time delay observations, interconnecting different coordinates systems, calculating orbit parameters and EOP simultaneously and so on. So the application of SVLBI in orbit determination of CE-1 is expected to further improve the accuracy of unknown parameters. In this paper, a relativistic SVLBI time delay observations model for CE-1 Transfer Orbit is derived and the estimability of unknown parameters is discussed. The optimal observation conditions are determined and some useful results are given by the calculation of simulated observations.

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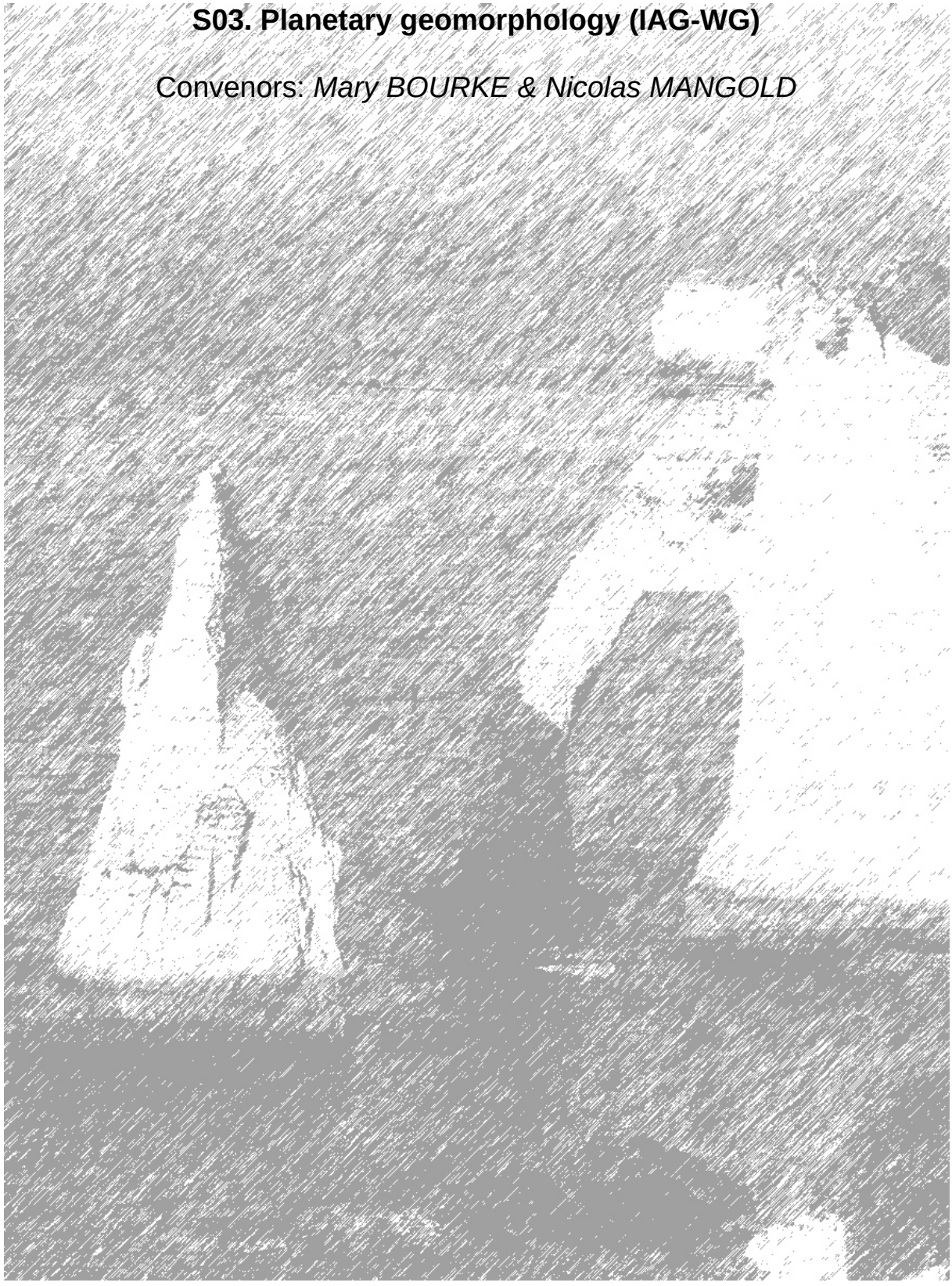
S03. Planetary geomorphology (IAG-WG)

Convenors: *Mary BOURKE & Nicolas MANGOLD*



Oral presentations:

Understanding the environmental fate of glaciovolcanic glass using the parallels between subglacial volcanism in Iceland and on Mars

DE VET S.(1), MERRISON J.(2), CAMMERAAT E.(1)
(1) IBED-Earth Surface Science, Unviversity of Amsterdam, AMSTERDAM, NETHERLANDS ; (2) Marslab, Department of Physics and Astronomy, University of Aarhus, AARHUS, DENMARK

Recent discoveries of volcanic glass on Mars show that amorphous materials are a vital ingredient in surface sediments and aeolian landforms. Mobilisation of these materials still occurs today based on geomorphologic evidence of erosion patterns and dune migration. Measuring a realistic fluid threshold for rolling of fresh glassy sediment was therefore the main aim of our study. In order to determine this threshold, we simulated the removal of a terrestrial analogue material in a low-pressure wind tunnel experiment.
Volcanic glasses on Mars most likely originated from glaciovolcanic eruptions and therefore share similar properties with volcanic glasses formed, e.g. in Iceland. Properties of the Martian glass particles are difficult to measure from orbit and hence we selected an unaltered analogue material from Iceland. Wind tunnel simulations at various atmospheric pressures were used to determine the shear stress required for removal by rolling. A semi-empirical model was fitted to predict removal on Mars. Various material properties of the glass were measured to evaluate the goodness of the obtained fit as a function the variation in material properties. We found that the model can be validly used to predict the removal on Mars. Large angular particles were found to be mobilised by rolling during strong winds and gust in the present-day environment of Mars. Abrasion of particles during win-induced rolling was simulated by rolling experiment for 15 weeks in rotating drums. As mobilisation of large particles is still at the limit of wind shears on Mars, their modification may have been much less than the textures that are commonly found in fine-grained aeolian sediments. This suggests that surface materials may have preserved a geochemical or physico-mechanical record of their subglacial eruption environment.

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Characteristics Of Basaltic Sand: Age-Dating Techniques And Understanding Size, Shape, And Composition As A Function Of Transport Process And Distance

CRADDOCK R.(1), ANDREWS B.(1), NANSON G.(2), ROSE T.(1), TIRSCH D.(3), TOOTH S.(4)
(1) Smithsonian Institution, WASHINGTON, DC, UNITED STATES ; (2) University of Wollongong, WOLLONGONG, AUSTRALIA ; (3) Institute of Planetary Research, German Aerospace Center (DLR), BERLIN, GERMANY ; (4) Institute of Geography and Earth Sciences, Aberystwyth University, ABERYSTWYTH, UNITED KINGDOM

The chemical and physical characteristics of sedimentary material can provide valuable clues about transport processes, distance traveled, and provenance. For a typical sedimentary deposit on Earth, for example, it has been shown that the ratio of feldspar to quartz can be used to assess the maturity (or transport distance) of a terrestrial deposit, because feldspar is more vulnerable to weathering than quartz. Further, chemical analysis can also be used to determine potential sediment sources, and grain-size sorting can be used to distinguish aeolian sediments (typically well-sorted) from fluvial sediments (poorly sorted in high energy environments). It is also common to use the shapes of individual quartz particles to determine transport process and distance, all of which can help us better understand the history of a sample of sedimentary material and the geological processes that created and emplaced it.
These traditional sedimentological concepts are now being applied to our interpretation of Martian surface materials. While such an approach seems logical, the problem is that most of our current understanding is based on sediments derived from felsic materials (e.g., granite) primarily because that is the composition of most of the landmass on the Earth. However, the Martian surface is composed primarily of basalt, which generates much different sedimentary particles as it weathers. Instead of quartz, feldspar, and heavy minerals commonly found in most terrestrial sedimentary deposits, basaltic sediments are composed of varying amounts of olivine, pyroxene, plagioclase, and vitric and lithic fragments. We are currently documenting the physical and chemical changes that take place in basaltic sediments as they are transported by wind, water and ide over increasing distances. This will result in an improvement in our understanding of traditional sedimentological concepts when applying them to Martian surface materials.

Action of sublimation in the formation of spiral-shaped ice megadunes on the martian polar caps

HERNY C.(1), CARPY S.(1), BOURGEOIS O.(1), PERRET L.(2), LE MOUELIC S.(1)
(1) Laboratoire de Planetologie et de Geodynamique de Nantes, NANTES, FRANCE ; (2) Laboratoire de recherche en Hydrodynamique, Energétique et Environnement Atmosphérique, NANTES, FRANCE

Orbital probes have revealed that martian polar caps comprise spiral-shaped ice megadunes. These dunes have a singular dynamic probably linked to their composition. Observations reveal that ice ablation occurs dominantly downstream of the megadunes, while ice condensation dominantly occurs upstream. Thereby the dunes move upwind. This phenomenon has been attributed to the combined action of katabatic winds and sublimation.

We propose to lead a physical downscaled experiment in an atmospheric wind tunnel to study the action of sublimation as a geomorphic control agent on the development of ice dunes. The experimental setup will comprise enable the generation of an air flow around a topographic object in order to study sublimation and condensation processes over time. The scaling of the experiment is based on a compilation of martian orbital observations available in the literature. We choose CO_2 ice as an analogue for the ice of martian caps in the experiment because of its ability to sublimate at terrestrial P/T conditions. An optical method (Particle Image Velocimetry) allows reconstructing the velocity field around the topographic object and a thermal method is used to estimate the rate of sublimation.

The first results of the experiment will be compared to orbital data on the Martian polar caps and to similar landforms on Earth, such as in Antarctica. This work will serve as a database to validate a numerical code taking into account ice phase changes and wind.

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Active geysers, dark flow and 'Spiders' in the Martian polar region

SCHMIDT F., ANDRIEU F., GARGANI J., COSTARD F., MASSOL H.
CNRS UMR8148 IDES, ORSAY, FRANCE

Discovered one decade ago with the high-resolution imaging camera, “spiders” are dendritic network, with a shape that looks like an arthropod. At the early spring, spiders are often associated with a dark fan that usually begins at the center of the feature. Later in the spring, dark flows develop episodically from these dark fans. These active processes have no analogues on Earth and may imply liquid water or CO_2 gas or other fluids. One class of model proposes that dark spots are formed in presence of liquid water below the CO_2 ice. Alternatively, the Kieffer model assumes a CO_2 jet formed by sublimation beneath a translucent slab ice.

Every year, during the polar winter, the surface temperature is low enough to condensate atmospheric CO2 (140 K). In the springtime, a layer of condensed CO_2 drapes the whole landscape with a thickness up to 1 meter. The spiders’ formation is most probably related to the CO_2 sublimation during the spring. According to Kieffer model, sublimation occurs at the bottom of a translucent CO_2 ice layer creating a trapped gas that goes into pressure. When pressure is large enough to crack the surface CO_2 layer, the gas escapes, carrying a large amount of dust and creating the vents and fans. The spiders are the cavities built in the regolith by this venting process.

Most recent studies using spectroscopic analysis, thermal measurements, geomorphologic studies imply a complex scenario of formation.

Remnants of an equatorial glaciated valley landsystem in Valles Marineris (Mars)

GOURRONC M.(1), BOURGEOIS O.(1), MÈGE D.(2), POCHAT S.(1), BULTEL B.(3)
(1) LPGNantes, Université de Nantes, CNRS, OSUNA, NANTES, FRANCE ; (2) Institute of Geological Sciences, Polish Academy of Sciences, WROCLAW, POLAND ; (3) Laboratoire de Géologie de Lyon, Université Claude Bernard Lyon 1, ENS Lyon, LYON, FRANCE

Various ice-related features occurring on the floor of Valles Marineris suggest that this canyon system that stretches along the Martian equator has experienced a period of past glacial activity. Three regions of Valles Marineris were investigated, Coprates Chasma, Candor Chasma, and Ius Chasma. Geomorphological observations are based on images and altimetry analysis by using the Context Camera (CTX), the High Resolution Imaging Science Experiment (HiRISE) and MOLA PEDR single tracks. The study reveals some features reminiscent of a past glaciated valley landsystem in these regions. A line running along the base of valley wallslopes and associated with spur and gully morphology can be interpreted as a periglacial trimline. Other landforms on the floor of Candor Chasma can be interpreted as stagnant ice features such as polygonal terrains, chaotic terrains which look similar to terrestrial ablation moraines with kettle holes. Ancient ice probably also persists now in Candor Chasma in the form of a debris covered glacier with a surface elevation that is consistent with that of the trimline. In Coprates Chasma, hanging valleys provide additional evidence for the former existence of an extensive glacial filling of Valles Marineris. Terraced mounds resting on the floor of Coprates Chasma and around basement domes can be interpreted as stagnant remnants of stratified ice. Altogether, these landforms define a full glacial landsystem consistent with global climate models that predict glaciations in Valles Marineris during the Late Amazonian.

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Deep-seated gravitational spreading in Valles Marineris ' observations and modeling

KROMUSZCZYNSKA O.(1), MAKOWSKA M.(1), GUEYDAN F.(2), GURGUREWICZ J.(3), MEGE D.(4)
(1) WROONA Group, Institute of Geological Sciences, Polish Academy of Sciences, Research Centre in Wroclaw, WROCLAW, POLAND ; (2) Géosciences Montpellier, UMR 5243- CC. 60 Université Montpellier 2, MONTPELLIER, FRANCE ; (3) WROONA Group, Institute of Geological Sciences, Polish Academy of Sciences, Research Centre in Wroclaw & Space Research Centre, Polish Academy of Sciences, Bartycka Warszawa, WROCLAW & WARSZAWA, POLAND ; (4) WROONA Group, Institute of Geological Sciences, Polish Academy of Sciences, Research Centre in Wroclaw & Laboratoire de planétologie et géodynamique, UMR CNRS 6112, University of Nantes, France, WROCLAW, POLAND

Deep-seated gravitational spreading (DSGS) of topographic ridges (sackung) has been interpreted in the Valles Marineris canyon on Mars on the base of identification of ridge-top splitting and uphill-facing normal fault scarps. DSGS features are much larger on Mars than on all documented DSGS instances on Earth. In order to quantify this difference, scarp dimensions obtained using Mars Reconnaissance Orbiter/CTX orbital images and stereo-derived DEMs have been compared with scarp dimensions at textbook terrestrial analogues in the Polish and Slovakian Tatra Mountains, obtained in the field using WADGPS and tape measurements. In the Tatras, the vertical offset of individual DSGS fault scarps does not exceed ~10 meters, whereas in Valles Marineris fault vertical offset is 40-1000 metres. Therefore, at least one order of magnitude of difference in scale exists between the terrestrial and Martian DSGS occurrences.

In both instances, DSGS has been interpreted to be a postglacial process. DSGS triggering, strain localization, and how ridge deformation proceeds in the terrestrial and Martian cases are investigated and compared using a finite element approach constrained by the observed distribution and quantification of ridge strain. Effect of ridge confinement by valley glaciers and viscous stress relaxation after deglaciation are accounted for. The rock weakening effects of water circulation and freezing/defreezing cycles in the ridge on the evolution of rock mass strength is considered. The first results relating to DSGS triggering and strain localization will be presented.

The latitudinal distribution of putative periglacial sites on the northern plains of Mars

BARRETT A., BALME M., PATEL M., HAGERMANN A.
The Open University, MILTON KEYNES, UNITED KINGDOM

Periglacial landscapes are found in cold regions on Earth where the freezing and thawing of the permafrost active layer plays an important role in shaping the landscape. A variety of distinctive landforms such as sorted circles, thermokarst depressions and solifluction lobes are indicative of periglacial environments on Earth. It has been suggested that similar features on the northern plains of Mars could be the result of the same, or similar processes. Since the formation of a periglacial landscape requires the freezing and thawing of water their presence on Mars would indicate that the thawing of water-ice has occurred in the geologically recent past. Periglacial landforms could have formed in past periods of higher obliquity when the environment was more conducive to the action of liquid water or due to the depression of the freezing point by brines under current conditions.

We have conducted a survey of putative periglacial landforms across the northern Martian plains. Over 400 HiRISE images of the walls and floors of >1 km diameter craters have been examined to map the locations of these landforms across regions of Acidalia, Utopia and Arcadia Planitia between 30 and 80 ^{o}N. These data allow an assessment of the latitudinal distribution of these features. Variations between the types of landform found in different regions of the Northern Plains of mars can also be assessed.

Scalloped depressions and gullies have a similar latitude range, and are frequently found south of 60^{o}Nsimilar features to the scalloped depressions of Utopia Planitia have been observed in both Acidalia and Arcadia Planitia, but are not found over as wide a range of latitudes in Acidalia. Possible sorted landforms (lobes, polygons etc.) can be found as far south as 40 and as far north as 70^{o}N but most are found between 45-65 ^{o}N. They seem to occur over a wider range of latitudes in Utopia Planitia than in Acidalia.

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Investigation of possible coastal and periglacial landforms in Gale Crater, Mars

LE DEIT L.(1), HAUBER E.(1), FUETEN F.(2), PONDRELLI M.(3), ROSSI A.P.(4), JAUMANN R.(1)
(1) DLR, BERLIN, GERMANY ; (2) Brock University, ST. CATHARINES, CANADA ; (3) IRSPS, PESCARA, ITALY ; (4) Jacobs University, BREMEN, GERMANY

The martian surface water reservoir appears to have been affected by a major change at the Late Noachian/Early Hesperian Epoch. The 150 km diameter Gale crater (-5.4°N, 137.9°E) was formed at this time, ~3.6 Ga ago, and is currently investigated in situ by the Mars Science Laboratory (MSL) rover, Curiosity. Gale is filled by sedimentary deposits including a crescent-shaped mound of layered deposits, Aeolis Mons (informally also named Mount Sharp), up to 5 km high and 6000 km^2 in area. In order to reconstruct the paleo-environments and the associated hydrological systems that existed within Gale, and their evolution through time, we provide a geomorphological study of landscapes using CTX and HiRISE images, and a HRSC DEM.

Possible morphologic indicators of the existence of a paleolake include a Gilbert-type delta, terraces, possible shorelines, and layered deposits on the crater floor. They are all located in the same elevation range, between -4450 m and -3700 m. The more confident detections of sulfates and phyllosilicates are also located at these elevations, which would correspond to the ancient lake levels. Assuming that the lake floor elevation corresponds to the current floor elevation, its maximum volume would have been 3615 km^3 with an average water depth of ~590 m. Lobate and fan-shaped deposits lie along the flanks of Aeolis Mons and at its base. They likely result from slow movements such as creeping as for rockglaciers. Other fan-shaped deposits are located at the mouth of deep re-entrants with steep headwalls on the western and southern slopes of Aeolis Mons. They share morphologic similarities with retrogressive thaw slumps on Earth, which result from the thaw of ice-rich permafrost. These possible periglacial landforms suggest the former presence of ice-rich permafrost, possibly under high obliquity conditions during the Hesperian. Consequently, Gale crater would have been a periglacial region that once hosted a lake.

Depositional Environment of Large Alluvial Fans in Saheki Crater, Mars

HOWARD A.(1), MOORE J.(2), MORGAN A.(1), HOBLEY D.(1), WILLIAMS R.(3), BURR D.(4), DIETRICH W.(5), WILSON S.(6), MATSUBARA Y.(1)

(1) University of Virginia, CHARLOTTESVILLE, UNITED STATES ; (2) NASA Ames Research Center, MOFFETT FIELD, CA, UNITED STATES ; (3) Planetary Science Institute, TUCSON, AZ, UNITED STATES ; (4) University of Tennessee, KNOXVILLE, TN, UNITED STATES ; (5) University of California, BERKELEY, CA, UNITED STATES ; (6) Smithsonian Institution, WASHINGTON, D.C., UNITED STATES

Alluvial fans extend up to 40 km into the interior of more than 110 Martian craters. The fans have gradients of about 2 degrees and are sourced from interior-rim drainage basins. Saheki crater contains the best exposures of fan stratigraphy due to selective post-deposition wind erosion that has raised gravel-floored distributaries into positive relief and exposed stratigraphic sections of interbedded fine deposits.

Distributaries generally extend from the crater apex to the fan terminus with sparse branching. Their tops are commonly paved with gravel estimated to have dominant grain sizes near the 25 cm/px resolution of spacecraft images; occasional meter-scale boulders are also seen. Wind erosion has resulted in distributaries becoming inverted by up to 80 m, exposing thick sections of bedded sediment on sideslopes. This bedded sediment is readily wind eroded, with visible layering of 1-3 m. Layers extend up to 1 km in the downslope direction, with local pinch-outs and possible unconformities.

We interpret the distributaries to have been formed by well-channelized fluvial flows depositing gravel in distributaries, with the thick layered wind-erodible sediment being deposited by overbank flows and dominated by granule-sized or finer grains. Alluvial fans in the Atacama Desert of northern Chile sourced from the Andean highlands are a potential analog.

Maximum discharges are estimated to range between 60-300 m^3/s, depending on sediment density and concentration. Runoff rates of 0.5 to 3 mm/hr would be required from the 340 km^2 upland basin. The most likely climatic environment generating runoff on these ~ 3.2 Ga fans would be from melting during favorable orbital configurations of annual or epochal snow accumulations. Our calculated runoff rates match existing estimates of possible discharge rates from melting snow on Mars.

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Surface dissolution on Titan: Ontario Lacus, Sikun Labyrinthus and other karst-like landscapes

CORNET T.(1), BOURGEOIS O.(1), LE MOUÉLIC S.(1), SOTIN C.(2), FLEURANT C.(3), LEFÈVRE A.(1), RODRIGUEZ S.(4), MALASKA M.(5), BARNES J.W.(6), BROWN R.H.(7), BAINES K.H.(5), BURATTI B.J.(5), CLARK R.N.(8), NICHOLSON P.D.(9)

(1) LPGNantes - Université de Nantes - UMR CNRS 6112 - OSUNA, NANTES, FRANCE ; (2) JPL/LPGNantes, PASADENA, UNITED STATES ; (3) LETG - UMR CNRS 6554 - OSUNA, ANGERS, FRANCE ; (4) LAIM - CEA Saclay, GIF SUR YVETTE, FRANCE ; (5) JPL, PASADENA, UNITED STATES ; (6) University of Idaho, MOSCOW, UNITED STATES ; (7) LPL, TUCSON, UNITED STATES ; (8) USGS, DENVER, UNITED STATES ; (9) Cornell University, ITHACA, UNITED STATES

Polar Regions of Saturn's major icy moon Titan are dotted with hundreds of closed depressions. Some of these are covered by liquid methane/ethane, which are metastable under Titan surface conditions (93 K, 1.5 bar). A karstic origin of these depressions seems highly likely [1,2].

Ontario Lacus, the widest depression of the southern hemisphere (235×75 km) is a flat-floored rounded depression lying within a wide and flat sedimentary basin. It appears to be liquid-covered over half of its surface, while the rest of the depression floor is probably composed of damp and smooth solid hydrocarbons. Landforms and climate of the area are close to those of the Etosha Pan [3], a karsto-evaporitic depression located in the southern part of the Owambo Basin (Namibia). This basin is covered by a superficial layer of calcretes that has formed and has been carved by repeated cycles of evaporitic crystallization and dissolution of calcium carbonates under a semi-arid climate. According to this analogy, Ontario Lacus may have form by dissolution of a surface layer soluble in liquid hydrocarbons. Sikun Labyrinthus, a region located at similar latitudes, also exhibits landforms diagnostic of dissolution processes. Dissected plateaus, polygonal terrains, remnant ridges and empty depressions are interpreted as fluviokarst, cockpit, tower karst and polje-like landforms [4,5].

Karst-like landforms are also observed in other regions, suggesting that the dissolution of a surface layer is a major land-shaping process on Titan. This surface layer may have formed by (1) precipitation of solid hydrocarbons produced in the atmosphere, or (2) evaporitic crystallization of hydrocarbons previously dissolved in an alkanofer.

[1] Bourgeois et al. (2008), 39th LPSC. [2] Mitchell et al. (2011), 1st Int. Plan. Cave Res. Work. [3] Cornet et al. (2012), Icarus, 218(2). [4] Malaska et al. (2010), 41st LPSC. [5] Malaska et al. (2011), 1st Intern. Plan. Cave Res. Work.

Climate Change on Titan: Hypotheses and the Geological Record

MOORE J.M.(1), HOWARD A.D.(2)
(1) NASA ARC, MOFFETT FIELD, UNITED STATES ; (2) University of Virginia, CHARLOTTESVILLE, VA, UNITED STATES

On Titan climate dictates the intensity and relative roles of fluvial and aeolian activity from place to place and over geologic time. Hypotheses of Titan's climatic evolution fall into three broad categories, regulated and dominated by the role, sources, and availability of methane: Steady State, Progressive, and Cyclic. Preliminary mapping of putative basement rock indicates that it mostly appears within 30° of the equator. Equatorial ancient Uplands regions on Titan exhibit pronounced "crinkling" interpreted to be fluvially-dissected ridge and valley topography. We interpret smooth, dark areas within these uplands units as local sedimentary deposits, often apparently in old craters. Low mid-latitudes contain obvious concentrations of circular features that may be radar bright or radar dark. We provisionally interpret these regions as heavily degraded and partially sediment covered cratered terrains. High mid-latitude regions on Titan exhibit dissected sedimentary plains at a number of localities. Much of the high mid latitudes are otherwise relatively featureless, as are much the lake-dotted polar regions, consistent with these latitude belts being dominated by plains-forming fluvial and lacustrine sediment. The types of terrains seen on Titan may be difficult to reconcile with a simple steady-state scenario. For Titan to have still-recognizable cratered terrains *and* ongoing fluvial activity could imply one or more of at least three possible explanations: (1) alkane fluvial erosion on Titan is extremely inefficient relative to that by water on the Earth and Mars; (2) fluvial erosion very rarely (or briefly) occurs on some regions on Titan; and/or (3) it has started raining on Titan only in geologically recent times. We are currently investigating which climate scenarios best fit the suite of landforms found within given regions, and as well might explain the latitudinal arrangement of regions across the face of the satellite.

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Evolution of terrestrial and Titan's rivers

MISIURA K., CZECHOWSKI L.
Warsaw University, WARSZAWA, POLAND

Titan is the only celestial body, beside the Earth, where liquid is present on the surface as lakes and rivers. In our research we use numerical model of the river to determine differences of evolution of rivers on the Earth and on Titan. We have found that transport of sediments on Titan is more effective than on Earth for the same river geometry and discharge.

Titan is a very special body in the Solar System. It is the only moon that has a dense atmosphere and flowing liquid on its surface. The Cassini-Huygens mission has found on Titan meandering rivers, and indicated processes of erosion, transport of solid material and its sedimentation. This paper is aimed to investigate the similarity and differences between these processes on Titan and the Earth.

The dynamical analysis of the considered rivers is performed using the package CCHE modified for the specific conditions on Titan. The package is based on the Navier-Stokes equations for depth-integrated two dimensional, turbulent flow and three dimensional convection-diffusion equation of sediment transport.

We considered our model for a few kinds of liquid found on Titan. The liquid that falls as a rain (75% CH_4, 25% N_2) has different properties than the fluid forming lakes (74% C_2H_6, 10% CH_4, 7% C_3H_8, 8.5% C_4H_{10}, 0.5% N_2). Other parameters of our model are: inflow discharge, outflow level, grain size of sediments etc. For every calculation performed for Titan's river similar calculations are performed for terrestrial ones.

We compare results of our calculation for flow of different liquids and for sediment transport for the Earth and for Titan. The basic statement is that on Titan the transport of sediment is more efficient than on Earth for rivers of the same geometry and total discharge.

We are very grateful to Yaoxin Zhang and Yafei Jia from NCCHE for providing their program – CCHE2D.

Martian valley network geometry from mars express stereo images topography: implication for martian climate.

ANSAN V., MANGOLD N.
LPGNnantes, NANTES, FRANCE

Since visible images have been acquired by Viking orbiter in 1976, valley networks have been mainly identified in the heavily cratered uplands dated Noachian (>3.5 Gyr). Valley networks on Mars have been the subject of considerable debates about their formation processes and their implications on the early Mars climate.

Based on orbital images, the branching valley networks could be classified in two groups: 1) dense valley networks with numerous tributaries and 2) valley networks with poor number of tributaries. The latter sometimes display small delta fans formed during a short time of fluvial erosion that requires episodic fluvial flows but likely not a globally different climate. For the dense valley networks, no erosion product is usually observed because they were subsequently eroded, or covered by later deposits (especially Hesperian lava flows). From crater counts, they seem to be mainly formed during the Late Noachian to the Early Hesperian.

Since 2004, the HRSC camera has acquired visual images in stereoscopic mode with typical spatial resolution of ~10m for the nadir images. Digital Elevation Models (DEM) can be generated with a spatial resolution of ~50 m. Based on this dataset, about 10 times better than the laser altimeter topography, we studied the branching valley networks in order to characterize the degree of erosion in different periods of Mars.

Our results show that the drainage density seems to be higher for younger terrains. The branching pattern is better preserved for young valley networks, even if the lithology and climatic proxy were not constant spatially and temporally during the Mars history. Second, although the young valley networks are more preserved, the power of fluvial erosion was higher during the Noachian with a higher vertical incision related to wider valleys. These results also show that 2D parameters cannot be used to derive the degree of incision and that the topography must be used to derive the actual degree of incision.

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The third dimension of surface process: using hydrological analysis of high-resolution elevation data on the Moon, Mars and Earth to evaluate the action of water

CONWAY S.J., BALME M.R.
Open University, MILTON KEYNES, UNITED KINGDOM

Planetary geomorphology commonly relies on comparison of the morphologies of surface features in two-dimensional image data. Such comparisons can suffer from problems of equifinality, where features formed by different processes look similar. A good example of this are gullies on Mars, which have been attributed to overland flow, debris flow, dry mass wasting and other exotic processes. On Earth, and ever increasingly on the Mars and the Moon, elevation data are being commonly used to provide stratigraphic relationships. With the growing availability of high resolution ~1 m/pix elevation data on all three bodies, avenues are opening for more detailed and complex investigation. Here we build on our previous work using terrain analysis techniques, previously primarily used in hydrological studies on Earth, to add the third dimension to the analysis of surface processes on planetary bodies.

We use stereo satellite images to build elevation models at 1-2m/pix on Mars and the Moon, and LiDAR data to build equivalent models on Earth. The terrain analysis relies on the analysis of local (e.g., slope, curvature) and far-field (i.e. those taking into account the upstream characteristics of the topography, such as distance from divide, upstream drainage area) terrain derivatives. We have already shown using these techniques that landscapes formed predominantly by overland-flow, debris flow and rockfall are distinguishable on Earth. We have also been the first to apply this work to Mars. Here we extend this work, to look at other surface processes and, for the first time, present analysis of the lunar surface.

The morphology and distribution research of boulders in Lunar Sinus Iridum

ZOU X., LIU J., ZHAO J., WANG W., LI C.
National Astronomical Observatories, Chinese Academy of Sciences, BEIJING, CHINA

Boulders scattered all over the lunar surface were revealed by high-resolution cameras on current space crafts. The causes of boulders are mostly from cratering ejection, some are made by microsize impact or slope colapsions. The chinese first lunar lander/rover Chang'E-3 is planed to land in the Sinus Iridum landing area in 2013. Using the high resolution image data, we can analyze the topographic features of the area. The first goal of our reseach is to reduce the risk of the Chang'E-3 meeting boulders during its soft landing in the area. With recognizing and measuring, we can get the size (length, width, height and volume) and pozition (x, y, z within lunar control framework) of each boulder from Chang'E-2 1.5m and LRO 0.5m high-resolution images. After that we established the boulder database which is also a great tool to research the classification, intensity and timeline of the lunar surface evolution.

Using the boulder measurements we find out many facts about the morphology, gathering type and disribution of boulders. Firstly, we maped 15.4 thousand boulder-groups of the area, sort them by their causes and distribution, and compare their difference in morphology. The boulder-groups covered about 10% of the area. Then, we calculate 211 boulders' height by measure their shadow lenth and the surface slope. We use differrent models to calculate different illumination cases to improve the accuracy. The statistics shows that most boulders are from secondary cratering causes and they are most fat-short rather than slim-tall. After all 17.0 thousand diameter measurements of boulders were made. The results shows that the bigest boulder is more than 23m long and the average size of detected boulders is 4.6m. In the last part of our research we used theoretical methods to research the morphology evolution of the region.

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Poster presentations:

A Valles Marineris synthesis

DEBNIAK K.(1), MEGE D.(1), GURGUREWICZ J.(1), MASSE M.(1), FORGET F.(2), LUCAS A.(3), SPIGA A.(2)
(1) Polish Academy of Sciences, WROCLAW, POLAND ; (2) Universite Pierre et Marie Curie, PARIS, FRANCE ; (3) California Institute of Technology, PASADENA, UNITED STATES

The Valles Marineris giant trough system opens an up to 10-km deep window into the geology of the Martian crust. Tectonic, volcanic, sedimentary, and erosional processes spanning a range of ~4 g.y. have been recorded along the trough walls and on their floor. They testify to a succession of paleo-environments and paleoclimates which have been a matter of debates since the Viking era. Far from being closed, these debates have been enriched and complexified by the accumulation of the subsequent datasets obtained by the Mars Global Surveyor (MGS), Mars Odyssey, Mars Express (MEx), and Mars Reconnaissance Orbiter (MRO) spacecrafts. The abundance of datasets, their diversity, very high resolution of visible imagery, as well as the small number of researchers involved in Valles Marineris exploration, contributed to thematic and geographic dispersion of studies to such a point that synthesis and correlation of previous works are necessary. From this point, new views and a new coherent framework for Valles Marineris evolution can emerge.

The undertaken study consists in the realization of a GIS of Valles Marineris that will include mosaics of selected datasets (MRO/CTX VIS images, Mars Odyssey/Themis night-time IR images, MGS/MOLA PEDR and DEM, MEx/HRSC images and DEMs, MRO/HiRISE images and DEMs), existing regional maps (MEx/OMEGA and MRO/CRISM mineral maps, gravity and magnetic maps), new regional or local maps (CTX DEMs, climate/paleoclimate models), basic geomorphologic description layers (in which geomorphology is not interpreted in terms of processes and environments), and advanced geomorphologic and geologic interpretation layers (in which processes and paleoenvironmental interpretations are proposed by the authors). The state of the art of this project, expected to be completed in 2015, will be presented.

Karst landforms as a geomorphic marker to record stratigraphic and litologic units in Sinus Meridiani (Mars)

BAIONI D., SGAVETTI M.
PARMA UNIVERSITY, PARMA, ITALY

Sinus Meridiani region is located next to Martian equator between 1°20' N to 2° 20' N latitude and 2° 50 ' W to 1°E longitude, covering an area of about 20,000 square kilometres, characterized by spectral signatures of evaporitic minerals.

A morphological and morphometric investigation of the study area through an integrated analysis of eighteen Reconnaissance Orbiter (MRO) High Resolution Imaging Science Experiment (HiRISE) was performed.

The analysis highlighted the presence of karst landforms that resemble similarly karst landforms that can be observed in different karst terrains on the Earth. In particular, four distinct karst terrains was observed in the study area characterized by different features displaying different kind and degree of karstification.

These differences seem to indicate the different relative karst susceptibility due to different solutional properties of these four units. Moreover, the results of this study suggest that the karst landforms can be used as useful geomorphic marker to record different units from the compositional and/or mineralogical point of view in the Sinus Meridiani area.

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Morphological characterization of landforms produced by springtime seasonal activity

GARGANI J.(1), JOUANNIC G.(1), COSTARD F.(1), BOURGEOIS O.(2), MASSÉ M.(3), CARTER J.(4), MARMO C.(1), NACHON M.(2), ORI G.(5)
(1) Univ. Paris-Sud, ORSAY, FRANCE ; (2) Univ. Nantes, NANTES, FRANCE ; (3) Polish Academy of Sciences, WROONA group, WROCLAW, POLAND ; (4) European Southern Observatory, VITACURA, CHILE ; (5) Univ. G. d'Annunzio, PESCARA, ITALY

On the basis of HiRISE images, we show that some perennial landforms on the Martian dune Russell are shaped by current seasonal viscous flows that occur during spring, after complete disappearance of the winter CO_2 ice layer, and are able to erode their substrate. These perennial landforms comprise a complex interconnected rills system that has morphological similarities with networks of meltwater channels on some terrestrial temperate glaciers. Activity has been recorded each year between 2007 and 2011 in this rill system, which grew at a rate of 10000 $m^2.yr^{-1}$. The morphology of the rill system is consistent with viscous flow of a material able to erode as well as to carry a non negligible quantity of sand. There are at least four processes that could explain the physical properties of these perennial rills estimated in this study: (1) brine flow, (2) liquid water flow mixed with sand, (3) liquid water flow mixed with snow or ice, (4) a combination of the previous three processes. The formation of these perennial rills occurred through multiple pulses probably in relation with a daily freeze/thaw cycle. Different methods have been used to estimate the velocity of flow required to form these perennial rills. The velocity estimated using image comparison (~10^{-3} - 10^{-4} $m.s^{-1}$) is smaller than the one estimated using the mechanical threshold of motion for sand grains (~10^{-2} - 10^{-3} $m.s^{-1}$) or to the one obtained by modeling the viscous flow dynamic (1 $m.s^{-1}$ – 20$m.s^{-1}$).

Impactive processes and morpholitogenes

YURY E.
Kuban State University, KRASNODAR, RUSSIAN FEDERATION

Meteorite craters are widespread on a surface of Earth and other planets. Crater landscapes of the Moon, Mars, Mercury and many satellites in Solar system were formed generally as a result of repeated blows of meteorites, fireballs, comets of various scale(Efremov,1999).

Space bodies and terrestrial gravitational processes (avalanches, landslides, collapses and mud streams) transform a surface on which they fall. Thus there are the special genetic forms of a relief named us impact one. At such influence in rocks and friable deposits there are considerable changes. At blows of space bodies rocks and minerals transform in and move on the periphery of a explosion crater. Therefore we selected special impactive.

Consider versia features of formation and transformation of impact relief and friable deposits it is necessary to allocate the next morpholitogenes classes: meteorite-shock, avalanche - shock, gravitational - shock.

Meteorite – shock morpholitogenes. Mechanism of influence of space bodies on a surface of Earth is well studied. At the same time varieties such morpholitogenes are a little known.

Avalanche - shock morpholitogenes. Formation of such forms of a relief possibly only under certain conditions. Shock forms are located in areas of the ancient glacianion being characterized bysteepslopes of glacial trough valleys or deep erosive valleys. Formation of the specified forms of a relief occurs in areas to considerable moistening, a frequent descent of avalanches and a large number of fragments of rocks.

Gravitational - shock morpholitogenes. About shock impact of landslide, and mudflow masses on a spreading bed it is a little known. Thus, now it is possible to explain an origin of a Earth relief and other planets of Solar system not only result of action of gravitational, endogenetic and exogenous processes, but also cosmogenical factors - in blows of space bodies to spreading bed.

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Formation and evolution of river deltas on Titan and Earth

WITEK P.
Institute of Geophysics, University of Warsaw, WARSZAWA, POLAND

River deltas are created as a result of transport and deposition of sediments by flowing liquids. These landforms are known to exist on Earth, Mars and Titan, the largest moon of Saturn. Titan is the only celestial body other than Earth where current surface conditions allow the fluids to exist and shape the surface. Lakes of liquid hydrocarbons and river valleys have been observed by Cassini probe. At the shore of Ontario Lacus, the largest lake of the southern hemisphere, there exist a feature interpreted as a two-lobed river delta. We simulate the flow and sediment transport to understand similarities and differences of sedimentary processes between Titanian and terrestrial rivers. We consider several possible chemical compositions of the flowing liquid and sediments for our models of Titanian rivers. We use two-dimensional depth-averaged hydrodynamic numerical model, based on the Reynolds approximation of momentum equations and the continuity equation. Additional equations are used to describe bed-load transport, suspended sediment transport and deposition.

The Geomorphology of Lyot Crater, Mars

BALME M.(1), GALLAGHER C.(2), CONWAY S.(1)
(1) Open University, MILTON KEYNES, UNITED KINGDOM ; (2) University College Dublin, DUBLIN, IRELAND

Lyot crater, Mars, is a relatively young (<3 Ga), deep (~ 7 km below Mars datum) impact basin situated at about 50°N, just north of the dichotomy boundary. The impact almost certainly penetrated the cryosphere, and would have exposed any groundwater zone existing beneath. Recent studies have linked large fluvial channels located outside Lyot's ejecta blanket with impact-release of groundwater or melting of ice [1], and small fluvial channels within the basin with much later climate-related events [2]. Thus the deposits and channel systems in and around Lyot crater provide an ideal study area for (i) investigations aimed at exploring the sediments and volatiles excavated during impact and perhaps a way of testing whether there was a groundwater zone, and (ii) studies of glacial and periglacial environments useful for understanding water on Mars throughout its history.

We present preliminary mapping of the various ice- and water-related landforms found in and around Lyot crater. Of particular interest are polygonal networks of metre-scale clasts, and a variety of channels, fans and lobate flows. The lobate flows exists within the crater rim and in high relief areas outside the crater. Fluvial-like channels and fans are seen both within the crater and on the ejecta blanket. The networks of polygonal clasts occur only on the eastern margins of the continuous ejecta blanket, at a radial distance of about 300 km from the crater centre. This pattern suggests that the emplacement of these landforms is genetically related to the impact.

Our working hypothesis is that the lobate flows, fans and chanels represent glacial/fluvial assemblages. The polygonal clast network is harder to explain, but could reflect the location of water-ice-rich zones in the ejecta blanket. Hence, this could be material excavated from the cryosphere during impacts and then reworked by periglacial processes at a much later time.

[1] Harrison, T.N., et al., GRL 2010. [2] Dickson, J.L., et al., GRL 2009.

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Numerical model of flow in some martian valleys

CZECHOWSKI L., WITEK P., MISIURA K.
University of Warsaw, WARSZAWA, POLAND

On the surface of Mars, under current conditions, liquid water could exist only occasionally in lowest regions of the planet. This water contains probably some components that decrease its freezing point and raised its boiling point. However billions years ago more dense atmosphere on the Mars allows for the presence of large volume of liquid water. There are a number of structures apparently resulting from owing liquid water in the past. They are of two types: outflow channels and valley networks. The Curiosity rover landed close to ancient river's valley, so some details concerning of the rivers flow on Mars will be known in the near future. In our research we investigate the possible flow in some chosen valley networks on Mars. The numerical model based on equations of turbulent flow is used. The erosion and transport of the solid material is described by another equation. We try to determine the basic properties of the flow, its erosion as well as the transport efficiency of the solid material. The comparison with the terrestrial rivers indicates some important differences that concern mainly the rate of erosion and sedimentation.

Geomorphological study of martian seasonal activity on the Kaiser crater dune field (46°10'S ; 18°50'E)

NACHON M.(1), GARGANI J.(2), JOUANNIC G.(2), COSTARD F.(2), CONWAY S.(3), BALME M.(3)
(1) Université de Nantes - Laboratoire de Planétologie et Géodynamique, NANTES, FRANCE ; (2) Université Paris-Sud XI - Laboratoire IDES, ORSAY, FRANCE ; (3) Open University - Department of Physical Sciences, MILTON KEYNES, UNITED KINGDOM

An increasing number of studies have shown that there is seasonal activity at high and medium latitudes on Mars, which leaves a lasting effect on the surface **[**e.g. **1**-**8]**. This seasonal activity takes a variety of forms (e.g., dark spots, dark flows, dust devil tracks, perennial rills, etc), and each generally occurs at the same time each martian year **[3**,**5**,**8]**.

The focus of our study is one of the largest barchan dunes in the Solar System (~7 km wide, ~300 m high), located on the dune field inside Kaiser crater (46°10'S ; 18°50'E). This barchan contains three groups of gully systems on the lee slope, which differ in morphology, orientation and location on the dune's slipface **[3]**.

We have used data from the High Resolution Imaging Science Experiment camera, onboard Mars Reconnaissance Orbiter, which provides high resolution images (~25 cm/pixel) over several martian years.

We have catalogued the occurrence of the various forms of seasonal activity occurring on the barchan, and focused on one particular type of activity which occurs in local autumn and winter and seems to originate in gullies. We have described in detail its evolution in morphology of this seasonal activity, that appears to involve significant quantities of dune material.

We have also described and characterised a discrete but relatively massive event that occurred in our zone of study.

We will discuss the processes that lead to this seasonal activity, which seem to be linked to the CO_2 seasonal cycle, and their impact on the long-term evolution of Martian dunes.

References : **[1]** Kieffer *et al.* 2006, Nature, 442:793–796. **[2]** Diniega *et al.* 2010 Geology, 38(11):1047–1050. **[3]** Dundas *et al.* 2010 Geophy. Res. Letters, 37:7202. **[4]** Gardin *et al.* 2010 JGR (Planets), 115:6016. **[5]** Reiss *et al.* 2010 Geophy. Res. Letters, 37:6203. **[6]** Hansen *et al.* 2011 Science, 331:575. **[7]** Kerezturi *et al.* 2011a, Planet. & Space Science, 59:1413–1427. **[8]** Jouannic *et al.* 2012 Planet. & Space Science, submitted.

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Mare Basalt thickness Model of Lunar Polar Regions

WANG W., LIU J., ZOU X., LI C.
National Astronomical Observatories, Chinese Academy of Sciences, BEIJING, CHINA

Thickness of Lunar mare basalts which cover most of the lunar craters and basins plays an important part in investigating the thermal history, lithospheric thickness, gravity field, and the effect of vertical impact. Basic approaches for determining mare thicknesses make use of a flooded crater's morphology, the composition of crater ejecta, and subsurface reflections observed in the radar sounding experiment. The interpretation of gravity anomalies can also be used to constrain the thickness of a mare deposit. In the 1970s, Eggleton, DeHon and Waskom produced lunar nearside maps of mare basalts with morphological methods. In 1998 and 2002, Oceanus Procellarum, Mare Humorum and Mare Smythii were studied by the Clementine multispectral data. After 1997, Yingst et al. calculated the lava ponds volumes of South Pole Aitken.

However, due to the coverage and resolution limitations of terrain and image data of historical exploration missions, the mare basalts distributions in the lunar polar region are little concerned. In this paper, based on the image and topography data from CE-2 and LRO missions, and gravity data from SELENE mission, the admittance and correlation between topography and gravity can be calculated. With their power spectra curves, the gravity anomalies of different depths can be divided, and the mass anomalies distributions can be inverted, among which the surface mass anomalies reflect the high density mare basalts distributions. Furthermore, it's concluded that mass anomalies of mare basalts and of crust-mantle terrain are of similar magnitudes, and they contribute together to the lunar masons.

Polar images of 7m/pixel obtained from CE-2 and images of 2m/pixel from LRO NAC are merged as the source data, in order to obtain more crater information. The diameters of craters larger than 1km are recorded, and together with the mean density anomaly (e.g.500kg/m^3) of mare basalts, we get the mare basalt thickness models of main craters of lunar polar region.

Rates of Dune Migration in a Polar Cavi on Mars

BOURKE M.(1), PARTELI E.(2), BYRNE S.(3), BERMAN D.(4)
(1) Trinity College, DUBLIN, IRELAND ; (2) Universität Erlangen, NURNBERG, GERMANY ; (3) University of Arizona, TUCSON, UNITED STATES ; (4) Planetary Science Institute, TUCSON, UNITED STATES

Sand is mobile under the current Martian climate. Here we present a detailed study of the morphometry and migration of barchan and dome dunes in the North Polar Region of Mars.

The dunes are located at the head of an unnamed Polar Cavi. Dune sediment is locally sourced from the Basal Unit exposed in the adjacent Cavi wall and are enriched with gypsum derived from the Upper Layered Deposits. The dunefield is composed of barchan and barchanoid dunes that traverse a number of topographic steps up and away from the Cavi head wall.

Dune width and length of 34 dunes were measured from 25 cm/pixel resolution HiRISE Images. In order to estimate dune heights, a HiRISE stereo pair were processed to build a high resolution DTM. Change in dune morphology and position was mapped using HiRISE images taken at two time steps extending over two Mars years.

Dune Morphometry. Dunes are on average 170 m long and 121 m wide. Mean dune height is 18 m and is positively correlated with dune width (R^2 = 0.71). 68% of the sample dunes are asymmetric suggesting that, similar to Earth, barchan asymmetry is a morphological norm.

Dune Displacement. Dunes at the Cavi sample site have migrated 5 m on average over 2 Mars Years. The individual dune rates are highly variable, measuring between 0.57 and 17.7 m. Dune displacement distance decrease with increasing dune height, but the relationship is poorly correlated.

Dunes in the North Polar Region are migrating under the current climate regime. Rates are variable and may be influenced by topography, proximity to other dunes but not dune form. The smallest dunes have migrated the greatest distance. These include both dome dunes and dunes that are transitional forms between dome and barchan.

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The alluvial fans of northern Chile as a terrestrial analog of the fan systems on Mars

MORGAN A.(1), HOWARD A.(1), HOBLEY D.(1), MATSUBARA Y.(1), MOORE J.(2), PARSONS R.(2), DIETRICH W.(3), BURR D.(4), WILLIAMS R.(5), HAYES A.(6)
(1) University of Virginia, CHARLOTTESVILLE, UNITED STATES ; (2) NASA Ames Research Center, MOFFETT FIELD, UNITED STATES ; (3) University of California, Berkeley, BERKELEY, UNITED STATES ; (4) University of Tennessee, KNOXVILLE, UNITED STATES ; (5) Planetary Science Institute, TUCSON, UNITED STATES ; (6) Cornell University, ITHACA, UNITED STATES

Alluvial fans in the Pampa de Tamarugal region of the Atacama Desert in northern Chile, located along a 180km stretch of the western slope of the Andes constitute an exceptional terrestrial analog for the numerous fans observed on Mars due to 1. similar scale (~30 km length, source basin relief ~2 km), and gradient (< 3°), 2. hyperaridity of the environment (Atacama precipitation rate of < 2 mm/yr), 3. low channel branching density, 4. dominance of wind over fluvial erosion of the inactive fan surface, and 5. dominance of mud sedimentation.

Sediment deposited on railroad tracks and roads indicates that flows have occurred within the past few decades. Vegetation is very scarce and localized to recently active flow channels. Avulsions occur frequently. The source region provides sediment of varying composition (fine grained mudstones, sandstones, volcanic ash) from the western edge of the Andes.

The exposed stratigraphy contains cobble-sized alluvium interbedded with fine-grained mudflows. Recently active flows are dominated by fine sediment with fine-grained, sheetflow-like mud deposits extending outward of the active channel for about 150m bilaterally. Well-sorted, rounded, gravel to cobble sized material on the channel floor was probably deposited by less muddy waning-stage flows. Multiple, compositionally distinctive overbank mudflows typically contain 10-25% clay, 10-50% silt, 15-60% sand, and <5% fine granules. Channels on inactive portions near the fan periphery have been partially inverted in relief by wind erosion of interbedded overbank deposits.

We infer the fans have formed through hundreds of separate (temporally widely spaced) flows, with only a small portion of the fan receiving sediment during a single event. We conclude that the processes and formative environment are good analogs for those that occurred on Mars. These lessons will be applied to future quantitative modeling.

Modeling barchan dune asymmetry

PARTELI E.(1), DURAN O.(2), BOURKE M.(3), TSOAR H.(4), HERRMANN H.(5)
(1) University of Erlangen-Nuremberg, ERLANGEN, GERMANY ; (2) University of North Carolina-Chapel Hill, CHAPEL HILL, UNITED STATES ; (3) Trinity College Dublin, DUBLIN, IRELAND ; (4) Ben-Gurion University of the Negev, BEER SHEVA, ISRAEL ; (5) ETH Zürich, ZURICH, SWITZERLAND

Barchan dunes — crescent-shaped dunes that form in areas of unidirectional winds and low sand availability — commonly display an asymmetric shape, with one limb extended downwind. Several factors have been identified as potential causes for barchan dune asymmetry on Earth and Mars: asymmetric bimodal wind regime, topography, influx asymmetry and dune collision. However, the dynamics and potential range of barchan morphologies emerging under each specific scenario are far from being understood, and if better understood could be used to indicate environmental conditions and dune morphodynamics on Earth and Mars. Here we use numerical modeling to investigate the formation and evolution of asymmetric barchans.

We find that a bimodal wind regime causes limb extension when the divergence angle between primary and secondary winds is larger than 90°; the extended limb evolves into a seif dune if the ratio between secondary and primary transport rates is larger than 25%. Barchans migrating along an inclined surface also display asymmetry. Such asymmetric barchans move laterally, with transverse migration velocity proportional to the slope of the terrain. Limb elongation induced by topography can occur when a barchan crosses a topographic rise; the limb closest to the topographic rise elongates downwind. Moreover, asymmetric barchan shapes caused by sediment influx asymmetry are transient: the limb subjected to the smaller influx elongates downwind, while the dune migrates laterally towards the region of higher influx. Asymmetry can be also triggered by collisions between two barchans with lateral offset, the colliding limbs of which merge to form a single limb extended downwind. Collisions between multiple barchans give rise to more complex asymmetric patterns. Our findings can be useful for making quantitative inference on local wind regimes or understanding the spatial heterogeneities in transport conditions of planetary dune fields hosting asymmetric barchans.

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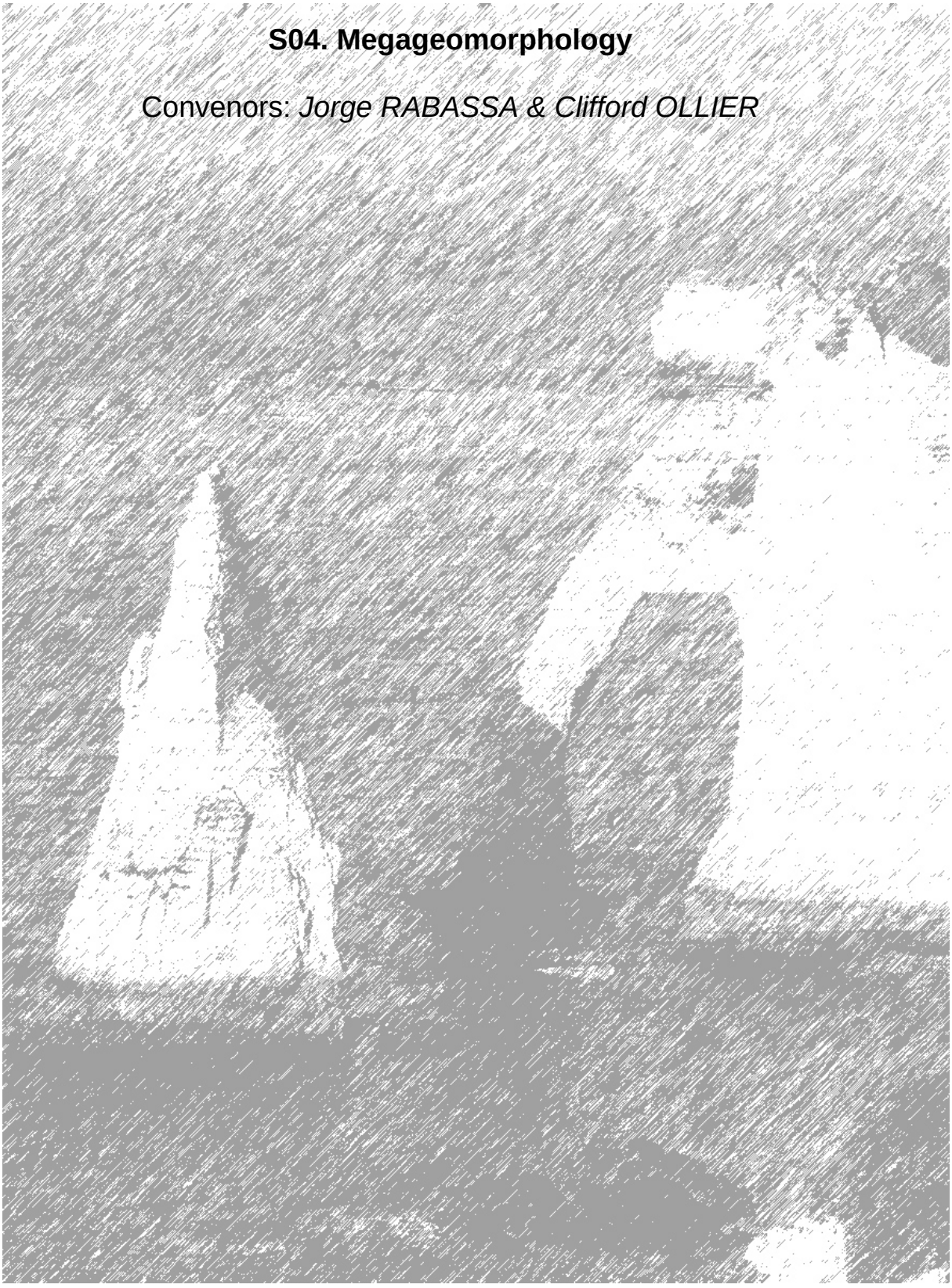
S04. Megageomorphology

Convenors: *Jorge RABASSA & Clifford OLLIER*



Oral presentations:

Late-Cenozoic relief evolution under evolving climate: A review of quantitative arguments

CHAMPAGNAC J.
ETH, ZURICH, SWITZERLAND

Relief is the defined as an elevation difference between two points. Relief can increase, decrease, or remain constant through time, regardless of the absolute erosion rates. The relief evolution directly reflects the spatial distribution of the equilibrium between the uplift and the erosion of rocks. Understanding how, why, and when relief has changed in the past can help to understand the causal relationship between tectonics, topography and climate and the relation between erosion and the climate. Relief change can be addressed by three different ways, or by combination of them: (1) direct quantification of differential erosion by surface dating, or direct erosion rate quantification with cosmogenic radionuclides inventories, (2) quantification of differential exhumation histories using thermochronology, and (3) numerical modeling of landscape evolution. This study mostly focus on the results from cosmogenic radionuclides dating that has demonstrated the ability to quantify relief change at kyr timescale, and from low-temperature thermochronology, which has been used to constrain relief change at Myr timescale, as well as a critical review of results from landscape evolution modelling. Finally, I review the different views provided by the literature on the potential links between relief and erosion, climate and tectonics, as well as their respective evolution through geological times. Tracking relief evolution is different than tracking changes in erosion rate, because relief evolution depends on the spatial variability of the erosion, not directly on the local or spatially-averaged erosion rates. Hence, tracking relief changes through time may provide insights on the location of the erosion, and therefore can be used to better understand (1) geomorphic/physical rules that govern each individual erosional agent (e.g. fluvial, glacial, etc.), and 2) how the distribution of the different erosional mechanisms are distributed in both space and time.

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Gondwana paleosurfaces: large-scale and long-term landscape evolution in cratonic areas of Argentina

RABASSA J.
CADIC-CONICET and Universidad de Tierra del Fuego, USHUAIA, ARGENTINA

Gondwana paleosurfaces in Argentina were identified by Juan Keidel and Walther Penck at the beginning of the 20th century. However, these concepts gradually disappeared from the Argentine geological scene, dominated instead by the influence of American geomorphologists, and particularly William Thornbury, who doubted about the existence of such ancient landforms, when one of the main paradigms of the time was that “practically there is no landscape older than the Pleistocene”. These landforms are the result of deep chemical weathering and/or pedimentation processes, developed in very stable tectonic and climatic environments, mostly under hypertropical climates, either extremely wet, arid or seasonally changing. Remains of the Gondwana paleosurfaces have been recognized in Argentina, from N to S, in the basaltic hills of the province of Misiones, the Sierras Pampeanas of the provinces of Catamarca, La Rioja and San Juan, the Sierras Chicas, Sierras Grandes and Sierra Norte of Córdoba province, the Sierras de San Luis, the Sierra Pintada or San Rafael Block of Mendoza province, the Sierras de Tandil, Sierra de la Ventana and the Pampa Interserrana of Buenos Aires province, the Sierras de Lihuel Calel of the province of La Pampa, the Somuncurá or Northern Patagonian Massif in the provinces of Río Negro and Chubut, and the Deseado Massif of Santa Cruz province. In other cratonic regions of Argentina, these surfaces have been down-warped in tectonic basins and are covered by sedimentary and/or volcanic units of various ages. The age for the Gondwana paleosurfaces has been estimated in between the middle Jurassic and the Paleogene. The Gondwana paleosurfaces were uplifted, fragmented, denudated and isolated during middle to late Tertiary due to the Andean orogeny, and they have remained above extensive pediplains and piedmont deposits, while climate and environments changed to more arid and cooler during the late Cenozoic.

Geomorphological characterization of relictic Gondwanic paleosurfaces in the Comechingones range, Central Pampean Mountains, Argentina

DEGIOVANNI S.
Universidad Nacional de Rio Cuarto, RIO CUARTO, ARGENTINA

The genesis and age of remnants of pre-Andean planation surfaces in the Pampean Mountains, described by several authors, are still controversial, but in general are considered as erosional surfaces (etchplains, pediplains) generated in Middle to Late Jurassic – Paleogene period. The surfaces preserved at the summit of Comechingones range (between 32º22´-32º51´S and 64º50´-64º57´W) were developed on Late Proterozoic-Cambrian moderate-high grade metamorphic rocks and Devonian granites. During the Andean movements almost all surfaces were fragmented, elevated and tilted, and consequentlyexposed to a new erosional cycle. They are partially covered by a Quaternary loessic sequence. Morphologic, genetic and evolutive features from these surfaces are discussed in this work, by using digital elevation models, and metalogenetic, stratigraphic, structural and chronological background information. The surfacesare located between 2150 and 1500 m.a.s.l. and are interpreted as a single level that tilts southwards and eastwards. The planation surfaces on metamorphic rocks show more homogeneity than the granitic surfaces, with a minimal local relief. In contrast, the granitic surfaces present residual landforms, such as bornhardts, tors and corestones, and greater fluvial incision. These paleosurfaces are linked to an etchplanation-pedimentation process associated with: 1- a deep weathering cycle in a tropical humid climate during Jurassic times. In the granitic rocks, in addition to the residual landforms, epithermal fluorite-chalcedony deposits (117±26 Ma) indicate a mixing of hydrothermal fluids with meteoric waters, at successively shallower depths (less than 2 km). 2- a denudation cycle in semiarid-arid climate, evidenced by the sedimentary record in the surrounding Mesozoic rifting basins. The different geomorphological evolution of the analyzed paleosurfaces was conditioned by the lithology and mainly by the degree of fracturing of granitic rocks.

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The Neogene evolution of the Congo and Kalahari basins, with a focus on the Congo-Zambezi watershed

FLUGEL T.J.(1), ECKARDT F.D.(2), COTTERILL F.P.D.(3)
(1) Department of Military Geography, Faculty of Military Science, Stellenbosch University, SALDANHA, SOUTH AFRICA ; (2) Department of Environmental & Geographical Science, University of Cape Town, CAPE TOWN, SOUTH AFRICA ; (3) AEON Geoecodynamics Research Hub, c/o Dept Botany & Zoology, University of Stellenbosch, STELLENBOSCH, SOUTH AFRICA

Two of the most distinctive morphological features of sub-Saharan Africa are the low lying Congo basin (mean elevation ~400 m.a.m.s.l) that abuts the elevated Kalahari plateau (mean elevation ~1100 m.a.m.s.l). These basins maintain the world's 2nd and 21st largest rivers by volume, the Congo and Zambezi respectively. The majority of the Congo-Zambezi watershed that separates these two continental rivers is a topographical smooth tableland, with the Angola highlands in the west and the Western branch of the East African Rift System (EARS) in the east, separated by a flat seasonal wetland. The Congo-Zambezi watershed is, therefore, a transition zone, incorporating three types of landforms: old, macro-landforms of the Kalahari Plateau and Congo Basin; newer, meso-landforms of EARS, horst and graben structures; and newer, process landforms evidenced by headwater capture features along the watershed. Thus, the Congo-Zambezi watershed is uniquely placed to provide insight into the development of the mega-geomorphology of southern and central Africa.

Hydrographically, the watershed separates the northerly flowing rivers of the Congo Basin from the southerly flowing rivers of Kalahari (Zambezi and Okavango) Basin. The evolution of these large river systems and their associated tributaries is of fundamental importance when investigating the ongoing development of the continental watershed. Remote sensing and GIS was used to study the region. Several key events, which are pivotal to understand of the geomorphic evolution of bimodal Africa, were identified. Much of the present day Congo system was established by the late Neogene, with the modern form of the Zambezi system being Plio-Pleistocene in age. However, some elements of both systems are substantially older than this. These results are combined with published data from several fields, including phylogeography, to provide an overview of the Neogene evolution of these landscapes.

The lateritic materials occurence in Brazil - geographic distribution and association to the paleosurfaces

LADEIRA F.S.B.(1), LEONARDI F.(1), SANTOS M.(2)
(1) Unicamp, CAMPINAS, BRAZIL ; (2) Unesp, OURINHOS, BRAZIL

The lateritic materials occurrence in Brazil is very common and widely treated by the literature. These materials correspond to lateritic profiles and deposits derived from reworking of such profiles, which concentrated iron and/or aluminum relative to bedrock.

Although quite common in brazilian literature there is no systematic mapping and association of these materials to geomorphological surfaces. The main objective of this study consisted in mapping the geographical distribution of these materials, its altitude occurrence and its association to the main brazilian morphostructural units.

Geological Mapping of Brazil in scale 1:1,000,000 existing in the literature was basic source for this work. The surface covered by brazilian lateritic materials corresponding to 11.69% of the Brazilian territory (995,372.28 km^2), 25.4% of the area occurs over 300 meters, 45.3% between 300 and 600 meters, 28.6 % between 600 and 1,000 meters and only 0.7% between 1,000 and 1,200 meters of altitude.

The larger occurrence areas of lateritic materials are concentrated in the northern and northwestern Brazil, while less significant areas are in the southeastern and northeastern and nearly nonexistent in the southern Brazil.

It is known that due to the representation scale, multiple occurrences were not mapped, especially those at higher altitude, which have more limited geographical distribution. More detailed mapping, geochemical characterization and association to the surfaces still need be performed.

ACKNOWLEDGEMENTS: to FAPESP for funding the project Geomorphic Paleosurfaces Correlation of Summit in Brazil, Uruguay and Argentina - dating, morphology, cartography, deposits and associated alteration profiles (2011/23325-7), and PhD scholarship for second author. To CNPq for the first author's productivity scholarship (312583/2009-5).

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Poster presentations:

Long-term evolution of West African drainage, denudation and paleo-river long profiles using the lateritic record from the Cenozoic

GRIMAUD J.(1), CHARDON D.(1), ROUBY D.(1), BEAUVAIS A.(2)
(1) GET Toulouse, TOULOUSE, FRANCE ; (2) CEREGE, AIX-MARSEILLE, FRANCE

We characterize and quantify the long-term erosion processes and drainage evolution of the West African craton on the basis of its Cenozoic lateritic paleosurface record. We use stepped, abandoned surfaces of regional extent as markers of former erosion levels. Each abandoned surface has a specific morphology and position within the landscape and is sealed by a type-duricrust. We assume that those surfaces, described all over West Africa and whose age is bracketed by published 39Ar/40Ar dates on lateritic K-Mn oxides of the Tambao Mn deposit in Burkina Faso, formed broadly synchronously on a craton scale. S1, the African bauxitic surface, was abandoned in the Mid-Eocene at ~ 45 Ma, S2, the Intermediate ferruginous surface at the end of the Oligocene (~ 24 Ma), and S3 and S4 the ferruginous pediments at ~ 11 and 6 Ma, respectively.

We produce interpolated surface maps based on remnant surfaces of S1 and S2. This allowed constructing large-scale cratonic relief at ~ 45 and 24 Ma and evaluating the modification of divides for 2 time spans (45-24 and 24-0 Ma). Subtraction of interpolated surface maps allowed evaluation of preliminary sedimentary fluxes exported over the same time intervals by sub-drainage area. Successive Paleo-river long profiles of the main drains were reconstructed by interpolating base levels corresponding to each paleosurface.

We document craton-scale drainage rearrangement and establishment of the modern drains of West Africa back in the Oligocene. Since then, the river long profiles evolved slightly and display stationary features such as knick points. Epeirogeny is suggested by convex patterns of modern and paleo-river long profiles on the slopes of the Hoggar swell, whereas the Guinean & Leo rises could be essentially inherited from the Eocene. Comparisons of denuded volumes with offshore clastic sedimentary record provide first-order preliminary constraints on the West African Cenozoic source-to-sink system.

The neotectonic period and geomorphology

OLLIER C.
University of Western Australia, PERTH, AUSTRALIA

Most mountain regions are dissected plateaus, formed by uplift of a planation surface. The age of mountains is not the age of the last folding (if any) but the age of vertical uplift.

A compilation of mountain uplift throughout the world shows that a major phase of uplift started about 8Ma, and much uplift occurred in the last 2 Ma. This period is known as the Neotectonic Period. It has several important implications to tectonics and geomorphology. In plate tectonics theory, mountains are explained as resulting from compression at active margins, and mountains in other locations are said to have been caused by the same process but further back in time. This is disproved by the young age of uplift in intercontinental and passive margin positions. Seafloor spreading and alleged subduction have been continuous for hundreds of millions of years, so cannot explain the world-wide uplifts in just a few million years.

Neotectonic uplift often affects broad areas though epeirogenic uplift, but may be more localised, as in the horsts of the Rocky Mountains. Downward movement forming rifts and graben is also associated with the Neotectonic Period, and together with uplift caused many changes of base level.

The Neotectonic Period does not fit into conventional theories of geomorphology. Davisian geomorphology depends on a rapid uplift to initiate a new cycle. The Neotectonic period might initiate several cycles but most planation surfaces are much older. King's pediplanation cycle has the same problem. He also had the formation of new continental margins as a way to initiate new planation surfaces, but this is long before the Neotectonic Period.

The increasing relief associated with Neotectonic uplift would have affected rates of erosion and sedimentation, and late Cenozoic climate.

Geomorphologists should be guided by their own findings, and refrain from theory-driven hypotheses of plate collision.

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Bajada del Diablo impact crater-strewn field: the largest crater field in the Southern Hemisphere

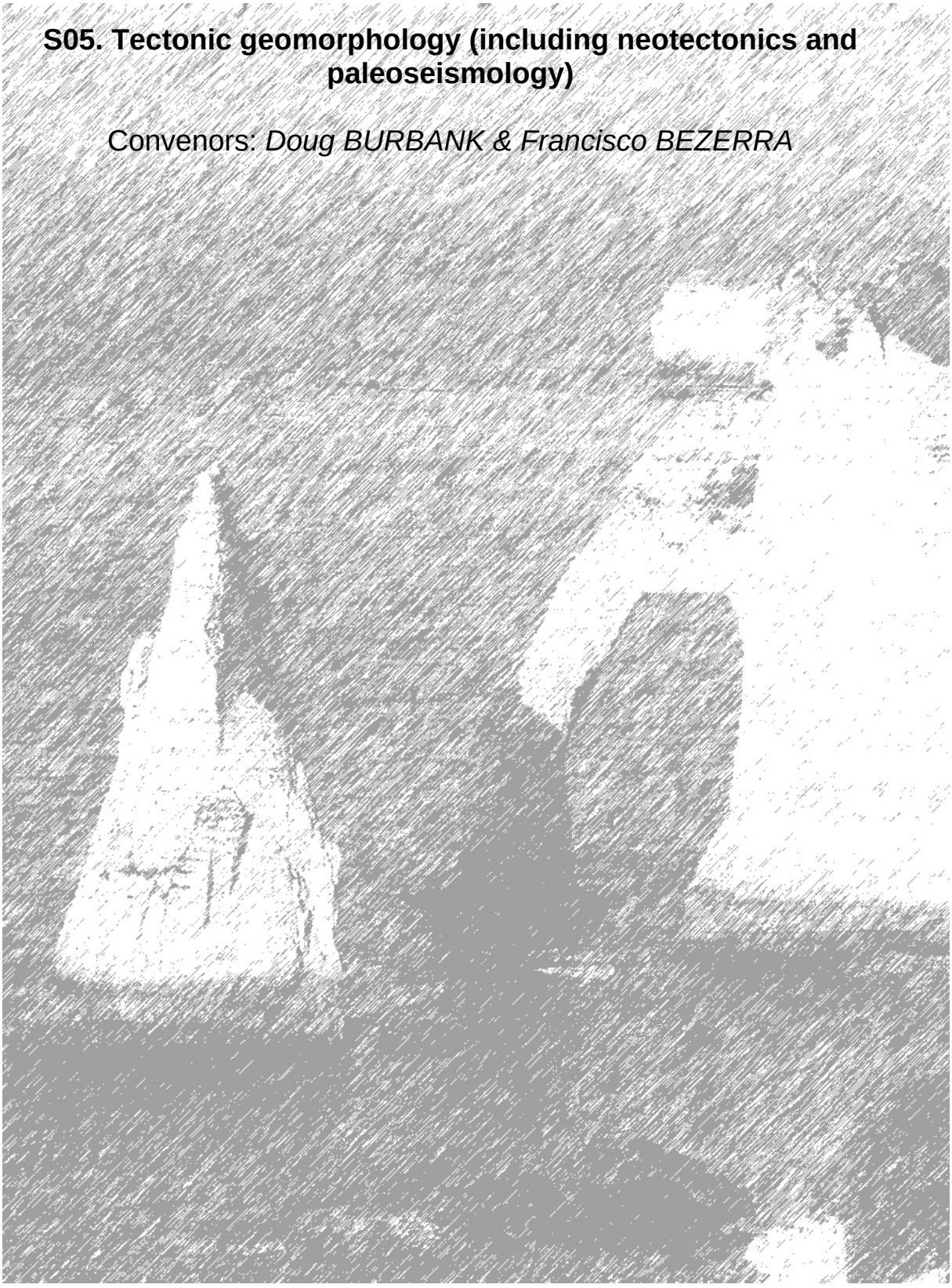
RABASSA J.(1), ACEVEDO R.D.(1), PONCE J.F.(1), MARTÍNEZ O.A.(2), ORGEIRA M.J.(3), PREZZI C.(3), CORBELLA H.(4), GONZÁLEZ-GUILLOT M.(1), ROCCA M.(5), SUBÍAS I.(6), VÁZQUEZ C.(3)

(1) CADIC-CONICET and Universidad de Tierra del Fuego, USHUAIA, ARGENTINA ; (2) Universidad Nacional de la Patagonia, ESQUEL, ARGENTINA ; (3) CONICET & Universidad de Buenos Aires, BUENOS AIRES, ARGENTINA ; (4) CONICET & Museo Argentino de Ciencias Naturales, BUENOS AIRES, ARGENTINA ; (5) Mendoza 2779, BUENOS AIRES, ARGENTINA ; (6) Universidad de Zaragoza, ZARAGOZA, SPAIN

Recent remote sensing analyses and field studies have shown that Bajada del Diablo, in Argentine Patagonia, is a huge, new crater strewn field. The Bajada del Diablo astrobleme-strewn field is a domain of enigmatic circular structures located in central Patagonia. Four different impact areas are herein described, investigated, mapped, and geo-referenced. A single, blurred crater dispersion ellipse has been identified. A total of 185 circular structures (some of which are partially obliterated by erosion or sediment accumulation), were identified by remote sensing techniques, but many have been evaluated in situ and interpreted as impact craters. Moreover, two of the structures have been surveyed in detail in the field using a total station instrument. The crater-type structures have diameters ranging from 100 to 500 m in width and 30 to 50 m in depth. The four impact crater fields were formed simultaneously, impacting upon a Miocene basaltic plateau and Pliocene–Early Pleistocene pediments. The original crater field was later eroded by Late Pleistocene fluvial processes, isolating the different areas. The rocks within the craters have strong and stable magnetic signature. No meteorite fragments or other diagnostic landmarks have been found yet. The origin of these crater fields may be related to multiple fragmentation of one asteroid that broke up before impact, perhaps traveling across the space as a rubble pile. Alternatively, multiple collisions of comet fragments could explain the crater formation. Other preliminary observations on collected samples (glass, breccias, and, most relevant, Fe-Ni-bearing spherules found within the impacted zones) are herein discussed. Based on field geological and geomorphological data, the age of this event is estimated to be bracketed between Early Pleistocene and the beginning of Late Pleistocene (i.e., 0.78–0.13 Ma ago).

S05. Tectonic geomorphology (including neotectonics and paleoseismology)

Convenors: *Doug BURBANK & Francisco BEZERRA*



Oral presentations:

Tectonic tilting toward the west during the past 7000 years indicated by spatial difference in relative sea-level changes across the Nobi Plain, on the footwall of the Yoro fault system, central Japan

NIWA Y.(1), SUGAI T.(1), OGAMI T.(2)
(1) The University of Tokyo, KASHIWA, CHIBA, JAPAN ; (2) Chuo University, TOKYO, JAPAN

This study detected tectonic tilting during the past 7000 years on the basis of spatial difference in relative sea-level (RSL) changes for six core sites on the Nobi Plain, on the footwall of the Yoro fault system, Japan. The cores reveal a typical deltaic succession in which sedimentary facies can be divided into five units; braided river (unit A), fluvial to intertidal (unit B), inner bay (unit C), delta front (unit D), and delta plain (unit E) in ascending order. Electrical conductivity (EC), which primary records salinity, in uppermost unit C is proportional to the thickness of unit D, and provides an indication of the water depth close to the top of unit C. We translated EC in unit C to water depth by applying the proportional relation. We then estimated RSL by adding the EC-derived water depth to the compaction-corrected sea-floor elevation for unit D obtained from sediment accumulation curves derived from over one hundred ^{14}C ages. RSL at 7000 cal BP is tended to be higher at the core sites farther from the Yoro fault system. RSL at the four core sites nearest the fault system has been rising continuously since 7000 cal yr BP, indicating subsidence in this area. This trend of continuous rise of RSL and the differences in RSL among core sites show that the Nobi Plain has been tilted down to the west in response to Holocene activity on the Yoro fault system. Our study shows that local variance of RSL is resulted from vertical tectonic displacement.

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Geomorphological evidence for a 2000 km long intracontinental fault system in the 'Stable Continental Region' of Western Australia

WHITNEY B., HENGESH J.
The University of Western Australia, CRAWLEY, AUSTRALIA

Analysis of tectonic geomorphology within the “Stable Continental Region” (SCR) of Western Australia indicates the presence of an approximately 2000 km long zone of interrelated dextral-transpressive neotectonic features including active faults and folds, herein referred to as the Western Australian Transpressional Belt (WATB). The WATB is coincident with an extended passive margin crustal domain that initially formed during periods of continental-scale rifting during the Paleozoic and Mesozoic Eras along the edge of Archean Pilbara and Yilgarn cratons. Neotectonic deformation is dominated by transpressional reactivation of these much older rift related structures.

Geomorphological features of the WATB are evident both onshore and offshore. The region’s arid climate, low gradient rivers, and low relief landscape are highly sensitive to minor perturbations in both climate and tectonically driven land-level changes. Analysis of fluvial systems in the WATB suggests hydrogeomorphic processes are influenced by crustal deformation on individual tectonic structures. Crustal shortening has topographic expression at the Cape and Giralia Ranges and also is expressed at the channel scale such as where the supercedent Minilya and Lyndon Rivers have deflected around the tips of growing anticlines. Bathymetric data from Australia’s northwest shelf indicate the presence of numerous transpressional tectonic structures as scarps on the seabed and deformed sea-level low-stand shoreline features.

The recognition of active fault systems within the Western Australian “Stable Continental Region” (SCR) indicates the presence of potentially significant seismic sources and will improve our understanding of seismic hazards in this SCR and other seismically enigmatic regions.

Passive vs. active control of tectonic structures on the recent sedimentary evolution of a turbidite system: a tectonic geomorphology study from the Po Plain (Northern Italy)

BARCHI M.(1), POZZOVIVO V.(1), GALBIATI M.(2), ROCCHINI P.(2), CAIRO E.(3)
(1) Universita' di Perugia, Dipartimento di Scienze della Terra, PERUGIA, ITALY ; (2) ENI E&P, S.DONATO MILANESE (MI), ITALY ; (3) STOGIT s.p.a., CREMA, ITALY

Seismic geomorphology may be defined as the application of analytical techniques pertaining to the study of landforms to the analysis of ancient, buried geomorphic surfaces as imaged by 3D seismic data, in a map view.

In this study we reconstruct the evolution of syn-tectonic clastic depositional systems from the late Messinian to the late Pleistocene in the subsurface of the central Po Plain, a structurally complex region, comprised between the opposite-verging South-Alpine and Northern Apennines thrust belts. The Northern Apennines external thrust is still active at very low deformation rate, as indicated by both seismicity and geodetic data.

Our innovative approach is based on image processing techniques and dedicated sofware, aimed to derive a continuous *Geo-Model* from 3D seismic data, which allows a comprehensive understanding of the geological models and a detailed definition of the sediments architecture; the interpretative workflow comprises a dynamic scanning (slicing) of the stratigraphic surfaces across the *Geo-Model*, computation and analysis of seismic attributes, fault detection, geobodies extraction and calibration to litho-stratigraphic data from wells.

Within our study area, the synsedimentary growth of three anticlines controlled the topography of the basins: the turbidite systems progressively filled a subsiding and tectonically mobile basin floor, forming a set of distinct ponded basins. After the Early Pleistocene, the tectonic activity decreased, but the structural imprint of the thrust still exerted a control on the basin topography, possibly through a combination of isostatic rebound and differential compaction of sediments. During the Late Pleistocene, the basin was filled by the rapid prograding of the Po Plain shelf and deltaic systems: however, even the most recent geomorphic features and the current hydrographic network show the imprint of the underlying structural high.

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Seismic and Eustatic cycles in the southern Apenine deformation front (Basilicate -Southern Italy)

DEFFONTAINES B.(1), FORTUNATO G.(2), MAGALHAES S.(2)
(1) Universite Marne-La-Vallee, MARNE-LA-VALLEE, FRANCE ; (2) ALphaGEOmega, PARIS, FRANCE

This detailed study re-interprete from a tectonic point of view the new soil datations of the different marine terrassic levels of the Tarento Gulf (Southern Italy) acquired by D.Sauer et al., Int Quaternary, 2009. By combining these observed datation to the known eustatic curve of the mediteranean sea along italian shore, we were able to better understand the landscape evolution of that deformation front and we are able to differenciate both active tectonic and eustatic processes and their related geomorphic features on the Tarento Gulf marine terrasses. Therefore the observed seismic cycle of the Southern Apenine deformation front is revealed and appear to be coherent with both a regular linear creep period (240 kyears) and a rapid uplift (42m) corresponding very probably to numerous major earthquakes events. This give us new major inputs to better understand the deformation front of Southern Apenine.

The sedimentary response of mountain environments to large earthquakes: an example from south Westland, New Zealand

FITZSIMONS S.(1), HOWARTH J.(1), JACOBSEN G.(2), NORRIS R.(1)
(1) University of Otago, DUNEDIN, NEW ZEALAND ; (2) Australian Nuclear Science and Technology Organisation, SYDNEY, AUSTRALIA

In tectonically active mountain belts large earthquakes trigger pervasive landsliding, which drives landscape evolution and is a source of considerable hazard to infrastructure and society. Despite this, the magnitude and duration of postseismic landscape response remains poorly understood. We use lake sediments to constrain the magnitude and duration of postseismic landscape responses in small range front catchments and large trunk valleys of the Southern Alps to sequential great (M_w8) earthquakes on the Alpine Fault. The lake sediments contain a detailed record of co-seismic, post-seismic and aseismic deposits that are correlated to the Alpine Fault seismic cycle using high precision chronologies derived from Bayesian modeling of AMS radiocarbon dates. The landscape response to the last three earthquakes (1717 A.D., ~1570 A.D. and ~1400 A.D.) persisted for several decades after each event in both range front and trunk valley catchments. During this time increased rates of landsliding on catchment hillslopes caused a threefold increase in sediment flux from the mountain belt. Increased postseismic sediment flux suggests that Alpine Fault earthquakes are important drivers of millennial scale denudation rates in the Southern Alps. The greatest impact of these events occurs in small range-front catchments that are situated adjacent to the fault, while larger catchments experience a more subdued sedimentary response that occurs over a longer duration. These data demonstrate that the landscape response to co- and postseismic landsliding in mountains can be protracted and a source of seismic hazard that persists long after the initial earthquake.

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Fossil shorelines at Corfu and surrounding islands deduced from erosion notches

PIRAZZOLI P.(1), EVELPIDOU N.(2), KARKANI E.(2)
(1) CNRS, PARIS, FRANCE ; (2) National and Kapodistrian University, ATHENS, GREECE

New geomorphological investigations carried out in 2012 along the coasts of Corfu, Othonoi, Paxoi and Antipaxoi Islands have allowed the identification of recent fossil shorelines. Former sea-level positions were deduced from sea-level indicators, such as emerged and submerged notches. Notch geometries (height, inward depth and vertex depth) were measured. Due to the absence of tidal records at the closest tide-gauge station during the period of fieldwork, an uncertainty of ±14 cm in depth measurements was taken into consideration.

A “modern” tidal notch, submerged ca.-20 cm, was observed in all studied islands, at various sites. This notch is regarded to have been submerged by the global sea-level rise that occurred during the 19th and 20th centuries at a rate exceeding the possibilities of intertidal bioerosion. Its presence provides evidence that no vertical tectonic movements occurred since its formation.

At Paxoi possible marks of erosion by waves, a few decimetres above sea level at two sites, may be interpreted as a still undetermined short-lived period of emergence. Below the “modern” notch, lower shorelines measured at –45±14 cm and-58±14 cm may correspond to the same fossil shoreline, apparently submerged by a coseismic vertical movement.

At Antipaxoi, no evidence of emergence were found and Holocene vertical movements seem to have been only of subsidence; two submerged tidal notches have been distinguished at about -70 and -120 cm.

On Corfu island impacts of ancient earthquakes have left some marks of emergence at about +20, +45, +110 and +140 cm, as well as marks of submergence at about -35 -50, -75, -100 and -180 cm.

The emergence of +140 cm, which had been previously dated at or after 790-400 cal. B.C., was detected through erosion notches at various sites of the western part of Corfu and seems to continue even more west, at Othonoi Island.

Fault activity, basin architecture and structural evolution of extensional tectonic depressions: case studies from central Apennines (Italy), investigated through geological and geophysical surveys

GORI S., FALCUCCI E., LADINA C., MARZORATI S., VALENSISE G.
Istituto Nazionale di Geofisica e Vulcanologia, ROMA, ITALY

The present tectonic setting of the central Apennines results from the superposition of a Plio-Quaternary NE-SW trending extension onto a preceding co-axial contractional deformation. This determined the formation of structural features during the compressive tectonic phase, some of which were then partly re-activated as extensional structures during the subsequent extensional deformation. Galadini and Messina (2001) and Cavinato et al. (2002) defined that a ENE-WSW trending regional tectonic lineament, known as “Avezzano-Bussi fault system” (Ghisetti and Vezzani, 1997), formed during the compressive tectonic phase, has been locally re-used as extensional feature during the Pliocene-Early Pleistocene, relating to it the early stage of formation of the Fucino Basin, the widest tectonic depression of central Apennines. After the Early Pleistocene, the progressive opening of the Fucino depression was “picked up” by the presently active NW-SE trending normal fault system, that bounds the basin to the NE.

As the “Avezzano-Bussi fault system” also affects the northern sectors of further central Apennine tectonic depressions, i.e. the Subequana Valley and the Sulmona Basin – which are in turn bounded to the NE by active NW-SE trending normal fault systems (e.g. Falcucci et al., 2011) – we aimed at unveiling whether the structural evolution of the Fucino Basin could have also affected these depressions.

At this purpose, we performed geological field studies in the Subequana Valley and the Sulmona Basin, coupled with geophysical investigations (ambient seismic noise and ground motion analyses), aiming at defining the architecture of the tectonic depressions and to relate it to the Quaternary structural evolution of the conterminous fault systems. These investigations allowed us defining a similar Quaternary structural evolution of the Fucino Basin, Subequana Valley and Sulmona Basin.

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Dating fault movement in southeastern Australia, using paleomagnetism

PILLANS B.
Australian National University, CANBERRA, AUSTRALIA

Dating recent fault movement in areas where basement rocks are pre-Cenozoic is challenging. Here I give two examples from the passive continental margin of southeastern Australia, where paleomagnetism provides chronological constraints on the timing of faultingt:

1. Lake George, straddles the crest of the Great Dividing Range at an elevation of 670 m, 30-40 km north of Canberra. Basement rocks are Paleozoic. The western margin of the lake is bounded by a prominent fault scarp, with local relief up to 300 m. Up to 165 m of lacustrine and fluvio-lacustrine sediment occurs beneath the lake floor, including quartzose gravels between 100 and 165 m depth, dated by magnetostratigraphy and pollen biostratigraphy to be 3-4 Ma. Correlative quartzose fluvial gravels, 70 m above the lake floor, on the upthrown side of the fault, are remnants of a westward flowing river, prior to uplift on the fault and formation of the lake. It is inferred that 170-235 m of vertical displacement has occurred on the Lake George fault in 3-4 Ma.

2. Australia's only nuclear reactor is a research reactor located at Lucas Heights on the southern outskirts of Sydney. In 2002, work was begun to replace the reactor that had operated on the site since 1958. Small faults, with dip separations up to 1.3 m were exposed in Triassic quartz sandstone bedrock in the excavation for the replacement reactor. Deep oxidative weathering has affected the bedrock, including formation of iron oxide layers, subparallel to bedding. One such layer, post-dating fault movement, has reverse polarity and therefore was deposited prior to the Matuyama/Brunhes reversal at ~0.78 Ma. Thus, fault movement is inferred to have occurred prior to 0.78 Ma. A paleomagnetic pole was determined for the mean remanence direction, and compared with the Australian Apparent Polar Wander Path to yield a minimum age of 5 Ma for the unfaulted iron oxide layer. The fault was deemed 'non-capable' and construction was allowed to continue.

Evolution of Neotectonic Landforms between Srinagar and Bagwan in Lower Alaknada Valley, Garhwal Himalaya, India

DEVI DATT D.
H.N.B Garhwal Central University,Srinagar,(Garhwal),Uttarakhand, SRINAGAR (GARHWAL), INDIA

The Himalayan Mountains represent a typical example of continuous upliftment with spells of tectonic restlessness or crustal disturbances. These disturbances indicate accumulation of inner tectonic stress in the crust. Some of the recent Pleistocene and Quaternary features are reactivated in the Himalayas those appear to have significant bearing on the neotectonism. In this paper an attempt has been made to identify the places of recent displacement and upliftment along the North Almora Thrust (NAT) in the Lower Alaknanda Valley of Garhwal Himalaya, India with the help of large scale topographical maps, Remote Sensing & GIS techniques and intensive field study.

Four sites are selected for the identification of neotectonic landforms. The recent neotectonic activities and associated features are reported in the quaternary deposition at the confluence of Dhundsir Gad and Alaknanda River near Kirtinagar and at the confluence of Takoli Gad near Chopriya village.

The study shows that there are significant evidences of neotectonic activities and associated landforms along the NAT in the Lower Alaknanda valley, which was not recorded earlier. This indicates that active movements took place along Thrust plane and transverse tectonic elements in the recent past. The main tectonic features in the Quaternary deposition are folding, faulting, tilting, thrusting and bending along the reverse/strike slip fault. Other tectonic features are upliftment of terraces, uneven level of terraces, triangular facet, and fault gap, drainage anomalies, pale channel, tilting of terraces etc. The neotectonic activities during past can be observed on Quaternary deposition at the junction of NW-SE, N-S and NE-SW trending lineaments and their proximity.

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Neo-tectonics in the Genesis of Terraces in the Eastern Himalayan Foothills between River Gish and Jaldhaka, North Bengal, India

BHATTACHARYA SOMA S.
Vivekananda College For Women, KOLKATA, INDIA

In the foot hill section of the Eastern Himalayas between the river Gish in the west and river Jaldhaka in the east the mountain front recedes northward to form a re-entrant which runs for about 20km. Absence of the Sub Himalayan zone here, probably due to relief thrusting, makes the fall from the mountains to the alluvial plains steep and precipitous. Geomorphic surfaces are extensive in the region and spectacular terraces have developed on them. Three distinct terrace levels are found exhibiting almost same height along all the river basins between river Gish and river Jaldhaka. The terraces are extended through the geomorphic surfaces far within hills.

Neo-tectonic activities, which are common in the Himalayas and occur as subsiding remnants of the great tectonic activity of the area and the resultant geomorphic processes, are responsible for the genesis of the geomorphic surfaces and the spectacular terraces built on them with several levels of development. The researcher aims to study the role of Neo-tectonics in the building of the terraces and tries to reveal the characteristic features of the terraces.

Key words: re-entrant, relief thrust, neo-tectonics, terrace levels.

New techniques within paleoseismological study of mountain terrains based on dendrocronological analysis and statistical approach by the example of SE Altai (Russia)

NEPOP R.(1), AGATOVA A.(2), MYGLAN V.(3), BARINOV V.(3)
(1) Institute of geology and mineralogy , NOVOSIBIRSK, RUSSIAN FEDERATION ; (2) Institute of geology and mineralogy, NOVOSIBIRSK, RUSSIAN FEDERATION ; (3) Siberian Federal University, KRASNOYARSK, RUSSIAN FEDERATION

This paper focuses on paleoseismogeological study of the mountainous, seismically active southeastern part of Russian Altai. It presents new dating technique that defines the timing of the seismically induced mass wasting processes and the erosion rate due to earthquake triggered landslides.

This new technique is based on estimating of the absolute age of tree injuries caused by rockfalls. Acontinuous 2367-years absolute tree-ring chronology “Mongun” developed for the adjacent region has enabled the use of dendrochronological analysis for this purpose. The accuracy of an approach was supported by data obtained from analyzing injuries occurred on trees as a result of rockfalls triggered by the 2003 Chuya earthquake (M_S=7.3), with its epicenter located within SE Altai. It allows us to determine the date of previously unknown medieval earthquake (which was also supported by radiocarbon ages of seismically cut fossil soil overlapped by that undistorted), estimate the age of seismically triggered landslides and specify the recurrence interval of strong earthquakes for SE Altai.

Another line of our paleoseismological investigations touch upon the study of seismically induced landslides which are especially important agents of denudation in tectonically active mountain terrains. In spite of diversity in climatic, geological, geomorphological conditions and peculiarities of seismic process for different areas, there is a good correlation between the magnitude of an earthquake and the volume of the largest landslide it causes. This relationship, calculated by us on the basis of data on 17 earthquakes all over the Globe, allows estimating the total volume of earthquake triggered landslides, the contribution of landslides caused by aftershocks and, finally, the Holocene erosion rate due to these landslides. Calculating the volume of all Holocene earthquake triggered landslides within SE Altai using the method of detailed profiling also supports our estimates.

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Tectonic Geomorphology of Slow Faults in Northern Mongolia: Implications for Seismic Hazard in Ulaanbaatar

FERRY M.(1), SCHLUPP A.(2), MUNKHUU U.(3)
(1) UMR 5243, Université Montpellier II, MONTPELLIER, FRANCE ; (2) UMR 7516, Université de Strasbourg, STRASBOURG, FRANCE ; (3) RCAG, Mongolian Academy of Sciences, ULAANBAATAR, MONGOLIA

Beside the famous series of M 8 earthquakes that struck western Mongolia in the first half of the 20th c., the Hustai fault presents a more directly concerning picture. With its northeastern tip located ~10 km from the city of Ulaanbaatar (1 M inhabitants), the 92-km-long fault may produce consequential M 7 earthquakes. It displays continuous microseismicity with five M 4+ since 1974 and a M 5.4 event in that same year. Most events occur in the shallow crust.

We present preliminary results of a multi-disciplinary study of the Hustai Fault, northern Mongolia. By combining high-resolution satellite images, digital elevation models, magnetic mapping, geomorphology and trenching, we provide a detailed morphotectonic map of the fault as well as insight on its recent episodes of surface faulting.

The Hustai Fault is more than 92 km long and divided into three segments. The northern segment is 23 km long and oriented N 68; the central segment is 33 km long and oriented N 55; and the southern segment is at least 36 km long and oriented N23. Overall, the Hustai Fault forms wide W open to the southeast. The active trace appears as a main trace running at the foot of the main topography and outlined by exhumed chert slabs, contrasts in water content, right-laterally offset streams and elongated sag basins. The latter are bounded on their SE edge by antithetic faults. Stream bed profiles show a systematic uplift of the NW block by 20-30 m and high-resolution satellite images document right-lateral offsets in the range of 20-30 m, thus suggesting an oblique regime. Antithetic faults only exhibit dip-slip movement in the order of a few meters (< 10 m).

An exploratory trench dug across the main trace reveals faulted Holocene deposits trapped inside the sag basins. Trench observations reflect the oblique nature of the fault with mixed normal and reverse faulting geometries.

Paleoseismicity of the North Zhongtiaoshan Fault zone, Shanxi Graben System, China

LI Y., LV S.
College of Urban and Environmental Science, Peking University, BEIJING, CHINA

The North Zhongtiaoshan fault is located in the east and south margins of the Yuncheng Basin, which is one of a series faulted basins in the Shanxi Graben System, Northeast China. Previous paleoseismological studies indicated that the east and the west segments of the fault have not moved in Holocene. Six trenches excavated across the North Zhongtiaoshan Fault recently, with 34 ^{14}C ages used to limit the faulting events. The trench I is on the west segment. 3 faulting events are revealed. The event 1 occurred between2030±40and 390±40a BP, with a vertical displacement of 1m; the event 2 occurred between 7300±50 and 5060±35 aBP, with a vertical displacement of 0.95 m; the event 3 occurred between 11070±50 and 7300±50 aBP, with a vertical displacement of 1 m. The Trench II is on the west part of the middle segment. 2 faulting events are revealed. The event 1 occurred after 2680±30aBP, with a vertical displacement of 1.6 m; the event 2 occurred between5370±40 and 4070±40 aBP, with a vertical displacement of 1 m. The trench IIIreveal 2 faulting events, the event 1 occurred between7000±40 and 3730±40aBP, the event 2 occurred between7700±40 and 7000±40 aBP. The trench IV revealed a faulting event from 6520±40 to 7910±40 aBP. The trench V revealed 8 faulting events since 28800±160 aBP, the youngest faulting event occurred after 3250±40 aBP, and the total vertical displacement is 14 m since 14490±80 aBP. The trench VI revealed 4 faulting events, the event 1 occurred after 720±30 aBP, with a tomb bed of the Dongjin Dynasty was vertically displaced 30 cm. The event 2 occurred between 4140±30 and 720±30 aBP. The event 3 and 4 occurred between 25870±140 and 4140±30 aBP.Trench studies indicate that the North Zhongtiaoshan Fault is a Holocene active fault, at lest there were 4 faulting events occurred on it. The youngest faulting events on the fault were possibly the surface ruptures of the two historical earthquakes in the Yuncheng basin.

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How old are the Himalayan river valleys?

GHOSH P.
Indian Statistical Institute, Geological Studies Unit, KOLKATA, INDIA

The first order physiographic features of the Himalayan landscape include high peaks, ridges and plateaus as well as enormous and numerous deep valleys of the trans-Himalayan rivers. These features are the product of tectonic movements driven by continuing collision between the Indian and Tibetan plates as well as the concomitant erosion by surface processes. The dimensions of the features are governed by the feedback relationships between the competing forces and the limits imposed by crustal strength. Therefore, the geomorphic parameters of some of the large-scale landforms could be used asses the long-term interplay between different land sculpturing processes.

This work studies the modern landscape of the entire Himalayas (as represented by SRTM DEM) through a new terrain analysis technique and reveals the shape and the arrangement of the major Himalayan valleys as well as the erosional relief of the individual valleys. The results show that the erosional relief is highest at the central part of the orogen compared to its western and its eastern flanking regions.

If it is assumed that the modern landscape has attained topographic steady state then the observed variation in erosional relief would primarily indicate along-arc variation in uplift averaged over the temporal range of formation of these valleys. However, in order to put this interpretation in the context of evolution of this mountain belt the temporal range is to be known. For that reason it needs to be determined when the major catchment valleys started to develop and if they are synchronous. We discuss this issue taking into consideration the existing theoretical models and observations as well as our own observations on the shape and spatial arrangement of the valleys and attempt to interpret the along-arc variability of the erosional relief.

The Pingding segment of the Altyn Tagh Fault (91°E): Holocene slip-rate determination from cosmogenic radionuclide dating of offset fluvial terraces

MERIAUX A.(1), VAN DER WOERD J.(2), TAPPONNIER P.(3), RYERSON F.(4), FINKEL R.(5), LASSERRE C.(6), XU X.(7)
(1) Newcastle University, NEWCASTLE UPON TYNE, UNITED KINGDOM ; (2) IPGS-EOST, STRASBOURG, FRANCE ; (3) EOS, Nanyang Technological University, SINGAPORE, SINGAPORE ; (4) Lawrence Livermore National Laboratory, LIVERMORE, UNITED STATES ; (5) Earth and Planetary Science Department, University of California,, BERKELEY, UNITED STATES ; (6) Maison des Géosciences, ISTerre, GRENOBLE, FRANCE ; (7) Central Earthquake Administration, BEIJING, CHINA

Morphochronologic slip-rates on the Altyn Tagh Fault (ATF) along the southern front of the Pingding Shan at 90.5°E are determined by cosmogenic radionuclide (CRN) dating of seven offset terraces at two sites. The terraces are defined based upon morphology, elevation and dating, together with fieldwork and high-resolution satellite analysis. The majority of the CRN model ages fall within narrow ranges (<2 ka) on the four main terraces (T1, T2, T3 and T3′), and allow a detailed terrace chronology. Bounds on the terrace ages and offsets of 5 independent terraces yield consistent slip-rate estimates. The long-term slip-rate of 13.9 ± 1.1 mm/yr is defined at the 95% confidence level, as the joint rate probability distribution of the rate derived from each independent terrace. It falls within the bounds of all the rates defined on the central Altyn Tagh Fault between the Cherchen He (86.4°E) and Akato Tagh (88°E) sites. This rate is ~10 mm/yr less than the upper rate determined near Tura at 87°E, in keeping with the inference of an eastward decreasing rate due to progressive loss of slip to thrusts branching off the fault southwards but it is greater than the 9 ± 4 mm/yr rate determined at ~90°E by GPS surveys and other geodetic short-term rates defined elsewhere along the ATF. Whether such disparate rates will ultimately be reconciled by a better understanding of fault mechanics, resolved transient deformations during the seismic cycle or by more accurate measurements made with either approach remains an important issue.

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Late quaternary landform evolution along the Indus River, Ladakh, NW Himalaya

KUMAR A., SRIVASTAVA P.
Wadia Institute of Himalayan Geology, DEHRADUN, INDIA

The Indus River is one of the largest rivers on Indian continent that originates from Mount Kailas passes through Karakoram zone, Ladakh Batholith and tectonic units of Indus suture zone. Thus the landscape along this river has potential to unravel responses of Indus River to the neotectonic evolution of Indus Suture zone and to arid climate of trans-Himalaya. The synoptic study of Quaternary evolution of the Indus River in these connections has not been done judiciously.

This study focuses this aspect using the remote sensing data ASTER DEM (30m), SRTM (90m) and Toposheets (1:50,000), field geomorphological mapping and Optically Stimulated Luminescence (OSL) Dating technique. The study area includes the stretch of river from village Nyoma to Dah, where the Indus River shows marked change in its channel pattern and geomorphic configuration. There are thick sedimentary fills of wide braided channel from Nyoma to Nimu and several levels bedrock strath terraces are observed from Nimu to Dah, where rivers flows into a thin gorge. The geomorphological and sedimentological studies have been attempted on the quaternary deposits of Indus River and sand ramps in this area. The dating of strath terraces indicated the bedrock uplift rates varying from 2-5 mm/y and that the thrust contact between the Ladakh Batholith and Indus Molasses is neo-tectonically active. These results surprisingly matched with the incision rates (2-12 mm/y) of NW Himalayan syntaxis (Burbank et.al, 1996 and Leland et.al, 1998). Hence this area is equally tectonically active to North western syntaxis of Himalayan (Nanga Parbat). The Indus molasses is highly deformed and thrusted with north dipping sequence of thrusts and high angled reverse faults from chilling to Nimu, where Zanskar River is flowing in the gorge and confluence with Indus River at Nimu. We envisage that the bedrock incision in this zone is in response to the uplift due to the Pleistocene-Holocene crustal shortening in the Indus Molasse.

Deforming rate and kinematics of a potential part of the Tibetan Plateau on the mid-portion of the Qilian Shan Moutian, China

HU X., PAN B., WANG J., LI Q., HU Z., CAO B., JIANG S.
Key Laboratory of Western China's Environmental Systems (Ministry of Education), Lanzhou University, LANZHOU, CHINA

How the Tibetan Plateau is extended is one of the key problems to understand the earth crust evolution in the frame of plate tectonics. A newly uplifting area, the Dahe region, locating between the Yumu Shan Mountain and the Qilian Shan Mountain, in the northeastern Tibetan Plateau, would supply us a fresh sight on the process that how the plateau is extended to a new region. The Dahe region was a relatively depressing or stable area before late Pleistocene, and received deep fluvial sediment derived from the Qilian Shan in the south. In recent 140 ka, the old depositing surface (alluvial fan) was deeply cut by the Dahe River and several fluvial terraces were formed. By the uplifted terrace staircases and warped long profiles of terraces, we can see that the region is not only experiencing uplifting, but also experiencing folding deformation. Below the old depositing surface, four staircases of strath terraces (strath is the old fluvial deposition) are formed by the Dahe River, and each terrace surfaces are buried by aeolian loess. By the OSL dating on overlying loess on the terraces and correlating to climate records, we obtain formation ages (terrace surface abandoning time) of the four terraces (from high to low): 143-125 ka BP, 103-97 ka BP, ~91 ka BP, and 14.5-12.8 ka BP. After the climate influence is subtracted by considering river-long-profile slop changes respect to different climate conditions, average uplift rate of the Dahe region is calculated as 0.53-0.67 mm/a in late Pleistocene. Through analyzing the geometry of the deforming terrace surfaces, we propose that a new blind thrust fault was derived from the main decollement in the upper crust, and thus the growing fault deduced the uplift of the Dahe region and the folding near the fault tip. If we assuming a constant rate of uplift, the Dahe region will uplift to the Plateau level of ~5000 m at 5-8 million years later.

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Differentiating between gravitational faults related to evaporite dissolution and tectonic faults by means of geomorphological mapping, trenching and geophysical surveys

GUTIERREZ F.(1), CARBONEL D.(1), LINARES R.(2), ROQUE C.(3), ZARROCA M.(4), GUERRERO J.(1), MCCALPIN J.(5)
(1) Universidad de Zaragoza, ZARAGOZA, SPAIN ; (2) Univerisdad Autónoma de Barcelona, BARCELONA, SPAIN ; (3) Universidad de Gerona, GERONA, SPAIN ; (4) Universidad Autonoma de Barcelona, BARCELONA, SPAIN ; (5) Geo-Haz Consulting Inc., CRESTONE, CO, UNITED STATES

Differentiating between gravitational and tectonic faults constitutes a relevant issue for seismic hazard assessment with a poorly developed scientific basis. Gravitational faults may cause surface deformation, but are not capable of producing damaging earthquakes like tectonic faults. Misinterpreting nontectonic faults as seismogenic structures may lead to significant seismic hazard overestimates with relevant implications. Active faults related to interstratal dissolution of evaporites have been investigated in several regions by detailed mapping, geophysics and trenching: (1) Faults controlling the Rio Seco Graben (Iberian Range, Spain), developed in the crest of a monocline caused by dissolution-induced sagging. (2) The Zenzano Fault (Iberian Chain, Spain), formed at the top of an erosional escarpment underlain by an upper brittle unit and a lower tectonically thickened evaporitic formation. (3) The grabens of Peracalç (Eastern Pyrenees, Spain), related to subsidence and lateral spreading of a brittle carbonate plate resulting from dissolution and outward expansion of an underlying evaporitic unit more than 2 km thick. (4) Flexural-slip fault scarps in the Rocky Mountains, Colorado, generated by the unfolding of a monocline due to the loss of basal-lateral support resulting from evaporite dissolution. The geometrical relationships observed in the trenches, together with the numerical dates, indicate that these gravitational faults may have episodic displacement behaviour, tend to reach Dmax/L (maximum displacement/length) ratios higher than those reported for tectonic faults, slip rates and displacement per event values are generally higher than in tectonic structures, and the inferred recurrence intervals may be significantly lower.

Neotectonic deformation of a Late Quaternary glaciofluvial outwash plain in Southern Denmark caused by glacio-isostatic fault reactivation

SANDERSEN P.B.E., JøRGENSEN F., MøLLER R.R.
Geological Survey of Denmark and Greenland (GEUS), HOEJBJERG, DENMARK

Unambiguous morphological expressions of Quaternary tectonic events are scarce in Denmark because the landscape has been intensively molded by the ice sheets during the Quaternary glaciations or has been altered by late/postglacial erosional processes. However, the Late Weichselian outwash plains outside the Last Glacial Maximum (LGM) in the western part of Denmark constitute an ideal landform for identifying tectonic events post-dating the glaciation because the gently sloping surface of the outwash plain has remained undisturbed by glacier ice.

Early observations of the irregular topography around the village of Tinglev led to the theory that the outwash plain must have been temporarily covered with ice from an early advance during the LGM that reached beyond the Main Stationary Line (Hansen 1978). According to this theory, this short-lived ice advance left behind thin sheets of dead ice which were subsequently covered by a thin sheet of meltwater sand during the final sedimentation of the outwash plain. When the dead ice melted, the irregular topographical features including lakes, bogs and sinkholes were formed.

This model is now challenged by results from interpretation of LiDAR-data that have enabled us to identify morphological features on the outwash plain indicative of neotectonic movements: Significant level changes along distinct lineaments, frequent slope changes of neighbouring areas, 180 degree changes in dip direction and presence of close lying polygonal areas with marked shifts in terrain level. Using information from boreholes and seismic data we relate these morphological features to movements of the underlying Tønder Graben structure. Dating of soil samples from depressions in the outwash plain constrains the onset of the deformations to around 9.000 years BP. We conclude that the deformation of the outwash plain is related to short-term reactivations of faults related to the Tønder Graben structure during the deglaciation phase.

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The topography of the Iberian Chain (Spain): tectonic and surface processes interaction in landscape evolution

SCOTTI V.(1), FACCENNA C.(2), MOLIN P.(2), SOLIGO M.(2)
(1) Université Roma TRE, ROME, ITALY ; (2) Universit? Roma TRE, ROME, ITALY

First-order topographic features, drainage system pattern and spatial variation in surface processes rates in tectonically active areas represent proxies to quantitatively characterize the landscape's response to tectonic forcing.

We investigated the recent landscape evolution of the Iberian Chain (NE Spain), an intraplate thrust-belt formed in Late Cretaceous to Middle Miocene times. In the whole Iberia, the Iberian Chain represents a unique case of dome-shaped topography. Its central sector is dominated by a wide planation surface, developed during Upper Neogene (?), presently liying at an average altitude of 1300 m. In Late Pliocene (?) -Quaternary, the onset of a regional uplift controlled the organization of the present fluvial network and the dissection of the landscape.

Geomorphic responses to tectonic forcing have been analyzed by the calculation of morphometric parameters, focusing on topography (map of local relief, swath profiles) and hydrography (basin hypsometric curve and integral, basin asymmetry factor, river longitudinal profiles and relative indices), using the SRTM DEM as main data source. Morphometric analysis has been also combined with radiometric Uranium-series dating of calcareous tufas lying on fluvial terraces. The results allow the estimation of incision rate along the High Tagus and Martin rivers.

Our results indicate that uplift and rock-type erodibility are the main factors ruling landscape evolution of the study area. The values of incision rate are very similar throughout the central sector of the range, indicating that, despite local small variation, the rivers respond mainly to a homogeneous regional uplift.

In conclusion, the Iberian Chain landscape is in a transient state in response to a recent uplift. Indeed, the fluvial processes that so weakly incised this landscape are still far from counterbalancing the tectonics input.

Morphotectonic analysis of coastal chalk cliffs in Picardy (NW France): field evidence of neotectonic fault systems occurrence in step-graben structure

DUPERRET A.(1), VANDYCKE S.(2), COLBEAUX J.P.(3), VAN VLIET-LANOE B.(1), DROMELET E.(4), CANCOUET R.(1)
(1) UMR 6538 CNRS Domaines Oceaniques, PLOUZANE, FRANCE ; (2) FNRS, Université de Mons, MONS, BELGIUM ; (3) Conseil Scientifique de l'Environnement Nord Pas de Calais, LILLE, FRANCE ; (4) Université Libre de Bruxelles, BRUXELLES, BELGIUM

Neotectonic activity is often difficult to evidence in the chalk of the Anglo-Paris basin using only geomorphological analysis. The chalk of a sedimentary basin, located in a context of actual low stress-field favors the formation of smooth landscapes, due to chalk exposure to continental weathering during actual period and Quaternary periglacial conditions.

We study in details a small area along the coastal chalk cliffs of the English Channel located at Bois de Cise in Picardy (NW France). The study site is located between the Variscan front crossing the Dover straits and the Bray fault system. The use of high resolution digital topography with LiDAR data (RGE-Alti) allow to evidence some particular surficial slope deformation, made of topographic steps aggregated behind the cliff face or along (perched) valleys transverse oriented to the cliff. These organised structures are defined as step-graben. Topographic steps present always a few meters high, a mean slope of 40°, several ten meters length and a linear morphology with slight curvatures at their borders.

At Bois de Cise site, a 3D field description will be presented. A step-graben develops along a transverse perched valley, where normal faults and tectonic faulting graben structure are evidenced on the cliff face. Step-graben structures are also associated with caves development at the base of the cliff, *i.e.* at about 100m below the surface of chalk plateau. Caves and temporary springs of fresh water along faults evidence a karstic behavior in the chalk and allow propose step-graben structures, as geological guides for hydrogeological circulation in the chalk of Picardy.

The observed normal faults cut quaternary deposits accumulated on the chalk at top of the cliff. This is a strong argument to prove the quaternary activity of step-grabens and a neotectonic activity recorded in the chalk of Picardy, mainly guided by the most recent paleostress field recorded in the chalk of NW France, with a NNE-SSW extension.

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Remote Sensing and Ground Penetrating Radar in the characterization of Tectonic Geomorphology of South Andaman Islands, India ' A step towards hazard preparedness and mitigation

SANKARAN B.
PONDICHERRY UNIVERSITY, PORT BLAIR, INDIA

The rapid growth of population and their excessive demand for resources, urbanization, industrialization have affected the coastal environment and its aquifers. Coastal flooding, tsunami and storm surge have inundated the coasts resulting in the contamination of aquifers, shoreline retreat and marginal land loss. The characterization of tectonic geomorphology is important as it throw lights on earthquake, tsunami and landslides. In the characterization of geomorphological landforms and structures, the remote sensing and Ground Penetrating Radar play a pivotal role. The interpretation of Indian Remote Sensing P6 satellite imagery and GPR image of South Andaman islands have brought out horst and graben, escarpment, synclinal and anticlinal valley, offsetting of beds, sinistral and dextral drag of beds. Therefore, the role of tectonically controlled structures and landforms cannot be negated in the wake of coastal faulting, submergence and emergence of shorelines exposed to several hazards.

The Andaman and Nicobar islands are confronted with many hazards such as tsunami, earthquake, landslides, erosion, coastal flooding and storm surge. The landforms and drainages are structurally controlled and are trending in NW-SW, NW-SE, N-S and E-W directions play a vital role in the landscape evolution. The NE-SW trending lineaments show sinistral drag of beds. The parallel faults have caused several horst and graben. The graben and the concave coasts acts as pathways for the inundation and/or coastal flooding causing contamination of fresh water aquifers thus reducing the land areas and recharge. The creeks are mostly fault controlled similarly act as easy channel way for tide propagation towards inland.

Therefore, a clear understanding of the tectonic geomorphology and its analysis is important in the present context of global warming and climate change for the sustainable development of South Andaman islands.

Prehistoric large earthquakes produced by slip on the Central Iran strike-slip faults

FOROUTAN M.(1), LE DORTZ K.(1), MEYER B.(1), SÉBRIER M.(1), NAZARI H.(2), FATTAHI M.(3), RASHIDI A.(4), BATEMAN M.D.(5), BRAUCHER R.(6), BOURLÈS D.(6), BENEDETTI L.(6), SIAME L.(6), TALEBIAN M.(2), GHORAISHI M.(2)

(1) Université Pierre et Marie Curie, Paris 06, ISTEP UMR 7193, F-75005, PARIS, FRANCE ; (2) Research Institute for Earth Sciences, Geological Survey of Iran, TEHRAN, IRAN ; (3) The Institute of Geophysics of the University of Tehran, TEHRAN, IRAN ; (4) Geological Survey of Iran, KERMAN, IRAN ; (5) Sheffield Centre for International Dryland Research, Department of Geography, University of Sheffield, SHEFFIELD, UNITED KINGDOM ; (6) CEREGE UMR 6635, AIX-EN-PROVENCE, FRANCE

Central Iran plateau appears aseismic during the period of time of few millenniums covered by the instrumental and historical seismic records. Nevertheless, it is sliced by several strike-slip faults such as the Dehshir and Anar faults that are hundreds kilometres-long. These faults display along-strike, horizontal offsets of intermittent gullies that give evidence for Holocene activity. Both the sharpness of these cumulative offsets and the absence of along fault microseismicity suggest these offsets have occurred through large and infrequent earthquakes.Then, demonstrating the occurrence of earthquakes in the Holocene is crucial for assessing the regional seismic hazard. The paleoseismic studies performed along these faults show that they hosted large ($M_w \approx 7$) earthquakes during the Holocene. Combining paleoearthquake indicators with OSL dating implies that three seismic events have occurred over the last 20.1±1.6 ka on the Dehshir fault and three seismic events over the last 15 ka on the Anar fault, suggesting average recurrences of at most 7 and 5 ka respectively for the Dehshir and Anar faults. The most recent event took place 2.0±0.2 ka ago on the Dehshir fault and between 3.6 and 5.2 ka on the Anar fault. For the later, this suggests the fault is approaching the end of its seismic cycle and the city of Anar could be under the threat of an impending earthquake. Additionally, our results confirm a previous minimum slip rate estimate of 0.8±0.1 mm yr^{-1} for the Anar fault, and a slip rate of 1.2±0.3 mm yr^{-1} for the Dehshir fault indicating the westernmost prominent right-lateral faults of the Central Iran plateau are characterized by slip rates close to 1 mm yr^{-1}. These faults, which have repeatedly produced large earthquakes with long recurrence interval during the Holocene, show that the Central Iran plateau does not behave totally as a rigid block and that its moderate internal deformation is nonetheless responsible for a significant seismic hazard.

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Uplift vs. denudation in the southern Apennines (Italy): geomorphologic evidence and constraints from terrestrial cosmogenic nuclides and apatite (U-Th)/He data

ASCIONE A.(1), CAPALBO A.(2), CAPOLONGO D.(3), MAZZOLI S.(1), PAZZAGLIA F.J.(4), VALENTE E.(1), ZATTIN M.(5)

(1) Dipartimento di Scienze della Terra, Università Federico II, NAPOLI, ITALY ; (2) Dipartimento di Scienze geologiche, Tecnologie Chimiche e Ambientali, Università Carlo Bo, URBINO, ITALY ; (3) Dipartimento di Scienze Geologiche e Ambientali, Università Aldo Moro, BARI, ITALY ; (4) Department of Earth and Environmental Science, Lehigh University, BETHLEHEM, PENNSYLVANIA, UNITED STATES ; (5) Dipartimento di Geoscienze, Università di Padova, PADOVA, ITALY

Over a variety of mountain belts, evidence that erosion rates are comparable with exhumation rates supports the idea that, under steady uplift and over 10^3-10^6 yr time scales, mountain chains tend to achieve dynamic equilibrium between uplift and denudation. We investigate the relationships between uplift and denudation in the southern Apennines, a young orogen affected by crustal shortening until c. 0.7 Ma, and subsequently by regional uplift. The study is based on the integration of geomorphologic and morphometric data with constraints to the uplift and erosion rates.

Quaternary marine terraces from the two sides of the mountain belt, and Pliocene-Pleistocene deposits from the chain axis, indicate that uplift coeval with shortening was both spatially and temporally uneven, and was slower than that (of c. 0.8 mm/yr) recorded after the ceasing of shortening.

Constraints to the denudation are provided by (i) cosmogenic nuclides and long-term sedimentary yield, constraining erosion rates, and (ii) low-T thermochronometric data, constraining the unroofing of originally deeply buried tectonic units. Paleoerosion rates range from c. 0.2 to 0.4 mm/yr, and are consistent with the 0.6 to 0.3 mm/yr exhumation rates. Collectively, such values average denudation affecting most of the mountain belt, which includes bedrocks with variable resistance to erosion. Such results, which provide information on different time windows (collectively spanning from the Early Pleistocene to the Present), suggest that denudation averaged over long time spans is insensitive to climatic fluctuations.

The overall data set indicates that the changing style and rate of uplift has not affected the development of denudation in the mountain belt. The imbalance between uplift and denudation, which is mirrored by the large-scale topographic features of the chain, appears as a result of the long response time of hillslope and fluvial systems with respect to the relatively young age of uplift acceleration.

Linking topographic indices and rock uplift rates to denudation in a low uplift rate setting: Betic Cordillera, SE Spain

BELLIN N.(1), VANACKER V.(1), KUBIK P.(2)
(1) Université Catholique de Louvain. Georges Lemaître Centre for Earth and Climate Research (TECLIM), LOUVAIN-LA-NEUVE, BELGIUM ; (2) Paul Scherrer Institute, c/o Institute of Particle Physics, ETH Zürich, ZURICH, SWITZERLAND

During the last decade, relations between catchment morphology, topographic indices, long-term catchment-wide denudation rates and rock uplift rates have been studied for high tectonic uplift rate settings. However, the validity of these relations for low uplift rate settings has received less attention.

Here, we present cosmogenic nuclide-derived denudation rates for 20 small catchments that were selected along a gradient of tectonic uplift within a region with low bedrock uplift rates (Betic Cordillera, SE Spain). Then, topographic indices were derived from high-resolution (10m) Digital Elevation Models to analyse the association between thespatial pattern of denudation rates and the spatial variability in stream-length normalized index (SLk), steepness index (k_{sn}), valley-width ratio (Vf), concavity indices (SCI-θ), hypsometric index (HI), mean local relief (Lr) and mean catchment slope (S_{basin}). Additional information on bulk erosion (minimum) was also derived based on the reconstruction of the theoretical pre-incision surface ($Bulk_{Er}$). This paper aims to unravel the association between the spatial variability in denudation rates, topographic indices and rock uplift rates.

Results indicate low denudation rates (mean = 63 mm kyr^{-1}) with high spatial variability between the selected Betic Sierras (13-246 mm kyr^{-1}). Spearman correlation coefficients show that SLk (0.8**), $Bulk_{Er}$ (0.6**), Vf (-0.62**) and Lr (0.52*) accurately reflect the spatial variability of denudation. The similar magnitude obtained between local rock uplift and denudation rates suggests that the rates at which millennial erosion processes shaped the eastern Betic Sierras was roughly constant through geological timescales. We suggest that eastern Betic Cordillera approached dynamic equilibrium where rock uplift is balanced by denudation (topographic steady-state).

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Long Term Evolution of Active Folding in North Africa: Surface deformation and modeling

MEGHRAOUI M.
EOST - Institut de Physique du Globe, STRASBOURG, FRANCE

The Atlas Mountains of North Africa experienced the largest thrust earthquakes of the western Mediterranean region. We investigate the geomorphologic similarities and differences between different active fault-related folds along the Africa - Eurasia convergent plate boundary. These active structures are seismogenic and the striking case studies are the 1960 Agadir (Mw 5.9), the 1954 Orleansville (Mw 6.7), the 1980 El Asnam (Mw 7.3), the 1992 Gafsa (Mw 5.3), the 1999 Ain Temouchent (Mw 6.0), and the 2003 Zemmouri (Mw 6.8) earthquakes. Using remote sensing images, or measured using space-borne geodesy (GPS or INSAR) combined with paleoseismic investigations the long–term active tectonics appear mainly as a thrust escarpment and fold-related faulting. The late Quaternary active folding is attested by the major uplift of late Pleistocene and Holocene alluvial and marine terraces and folding with steplike morphology. The El Asnam active fold shows the coseismic ruptures and 0.6 to 1.0 mm/yr uplift rate. The 2003 earthquake was responsible of ~ 0.5 m uplift along ~ 55 km shoreline east of Algiers. West of Algiers on the coastal Sahel anticline, the levelling and dating of uplifted successive benches and notches document the incremental folding uplift with0.84 – 1.2 mm/yr uplift rate in the last 120-140 ka. The timing of successive uplifts related to past coseismic movements on active folds illustrate the episodic activity of thrust ruptures and their relation to past earthquakes. The dislocation modelling of coseismic thrust ruptures document the incremental evolution of active folds and illustrate the surface deformation. The relatively fast folding growth during late Pleistocene and Holocene in the Atlas Mountains attests for the significance of earthquake activity and the importance of convergent movements between Africa and Eurasia in the Western Mediterranean.

The role of tectonics on the evolution of late Quaternary Amazonian landscape

ROSSETTI D.(1), ROSSETTI D.(1), HYAKAWA E.(2), BERTANI T.(1), ZANI H.(1), CREMON É.(1)
(1) INPE, SAO JOSE DOS CAMPOS, BRAZIL ; (2) Universidade Federal de Alfenas, ALFENAS, BRAZIL

The Amazonas basin houses the most impressive ecosystem on Earth. This region is of relevance for the reconstruction of Quaternary climate changes due to its role as a global climate regulator. Changes in sedimentation and river dynamics over the Quaternary have been linked to climate. This reasoning could have primacy over other hypotheses if one disregards other influences on landscape evolution, such as tectonics. Considering the latter, a scenario different than currently reconstructed under a paleoclimatic scheme can be depicted. Although the majority of the geological investigations considers this region as a tectonically stable setting in the Cenozoic, several publications suggest that the Amazonian lowlands were undergone to tectonic deformation even in the Holocene. Hence, previously proposed climatic-related hypothesis for landscape dynamics may be an oversimplification of the geological record. This should be revisited in the light of a tectonic hypothesis. Advances in this field are still biased by a high degree of criticism on the tectonic influence over this region. The aim of the present work is to present morphological evidence for relatively recent tectonic activity in the Amazonian lowlands exploring mostly remote sensing products. The results revealed anomalous features, consisting of: lateral displacements of entire depositional systems (i.e., megafans, paleochannels and entire fluvial valleys), localized fluvial terrace downcutting and deposition, straight channels with orthogonal junctions, anomalous meander loops and enlarged river segments, highly asymmetric drainage basins, multibasinal drainage, and orthogonally-shaped lakes. It is unquestionable that geomorphic processes and changes in landscape dynamics over this region was strongly influenced by fault activity. This factor should be better understood prior to issuing climatic inferences when reconstructing the Quaternary history of the Amazonian lowlands.

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Uplift history of the coastal Central Andes deduced from morphology

REGARD V.(1), MARTINOD J.(1), CARRETIER S.(1), SAILLARD M.(2), PEDOJA K.(3), RODRÍGUEZ M.P.(4), RIQUELME R.(5), HÉRAIL G.(1), BENECH N.(1), GUILLAUME B.(6), AGUILAR G.(7)
(1) GET, Université de Toulouse/UPS/CNRS/IRD, TOULOUSE, FRANCE ; (2) Géoazur, Université Nice Sophia-Antipolis/CNRS, VILLEFRANCHE-SUR-MER, FRANCE ; (3) M2C, Université de Caen/CNRS, CAEN, FRANCE ; (4) Dep. Geología, Universidad de Chile, SANTIAGO, CHILE ; (5) Dep. Ciencias Geológicas, Universidad Católica del Norte, ANTOFAGASTA, CHILE ; (6) Geosciences Rennes, université de Rennes 1/CNRS, RENNES, FRANCE ; (7) Universidad de Atacama, Dep de Geologia, COPIAPO, CHILE

Most of the Pacific coast of the Central Andes, between 15°S and 30°S, displays a wide (a couple of kilometres) planar feature, gently dipping oceanwards and backed by a cliff. This morphology, usually of marine origin, is called *rasa.* Such feature and marine terraces have been observed without important gap, along the 1,500-km-long study area. This is a clear evidence of uplift, even along the 1,000m-high cliffs in the Atacama area, in northern Chile.

In a previous work (Regard et al. 2010), we observed the main cliff foot at *rasa* summit has similar elevation (~110 m amsl) over most of the study area. Moreover, the compilation of published chronological data and the extrapolation of re-appraised uplift rates provide evidence for a common cliff foot age of around 400 ka (i.e., Marine Isotopic Stage MIS 11). Additional geological constraints show that the area has not undergone significant uplift since the Pliocene. Thus we proposed a renewal of uplift in the Central Andes forearc after a late Pliocene quiescence or subsidence.

Since then, we observed in north-central Chile continental pediments connected to the *rasa* summit, with similar dating constraints. Pediment setup is a long process which needs little base level variation: pediments have probably formed during the same late Pliocene-early Pleistocene quiescence, as proposed for the *rasa* (Rodriguez et al., in press).

We present new 10Be ages and further field mapping allowing for a finer description of this history.

References: Regard, V., et. al., Renewed uplift of the Central Andes Forearc revealed by coastal evolution during the Quaternary*. Earth and Planetary Science Letters*, 2010. 297: p. 199-210, DOI: 10.1016/j.epsl.2010.06.020.

Rodríguez, M. P., et. al., Geochronology of pediments and marine terraces in north-central Chile and their implications for Quaternary uplift in the Western Andes: *Geomorphology*, in press, doi: 10.1016/j.geomorph.2012.09.003.

Local tsunamigenic earthquakes off northeastern Venezuela, in the southern Caribbean realm

AUDEMARD F., LEAL A.
Venezuelan Foundation for Seismological Research -FUNVISIS-, CARACAS, VENEZUELA

The 1983 National Inventory of Geologic Hazards and the 1999 Catalog of felt/destructive Venezuelan Earthquakes (1530-1998) report reliably the occurrence of tsunami waves on the Caribbean eastern Venezuelan coasts, or phenomena that might be interpreted as substantial sea level modifications in the region, during 5 local earthquakes only. We have confirmed this through the search and evaluation of the accounts by primary sources (eye witnesses) of the tsunami inundation during the 5 events. Such tsunamigenic events are the 1-IX-1530, 15-VII-1853, 29-X-1900, 17-I-1929 and 9-VII-1997 earthquakes. All but the 1900 shock affected the Cumaná city, and the offshore right-lateral strike-slip El Pilar fault has been accounted for. The 1900 AD tsunami waves were reported along most of the Ensenada de Barcelona coast (W of Cumaná) and Los Roques Archipelago, being this quake attributed to the San Sebastián fault segment running offshore Cabo Codera. The 1530 and 1853 quakes were produced by the Cariaco trough segment of the El Pilar fault, within a restricted over-1000-m-deep marine pull-apart basin on the San Sebastián-El Pilar releasing step-over, whereas the 1929 and 1997 events occurred on the Cariaco gulf segment. Several authors have interpreted all four events as the result of major submarine sliding inside the steep-walled trough. First-hand accounts by locals about the abnormal waves during the Cariaco 1997 event, as well as the identification of coastal sliding at the Manzanares river mouth at Cumaná, support this thesis at least for the two latest events, because of the small size of the tsunami-affected area. In addition, recent monitoring (CARIACO Project) has observed turbidite currents in the Cariaco trough and the Manzanares canyon during the Cariaco Mw 6.9 quake and the smaller Mw. 5.2 August 2008 event. However, the 1900 tsunami, and the 1530 and 1853 tsunamis by extension, appears to result from right-lateral tectonic slip along the Cariaco trough walls.

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Active deformation of a passive margin: geomorphic evidence for persistent faulting consistent with the 23 August, 2011 Louisa County, VA earthquake

BERTI C., PAZZAGLIA F.J., MELTZER A.S.
Lehigh University, BETHLEHEM, PA, UNITED STATES

The recent Virginia seismic sequence, originated by the M 5.8 Louisa County, VA earthquake in August 2011, offers a singular opportunity, to our knowledge, to integrate seismicity with a long term record of deformed geomorphic markers in the intraplate setting of the eastern U.S. passive margin. Over 340 recorded aftershocks define a clear NE-SW striking SE dipping fault plane extending 7-9 km along strike at depths from 1 to 7 km.

Preliminary geomorphic field work along the South Anna River in Louisa County has mapped evidence for repeated faulting and surface deformation surrounding the illuminated fault plane, as warped (middle-late Pleistocene?) straths and terrace deposits. The South Anna River has several large knickpoints in its long profile. We suspect that these have been created by both far-field base level fall and local faulting. In the area affected by the recent earthquake, the top of a large knickpoint at Byrd Mill (VA Rt 649) is accordant with a low-gradient strath terrace that projects downstream across the epicenter of the recent earthquake, in the Yanceyville area. Continuing downstream for several kilometers beyond Yanceyville, the strath terrace and its thin alluvial cover climbs about 6 to 10 m in elevation, ultimately showing a clear downstream divergence from the South Anna channel. This observation is best explained by a history of local uplift of the bedrock consistent with the reverse fault focal mechanism of the recent earthquake. This interpretation is further supported by a higher, older terrace that shows a similar downstream divergence, and by channel form, that changes from low-gradient, low sinuosity in the subsiding footwall to steeper, higher sinuosity in the uplifting hanging wall.

Poster presentations:

Quaternary tectonic deformation in the front of the northern Tian Shan, northwestern China revealed by sedimentary and geomorphic evidences of the Urumqi River

LU H.(1), ZHANG T.(1), LI Y.(2), SI S.(2), ZHENG X.(1)
(1) Department of Geography, East China Normal University, SHANGHAI, CHINA ; (2) Key Laboratory of Earth Surface Processes of Ministry of Education, Peking University, BEIJING, CHINA

Timing of Quaternary deformation in the range front of the Urumqi River is still unclear. Here we chronologically constrain deformation in this region by analyzing the deformed Pliocene and lower Pleistocene strata as well as terraces of the Urumqi River.

The oldest alluvial fan (F_1) of the Urumqi River is composed of ~400-m-thick lower Pleistocene conglomeratic strata. Near the fan end, the underlying Pliocene strata were folded and exposed due to basinward thrusting of the range-bounding fault. Wherever the two strata are juxtaposed, the dips of the lower Pleistocene gradually decrease upward from ~90º near the river bed to ~45º at the ditch on the west bank. This change in the dips of the lower Pleistocene is interpreted to indicate the occurrence of growth strata (Burbank et al., 1996), suggesting continuous tectonic deformation when the conglomeratic sediments deposited. An ESR age of 1148 ka for the sample from the top of the fan F_1 (Zhou et al., 2002) shows that aggradation of this fan ended around this age. We thus propose that deformation in the study area continued at least till ~1.2 Ma.

The further deformation is revealed by geomorphic evidences of the Urumqi River. Nine terraces (T_1 to T_9) are identified in the range front. The highest terrace T_9 surface is the surface of F_1. T_7, T_5, and T_4 with relatively planar surface are well displayed on the east bank. The longitudinal profiles of the there terraces obviously display fold deformation just near the fan end of F_1, decreasing systematically in magnitude of deformation. ESR ages of two samples from terraces T_7 and T_5 are 255±25 and 142±14 ka, respectively. Combining with an ESR age of 114 ka for the sample from the undeformed terrace T_3 (Zhou et al., 2002), we conclude that Quaternary deformation in the range front of the Urumqi River continued till late Middle-Pleistocene.

Burbank, D.W., et al. Basin Res., 1996, 8, 199-223.

Zhou, S.Z., et al. Science in China(Ser. D), 2002, 45(11), 961-968.

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Sequence stratigraphic analysis and hydrocarbon prospects of the late Neogene-Quaternary off shore sediments north west of Sinai, Egypt

ELHABAB A., EL ADSANI I.
College of Technological Studies, KUWAIT, KUWAIT

Detailed sequence stratigraphic analysis of the Late Neogene-Quaternary offshore subsurface sediments, NW of Sinai has revealed five third-order major depositional sequences. The Late Miocene sequences include two sequences, MSq-1 and MSq-2 whereas the Plio-Pleistocene sediments are represented by the sequences, PSq-1, PSq-2 and P-QSq. The different characteristics of each sequence are discussed in detail including their boundaries, transgressive and maximum flooding surfaces and the characteristic features of the enclosing systems tracts. The sequential evolution of the encountered sediments has revealed four successive depositional cycles mainly related to the sea level oscillations of the paleo-Tethys during the Late Neogene-Quaternary times. Moreover, for further hydrocarbon prospects in the study area and surroundings along the Egyptian offshore, the study recommends that: 1) The efforts should be directed to the stratigraphic traps comprising the sandy levels within the high-stand system tracts (1 st priority) and the sand levels within the transgressive systems tracts (2nd priority). 2) The efforts should be directed to the combination traps consisting of the sediments of Pliocene sequence-2 (PSq-2) when only affected by the rollover anticlinal folds.

Keywords: Neogene – Quaternary — Stratigraphic Sequence – depositional – Tethys – hydrocarbon prospects

Landscape evolution in a active tectonic context: the case of the Aterno river basin (L'Aquila, Abruzzo, Italy)

FUBELLI G.(1), FALCUCCI E.(2), GORI S.(2), DELLA SETA M.(3), FREDI P.(3)
(1) Department of Geological Sciences, Roma Tre University, ROME, ITALY ; (2) INGV Istituto Nazionale di Geofisica e Vulcanologia, ROME, ITALY ; (3) Department of Earth Sciences Roma "La Sapienza" University, ROME, ITALY

The intermontane basins of Central Apennines are key areas to comprehend Quaternary morphotectonic evolution of this part of the mountain chain, where active tectonics strongly affected the assessment of previous drainage basins and networks. The present Aterno River catchment – the study area of this work - is located in Abruzzo Region and crosses some of these intermontane basins. Our aim is to reconstruct the shape and location of the paleo-Aterno River catchment before the occurrence of the extensional tectonics that determined its present configuration. The expected results might contribute to the better comprehension of the role played by both the tectonic and geomorphological events in the recent landscape evolution.

To model the Aterno River paleo-drainage basin we used a simple GIS based method. GIS technique allowed outlining and redrawing the shape of the Quaternary alluvial plain and tributary fans. The first step was the sampling of all the remnants of the plain surface and of the lower limit of the Quaternary deposits, from a 20 m resolution DTM. Then, using geospatial analysis, we reconstructed the top and base surfaces of this sedimentary body. The raster difference between the top and base surfaces allowed us estimating also the alluvial deposit thickness, thus confirming the occurrence of Quaternary faults in the study area, whose activity is also testified by paleoseismological data. Extending the investigations to the surrounding divide areas characterized by a gentle landscape (known in the literature as “Paleosuperficie Sommitale”), elevation ranging between 1100 and 1500 a.s.l. and lack of continental deposits, we reconstructed the relict erosional landscape existing before the occurrence of the extensional tectonic that affected this part of Apennines. The correlation between the relict erosional landscape and the Quaternary alluvial plain surface, allowed the localization of the head of the paleo-Aterno River drainage basin.

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Application of Geomorphic Indices of Active Tectonics (GAT) in Morphotectonic Analysis of the Par River from Western India

HIRE P.S.(1), PATIL A.D.(2)
(1) G. E. Society's Arts and Commerce College, JAWHAR, INDIA ; (2) Department of Geography, Tilak Maharashtra Vidyapeeth, Gultekadi, PUNE, INDIA

In order to test the hypothesis of ongoing uplift or neotectonic activity in the Par River Basin from Western India, a part of western Deccan Basalt Province (DBP), geomorphometric analysis was carried out and commonly used geomorphic indices of active tectonics (GAT) such as the hypsometric integral (HI), the basin asymmetry factor (AF), the valley width-height ratio (Vf), the stream gradient-length ratio (SL), and the basin elongation ratio (Re) were derived. ASTER-DEM data and ArcGIS were used to derive the indices. Tectonic geomorphic analysis based on five proxy indicators suggests that the index values are not very far from the GAT values typically associated with drainage basins affected by active tectonics and deformation. Therefore, the presented results indicate that the Par River Basin belongs to the class of relatively high tectonic activity as compared to other river basins of western DBP. The results are consistent with field observations on landforms and geology.

Evolution of large-scale gravitational deformations in tectonically-controlled mountain slopes

BUCCI F., CARDINALI M., FIORUCCI F., GUZZETTI F., SANTANGELO M.
CNR-IRPI, PERUGIA, ITALY

Evidences of large-scale gravitational movements evolving close to Quaternary faults have been recognized in the north eastern Sicily (south Italy) through the visual inspection of multi-scale and multi-temporal aerial photographs. Geomorphological and photo-geological survey have defined the relationship between the gravitational displacements and the tectonically-controlled landscape modifications conditioned by the presence of fault planes crossing the mountain slopes. In most cases the faults played, or are playing, an active role in increasing the local relief. Furthermore their activity represents the main geomorphic factor conditioning the gravitational movements. These mass movements may have developed in response to the slope weakening subsequent to multiple earthquake events, thus they occurred in the same time period of the Quaternary fault activity. In other cases the faults have also played a passive role by forming the boundary of the sliding masses and coincide with the slip surfaces. In both cases the evolution of the large-scale mass movements is conditioned by the incision of the hydrographic network in response to regional Quaternary uplift. The related erosion causes modifications of the slope morphology and the exhumation of weak discontinuities which may lead to slope instability. The spatial association of Quaternary faulting and large-scale gravitational movements greatly increases the hazard in fault-controlled mountain front landscapes. The evolution of tectonic displacement by coseismic offset may represent a potential cause for the sudden and catastrophic evolution of the gravitational movements. After their emplacement, the large-scale landslide bodies are deeply dismantled by the recent morphogenesis, including recent and present-day landslides that can propagate without any evidence of tectonic displacement and further increase the local landslide hazard.

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Neotectonic structures in the precordillera geological province. Structural setting from geomorphologic, gravity and magnetic data

PERUCCA L.(1), RUIZ F.(2)
(1) UNSJ-CONICET, SAN JUAN, ARGENTINA ; (2) UNSJ, SAN JUAN, ARGENTINA

The Central and Eastern Precordillera of San Juan, Argentina, form oppositely verging thrust systems on the western and eastern sides of the Matagusanos-Maradona-Acequión valley, resembling a thick-skinned triangle zone with significant changes in the axis position along strike, north to south.

Between the Del Agua and the De La Fecha rivers, for example, the axis ofthis triangular zone is located in the eastern portion of the depression, while to the north, it is placed in the western flank. Changes in the position of the triangle zone axis along strike, alternatively to the east or to the west, would take place during Pliocene-Pleistocene times.

Geophysical, geodetic and geomorphologicdata indicate a sub-surface structure striking NE, with dextral displacement and oblique to the general direction of the foreland, shows that the change in the location of the triangular area could be attributed to stress transfer favored by heterogeneities in the basement, provoking its jump through longitude.

By analytic signal analysis of magnetic anomalies, it is possible to assess the regional role of structural control of the coupling between Pie de Palo and Eastern Precordillera. The basement blocks oblique arrangement could explain transversal lineaments and the sigmoidal geometry of the Eastern Precordillera.

Basement structures might have also played a primary role in the localization of quaternary faults trending N-S. A structural cross section shows the same Cenozoic faults with opposing vergence, responding to different controls imposed by those previous basement structures.

Capturing the timing and rates of valley incision through cave dating in the Eastern Pyrenees: geodynamic implications

CALVET M.(1), GUNNELL Y.(2), HEZ G.(3), BRAUCHER R.(4), GUILLOU V.(4), BOURLES D.(4), DELMAS M.(1), SORRIAUX P.(5)
(1) Université de Perpignan-Via Domitia, EA 4605 Médi-Terra., PEPIGNAN, FRANCE ; (2) Université Lumière-Lyon 2, UMR 5600 CNRS Environnement, ville, société., LYON, FRANCE ; (3) Université de Savoie, UMR 5204 CNRS Edytem, LE BOURGET DU LAC, FRANCE ; (4) Aix-Marseille Université, CEREGE CNRS UM 34, AIX-EN-PROVENCE, FRANCE ; (5) Total E&P, PAU, FRANCE

Tectonic uplift in active mountain belts narrowly controls the rate and tempo of valley incision, with additional modulation effected by climatic change. There is no consensus over whether the Pyrenees still is an active orogen, even though surface uplift rates based on modern land levelling techniques register values of up to 1 mm/yr. Clarifying matters for the longer term should rely on opportunities to measure and date the vertical displacement of landforms of known initial geometry. Fluvial terrace systems in the Pyrenees have so far not yielded any dated sequences that reach further back in time than the latest Middle Pleistocene. Subterranean karstic networks, however, provide a fruitful alternative, with potential for obtaining coupled ^{26}Al and ^{10}Be burial ages for fluvial sediment which became trapped in limestone cavities while being conveyed through the catchment during valley incision.

Suitable subhorizontal, gravel-filled phreatic cave galleries cross-cut by limestone canyon sidewalls occur in the Têt valley. These can effectively be treated as a bedrock straths correlatable with subaerial terrace treads situated further up- and downstream. Such markers also provide information about karstic base levels, which in this setting connect directly to the regional marine base level.

The Têt valley exhibits a succession of cave levels spanning 300 m of vertical relief, two of which have been dated. Quartz-rich sediment samples were collected from of each system but also replicated among sand-sized and gravel-sized clasts, dated separately. Initial results reveal a continuous process of canyon incision throughout the entire Pliocene and Quaternary, with relatively steady mean incision rates. Nuclide inheritance in the samples provides added information about catchment-wide mean denudation rates. These rates are found to triple after 2 Ma, clearly reflecting a climatic signal linked to the onset of the Pleistocene glacial–deglacial cycles.

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Geomorphologic correlation of the reconstructed and contemporary relief in Kolubara - Tamnava Coal Basin

KEZOVIC M., DRLJEVIC N.
EPI Serbia, Kolubara-Open Cast Mines, LAZAREVAC, SERBIA

Based on results of the geophysics exploration and numerous exploration drillings, morphometric-statistyc analysis and field research, geomorphologic correlation of the Kolubara-Tamnava coal Basin was reconstructed through time from paleo-relief up to modern relief.

Directions of neo-tectonic movement were defined, structures separated and neo-tectonic zoning performed, and all of that based on connection between relief and neo-tectonic movements.

Keywords: Geomorphologic correlation, Kolubara-Tamnava coal Basin, relief, neo-tectonic movement.

Tectonic influence on the geomorphologic evolution of tocantins river near Maraba, South Amazonia

MORALES N.(1), FELIPE L.B.(2), SOARES JR. A.V.(3)
(1) Universidade Estadual Paulista - UNESP, RIO CLARO, BRAZIL ; (2) Universidade Federal do Pará - UFPA, MARABÁ, BRAZIL ; (3) Universidade Federal de São Paulo, SÃO PAULO, BRAZIL

Supportted by high-resolution remote sensing, digital terrain models and field survey geological and geomorphological studies were carried out in the region of Maraba, Southern Amazonia, northern Brazil. They allowed the recognition of tectonic faults influencing the geomorphological subdivision, the distribution of Cenozoic sediments and fitting the Tocantins River into a structurally controlled basin. Geomorphologic compartments fit around the Archaean basement rocks (Amazonian Craton), Araguaia Belt (Upper Proterozoic low-grade metasedimentary rocks), domains with residual tabular relief sustained by sediments Barreiras Group and downward blocks at the right margin of the Tocantins River. Sets of lineaments denounce the macroscopic structural pattern and they coincide with the principal directions of the mapped fractures. Geomorphologic boundaries between compartments are defined by faults or fault zones. NS normal faults control the Tocantins River downstream and limit the outcrops of Barreiras Group that from these failures towards East occurs as proximal alluvial fans, stating that it was an important geomorphologic boundary at that time of sedimentation. This set of rocks shows well-developed lateritic profile associated with a planing surface also preserved on top of flattened hills. Faults striking WNW-ESE to NW-SE control down compartments, fitting the rivers and docking the Tocantins River into a pull-apart basin controlled by NS and NW-SE normal faults, forming a rhombohedral geometry that controls the quaternary alluvial plain. The arrangement of faults and their kinematic interpretation point to a transtensive segment associated with dextral transcurrent system oriented near the EW direction. This arrangement is interpreted as associated with neotectonic regime in intraplate environment, resulting from the migration to NW of South American Plate and its interaction with the Nazca and the Caribbean Plates.

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Recent tectonics control on the morphological evolution of the eastern sector of the Monti Sabatini Volcanic District (Lazio, Italy)

CICCACCI S.(1), FALCUCCI E.(2), FREDI P.(1), LUPIA PALMIERI E.(1)
(1) Dipartimento di scienze della terra - sapienza Universita di Roma, ROME, ITALY ; (2) Istituto nazionale geofisica e vulcanologia, ROME, ITALY

This work focuses on the role of recent tectonics in the morphological evolution of the eastern sector of the Sabatini Volcanic District (Lazio). The Monti Sabatini volcanism evolved in a NW-SE directed Graben, tied to the tensile tectonics which followed the compressive phases of the Apennine building. The typically areal and mainly explosive volcanism of this District started about 0.6 m.y. B.P. and lasted until 0.05 m.y.B.P.. Volcanic activity affected a total area of about 1600 km^2 to the North of Rome; in the eastern sector, however, the most important emission centres concentrated in the surrounding of the present towns of Sacrofano, Morlupo and Castelnuovo di Porto.

The present morphology of the study area is strongly conditioned by the volcanic events. Actually,volcanism represents one of the main morphogenetic processes although it is efficaciously helped by the more recent processes due to surface running waters. The control exerted by recent tectonics on the evolution of the area is also clearly evident. The study of drainage network pattern shows the existence of many anomalies in the spatial arrangement and in the flow directions of fluvial channels which are often inconsistent with regional slope. The analysis of these morphological anomalies allowed inferring the existence of some tectonic dislocations, besides those leading the same volcanic activity, which are likely to have acted after the volcanic paroxysmal phases. Moreover, the areal distribution of geomorphic parameters allowed the identification of differentially uplifted or downthrown areas.

The study area is not considered as highly seismic; however seismological data about historical and contemporary earthquakes (the most recent occurred close to the Morlupo town on 10 July 2011, with magnitude 3.2) seems to support both the existence and the recent activity of some of the morphologically inferred tectonic lines.

Spatial variation in erosion rates and river longitudinal profiles along the Calabrian Arc

OLIVETTI V.(1), MOLIN P.(1), CYR A.(2), FACCENNA C.(1)
(1) Università Roma TRE, ROME, ITALY ; (2) U.S. Geological Survey, MENLO PARK, CALIFORNIA, UNITED STATES

Fluvial systems are very sensitive to tectonic and climatic changes. So, deviations from a smooth concave-up river longitudinal profile indicate the landscape is in a transient state of disequilibrium. The relationship between erosion rates and uplift rate provides further evidences of steady state or transient landscape. In this framework, in order to study the different landscape response to tectonic forcing we analyzed two regions in the Calabrian Arc, the Sila Massif and the Messina strait, through the comparison of the river longitudinal profile with the erosion rates calculated by ^{10}Be content in modern fluvial sediments. The Sila Massif is characterized by uplift rate of 0.8-1 mm/yr and by a low relief upland (mean elevation of 1200 m), interpreted as a relict of an old landscape developed in stable base level conditions. The Messina Strait, one of the most seismically active region in the Mediterranean, is constituted by a narrow and deep NNE striking topographic depression. The elevation of dated marine terrace on both strait margins indicates uplift rates of 0.6-1,6 mm/yr. In the Sila Massif, the shape of river longitudinal profiles as well as the wide range of erosion rate values indicates a landscape in a transient state in response to an uplift not yet counterbalanced by erosion. In the Messina Strait smooth concave up river profiles and high erosion rate comparable with uplift rate indicate a landscape in almost steady state condition.
In conclusion, although the Sila Massif and the Messina Strait region are characterized by similar climate and lithology, their landscapes evolve differently in response to a slightly different rock uplift rates and probably to a different susceptibility to erosion as a consequence of tectonic deformation.

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Quaternary landscape response to neotectonics and fluvial processes: an example from the San Jose del Cabo basin, Baja California, México

MARTINEZ-GUTIERREZ G.
Universidad Autonoma de Baja California Sur, LA PAZ, MEXICO

The San José del Cabo fault is located in the southern tip of Baja California peninsula and extends about 100 km with a NNW-SSE trending. The fault defines the boundary between Mesozoic metamorphic-igneous massif, and Tertiary-Quaternary sedimentary sediments (San José del Cabo basin). The fault represents the major geomorphic structure in the region. East-West elongated-watersheds occur perpendicular to the fault that supplied sediments to the basin. Quaternary alluvial deposits (El Chorro Formation) represent the late sedimentary event within the basin. These sediments are deeply incised by ephemeral streams from the massif's watersheds. Field-work and geomorphological mapping in the San Jose de Cabo basin, using field survey, topographic maps, aerial photographs and SPOT imagery revealed a landscape characterized by a series of dissected alluvial fans and channel pattern changes across the San Jose del Cabo fault. The Quaternary alluvial-fan surfaces were dated using scarp diffusion approach. The oldest geomorphic surface corresponded to the upper section of El Chorro Formation, which exhibits four levels of terraces stages produced by diverting streams and incision processes crossing the fault. These features are unique only in this section of the San Jose del Cabo fault; but field evidence does not show surface ruptures. Dating of the terraces suggests a time-average incision rate of ca. 0.4 m/ka was estimated for the last 2.6 Ma. The incision and later stream capture (present stream) was probably a climatically rather than tectonically driven process, although probably assisted by a long-term base-label changes.

Uplifts of the Longmenshan mountain in the eastern margin of Tibetan Plateau constrained by geomorphic evidences

ZHANG S., DING R., MAO C., LI T., LV Z.
Institute of Crustal Dynamics, China Earthquake Administration, BEIJING, CHINA

Longmenshan mountain is a striking Cenozoic orogen as the eastern margin of the Tibetan plateau where Mw 7.9 Wenchuan earthquake occurred in 2008. We have rebuilt the surface deformation history in late Cenozoic there by geomorphologic surveyings.

Peneplain and river terrace are two kinds of ideal datum planes for gauging the tectonic deformation in Cenozoic time there. The relict tertiary peneplains were recovered by DEM analysis and field work. There are two levels of peneplains whose peneplanations may begin in early Cenozoic time and end at late Miocene when the final fluctuations of elevations were possibly less than one kilometers.

Dadu river and Minjiang river, two major streams across the east Tibetan plateau, recorded the Quaternary deformations by river terraces. The two main streams incised into the peneplains and formed a staircase of terraces no less than ten levels. The highest terrace is a strath which joins with the pediplane in the east piedmont of Longmenshan mountain.The longitudinal profiles of the river terraces were surveyed.

Based on the correlations of the peneplains, the southeastern side of Longmenshan mountain shows thrust-faulting with a total vertical slip of ～4500 m against the Sichuan basin since late Miocene, meantime the mountain range has been uplifting with the Longriba fault as the west boundary where vertical thrust slip is insignificant. As a landform barrier between Tibetan plateau and Sichuan basin, the crest lines of the mountain are about 500 to 1000 m higher than the hinterland surface on the west side. In a word, Longmenshan mountain has been formed by the combination of eastern-wing thrusting and west-wing flexing which are attested by the deformation of the Tertiary peneplains,the longitudinal profiles of river terraces and modern geodetic levelling surveys. We suppose that fault-bend folding of the upper crust may be the leading factor for the uplifting of the mountain.

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Morpho-structural features and drainage pattern related to extensional faulting: an example from the Northern Apennines (Italy)

MIRABELLA F.(1), BUCCI F.(2), CARDINALI M.(2), GUZZETTI F.(2)
(1) Dip. Scienze della Terra, University of Perugia, PERUGIA, ITALY ; (2) Istituto di Ricerca per la Protezione Idrogeologica, PERUGIA, ITALY

The combined effect of regional uplift, denudation/deposition processes and active faulting produces characteristic drainage networks and morpho-structural features. In areas undergoing extensional faulting, the investigation of the tectono-sedimentary evolution of fault-controlled basins through the analysis of morpho-structural features and drainage pattern can provide valuable information on the space-time evolution of the active deformation.

We explore this topic on a Quaternary extensional basin located in the upper part of the Puglia and Attone basins (Northern Apennines of Italy) where both GPS and seismological data reveals the recent tectonic activity of the area. The Quaternary extension has been accommodated by NW-SE trending normal faults, which have attained mature morphologic and structural features and, nowadays, separate mountain ranges from intermountain basins.

In order to understand the Quaternary evolution of the study area, we integrate field data with river longitudinal profiles analysis and aerial-photo-geological interpretation. Most of the morpho-structural features were identified through the analysis of multi-scale and multi-temporal aerial photographs, identifying the: (i) attitude of fault and bedding planes, (ii) fault-controlled landslides, (iii) pattern of rivers network and (iv) spatial distribution of river terraces.

Basing on our analysis we show that recent faulting occurs on NE-dipping and SW-dipping structures, which cut the inherited landscape and deform the continental deposits. Recent fault motion has conditioned the rivers pathway and the tectono-sedimentary evolution of their valleys, where fault-controlled subsidence has captured the river courses and produced subsiding plains. The location of landslides close to extensional faulting suggests a structural control also on the morphological instabilities and hence has implications for hazard.

Morphological and hydrological response to extensional faulting. An example from the Northern Apennines of Italy

MIRABELLA F.(1), PUCCI S.(2), DEMARTINI P.M.(2), CIVICO R.(2), BURATTI N.(1), BAGLIONI S.(1), SMEDILE A.(2)

(1) Dip. Scienze della Terra, University of Perugia, PERUGIA, ITALY ; (2) Istituto Nazionale di Geofisica e Vulcanologia, ROMA, ITALY

Extensional faulting produces areas undergoing anomalous trends of erosion and sedimentation at the faults footwall and hanging walls respectively. The record of the uplift/subsidence history related to faulting can hence be provided by the investigation of the sedimentation record as documented by syn-tectonic basins infill as well as by the incision history as provided by the flights of river terraces and erosional surfaces.

We show evidences of drainage inversion due to faulting in the Northern Apennines of Italy where extensional faulting is active since the lower Pleistocene and documented by seismological and GPS data. This work is in progress, the aim is to show that the investigation of both the morpho-structural features and the rivers incision history provides a key to the understanding of the continuity of the deformation processes through time.

We analyze two intermountain basins (Nese and Pantano) and the main rivers draining them (Nese and Caina). Both basins are associated to the activity of two west-dipping fault segments which acted as barriers to the waters flowing to the east.

At present, the Nese basin is still drained towards the east by the Nese river after the incision of the barrier. On the contrary, the Pantano basin is presently drained in the opposite direction by the Caina river flowing to the west. The analysis of the remnant surfaces hanging above the Pantano basin testify for the paleo eastward-directed drainage which is now inverted towards the west.

We plot the rivers profiles and project onto them the faults location and the terraces and erosional surfaces position. We compare the data with the analyses of the continental basins deposits obtained through a motor hand driller sampling system.

We discuss the drainage inversion and the obtained data in the context of the normal faults activity by focusing on the possible role of footwall uplift and/or of fault segmentation in producing such a configuration.

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Tectonic versus climatic controls on landscape denudation: A test in the central Himalayas

GODARD V.(1), SPINABELLA F.(1), BOURLÈS D.(1), BURBANK D.(2), BOOKHAGEN B.(2), FISHER B.(2), MOULIN A.(1)

(1) CEREGE - Aix-Marseille University, AIX-EN-PROVENCE, FRANCE ; (2) ERI - UC Santa Barbara, SANTA BARBARA, UNITED STATES

Landscape denudation in actively deforming mountain ranges is under the dual control of internally driven rock uplift and erosion due to surface processes. The relative contribution of these factors in setting the pace of landscape evolution is key to our understanding of orogenic evolution and lies at the core of an emerging paradigm which proposes that external factors could be the predominant driver of deformation in orogenic systems.The Himalaya are a favorable location to tests these propositions due to the intensity of tectonic and geomorphic activities and the host of data available. To study sort-term denudation in a ~200-km-wide region of the Lesser Himalayas in central Nepal, we measured 10Be concentrations in detrital sediments from small basins to infer their denudation rates at millennial time-scales.

Along a northward strike-perpendicular transect, denudation rates start at <0.5 mm/yr in the Lesser Himalayas before sharply rising to 2-3 mm/yr when crossing the Physiographic Transition and reaching the southern flank of the high range in the Higher Himalayas. Despite a more than 5-fold increase in denudation rate between the two extremities of the transect, it is noteworthy that the corresponding areas display similar relief, distribution of hillslope angles, and precipitation rates. The only parameter that presents a significant co-variation with denudation is the long term-rock uplift rate resulting from the flat-ramp transition along the MHT.

We propose that in this rapidly uplifting mountain range, landscapes are rapidly adjusting to changing climatic conditions and that denudation is, therefore, mainly limited by the rate at which material is pushed upward by tectonic processes and made available for removal by surface processes. In this particular context, variations in precipitation appear to have mainly a second-order modulating role on the denudation signal that is primarily set by the background rock-uplift rate.

Role of Neogene-Quaternary faults on landform evolution in the continental margin of northeastern Brazil

BEZERRA F.(1), ROSSETTI D.(2), ANDRADES FILHO C.(3), NOGUEIRA F.(4), GÓES A.M.(5), MEDEIROS W.E.(1), OLIVEIRA R.G.(6), FUCK R.A.(7)

(1) Federal University of Rio G Norte State, NATAL, BRAZIL ; (2) Instituto Nacional de Pesquisas Espaciais, SÃO JOSÉ DOS CAMPOS, BRAZIL ; (3) Universidade Estadual do Rio Grande do Sul, SÃO FRANCISCO DE PAULA, BRAZIL ; (4) Federal University of Campina Grande, CAMPINA GRANDE, BRAZIL ; (5) University of São Paulo, SÃO PAULO, BRAZIL ; (6) Brazilian Geological Survey, RECIFE, BRAZIL ; (7) University of Brasília, BRASÍLIA, BRAZIL

The eastern continental margin of South America comprises a series of rift basins developed during the breakup of Pangea in the Jurassic-Cretaceous. We concentrate our study in the Paraíba Basin, where sediment deposition spans from the late Cretaceous to the Quaternary. The region is one of the most seismically active parts of the South American stable continental margin. We integrated high resolution aeromagnetic data with topographic, structural, and stratigraphic data to evaluate the role of faults in the deposition of Neogene-Quaternary sediments and related landform evolution. Our results indicate that the reactivation of basement faults controlled depocenter location, geometry, and orientation, and coastal morphology in the Neogene-Quaternary. Tablelands along the coast are cut by linear alluvial valleys. These valleys mainly trend NE, are bounded by faults, and exhibit topographic breaks 20-40 m that bound Quaternary alluvial deposits. The throws of these faults are on the order of hundreds to tens of meters in Cretaceous units and tens of meters in Neogene-Quaternary units. The coastal tablelands are slightly tilted seaward, as shown by the gradual decrease of the height from ~200 m to ~50 m. In the littoral zone, these tablelands form sea cliffs 30-50 m high. Faults were reactivated as oblique-normal and oblique-reverse faults. Multiple episodes of faulting are recorded, which are followed by concomitant sedimentation. We conclude that this coastal topography is characterized by tablelands, which correspond to horsts and grabens, with alluvial valleys entrenched in the latter. Degraded fault scarps mark the transition between faulted blocks. In the Neogene-Quaternary, faulting resulted in subsidence-uplift, which was largely responsible for the present-day morphology of the continental margin. Results of this study show that the passive margin of South America has been active long after the breakup.

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Travertines distribution in Southern Italy: tectonic and geochemical implications

SANTANGELO N.(1), ASCIONE A.(1), IANNACE A.(1), IMBRIALE P.(1), SANTO A.(2)

(1) Department of Earth Sciences,University of Naples Federico, NAPOLI, ITALY ; (2) Department of Hydraulic, Geotechnical and Environmental Engineering, Applied Geology Division, University of Naples Federico, NAPOLI, ITALY

In the present paper we claim that all the geologically significant travertine/tufa bodies of southern Italy due their existence to CO_2-rich waters feeded by deep-seated faults. Meteoric waters alone can precipitate only limited amount of carbonates. The data presented include: i) a field analysis of the relationships of the main tufa outcrops with active faults, ii) a appraisal of the chemical data on the springs associated to the tufa/travertines, iii) a petrographic and stable isotope investigation of selected tufa outcrops.

The analysis of travertine distribution pointed out that both ancient and recent travertine bodies systematically crop out close to active deep seated faultsof regional relevance, which generally bound the main extensional basins of the chain. As regards to karst springs only 18 out of 65 are associate with present or fossil travertine deposition. Even if all the springs show a Ca-Mg-HCO_3 freshwater typical of limestone aquifers, the depositing travertine springs have higher salinity and alkalinity, are slightly warmer and have lower pH. Furthermore, they are always enriched in SO_4 and CO_2.

We acknowledge that organic activity play an important role in shaping the texture of the deposits through a micro-control on the precipitation environment. However, a supplementary source of CO_2 is a necessary prerequisite for inducing a rise of TDS and alkalinity sufficient to sustain the precipitation of geologically significant carbonate deposits. This is confirmed by $d^{13}C$ values of travertine samples which are systematically positive and compatible with a crustal or mantle derived carbon source.

The co-presence of mineral springs and travertine deposits with peculiar karst morphologies (karst collapse sinkholes) already pointed out in literature, seem to confirm the strong interrelations linking dissolution phenomena, and consequent carbonate deposition, to the rising of aggressive fluids along active faults.

Denudation rate spatial variation across the Eastern Tibetan margin

ANSBERQUE C.(1), GODARD V.(1), BELLIER O.(1), DE SIGOYER J.(2), LI Y.(3), LIU-ZENG J.(4), REN Z.(4), BOURLÈS D.(1)

(1) CEREGE, Aix Marseille University, AIX EN PROVENCE, FRANCE ; (2) Laboratoire de géologie ENS, PARIS, FRANCE ; (3) Chengdu University of Technology, CHENGDU, CHINA ; (4) China Earthquake Administration, BEIJING, CHINA

The Eastern Tibetan margin, delimited by the Longmen Shan range, forms one of the steepest topographic escarpment in the world. Most of the current deformation in Eastern Tibet appears to be accommodated in the Longmen Shan thrust system whose major seismogenic potential is attested by the 2008 Wenchuan earthquake. The velocity gradient across the margin revealed by GPS measurements (e.g. Shen et al., 2009) decreases significantly from west to east. These observations suggest that other tectonic structures might contribute to the global deformation in Eastern Tibet, such as the recently identified Longriba Fault Zone (e.g. Xu et al., 2008).

Understanding the global deformation pattern over this area requires to constrain the parameters of the geomorphic evolution of the margin. Quantifying denudation rates using cosmogenic nuclides is an efficient way to assess spatial variation in denudation, and provide some critical insights on the effective role of various parameters such as tectonic, climate or nature of geological substrate, on surface processes. Apprehending the spatial evolution of geomorphic context through the Eastern Tibetan margin using this method will permit to assess differences in denudation intensity across the Longriba Fault Zone, which appears to present significant thrusting activity on some of its major strands.

Our dataset consists in 20 new denudation rates inferred from 10Be concentrations in river sediments from small (2nd or 3rd order) catchments at the edge of the Plateau. Starting from high denudation rate at 0.5-0.6 mm/yr at the range crest, we observe a decrease down to <0.1 mm/yr toward the west and the headwaters of the Minjiang basin. This gradient in denudation rate occurs under homogeneous precipitations, suggesting that it is either the consequence of a long-wavelength (~100 km) variation in rock uplift across the topographic step or the expression of progressive propagation of margin dissection toward the Plateau interior.

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Channel-profiles metrics in tectonic geomorphology: new insights from a continental piedmont area, a sub-marine canyon system and analogues on Mars

BAIONI D.(1), CAVITOLO P.(2), DELLA SETA M.(3), FREDI P.(3), GIANGIOLINI F.(2), NESCI O.(2), SAVELLI D.(2), SGAVETTI M.(1), SPIGARELLI A.(4), TRAMONTANA M.(2), TROIANI F.(2)

(1) Department of Physics and Earth Sciences, University of Parma, PARMA, ITALY ; (2) Department of Earth, Life and Environmental Sciences, University of Urbino, URBINO, ITALY ; (3) Department of Earth Sciences, Sapienza University of Rome, ROMA, ITALY ; (4) SAIPEM-Energy Service, ENI Group, FANO, ITALY

Quantitative geomorphic analysis of landforms has developed and validated many indices that identify the fingerprints of active tectonics on the topography. Specifically, the Steepness Index (Ks), the Stream Length-Gradient Index (SL) and the Distance-Slope (DS) log-log plots of longitudinal profiles are particularly useful in tectonic Geomorphology to delineate catchment morphology and channel-profile anomalies. Numerous tests have demonstrated the validity of channel-profile metrics to detect tectonic-generated knickpoints, especially along trunk valleys. In particular, the Ks index demonstrated to be useful in detecting anomalies in catchment morphology and channel-profiles related to active tectonics in both emerged ranges and sub-marine canyons. Recent outcomes from analogous investigations on Martian surface match the findings from catchments on Earth. Further researches, however, are needed to better understand the sensitivity of the single parameters in detecting tectonic-generated knickpoints in different geodynamic and physiographic settings. Additional investigations are also necessary to verify the validity of the channel metrics regardless of specific typology of flows, for example along debris-flow dominated channels, submarine canyons, and drainage systems on Mars that do not belong to the typical fluvial systems. Accordingly, our research focuses on the calculation and evaluation of Ks, DS, and SL indices, derived from Digital Terrain Models (DTMs), within different test areas from emerged and sub-marine zones on Earth and analogues from Mars. Preliminary results obtained within the Adriatic piedmont area of Apennines (Italy) and a sub-marine canyon system at the Makran margin (Iran), as well as findings from Mars, emphasize the capability of channel-profiles metrics to detect the long-wavelength effects of regional tectonic structures regardless of style and rate of deformation, as well as regardless of processes that act along the present channels.

Relationships between tectonic fractures and cliffs morphologies: examples along chalk coast in France (Normandy, Picardy, Boulonnais)

VANDYCKE S.(1), DUPERRET A.(2), COLBEAUX J.P.(3)
(1) University of Mons, MONS, BELGIUM ; (2) Institut UniversitaireEuropéen de la Mer, UMR 6538 CNRS, 29 280 PLOUZANÉ, FRANCE ; (3) Conseil scientifique de l'Environnement Nord Pas-de-Calais, BP 216 LILLE, FRANCE

Fractures, in particular master joints and faults, have an active role in the geomorphological development of the chalk cliffs. Master joints are defined as planar structures cutting the total height of a chalk cliff. They are repeating at equal distance with plumose and twist hackle steps. In some particular areas, flint filling is associated to jointing. In clayey chalk, hybride joints can be also very developed. The faults are used to define the tectonic context in relation with the main geological events of the basin environment. But, the number of faults is quite small comparing to the jointing. These tectonic features have a direct impact on the development of the coastline, in terms of trending but also concerning slope development and local cliff morphologies.

Normandy and Picardy chalk districts are located in the most protected sedimentary deposit zones of the Anglo-Paris Basin far from the active crustal zone in Europe. Nevertheless the chalks deposits have recorded tectonic events mainly in relation with inversion tectonics and crustal development of the English Channel. In the Boulonnais, chalks fracturing are mainly influenced by the tectonic evolution of crustal Nord-Artois-Shear Zone.

Faults, joints and fractures have a strong influence on the hydrologeological dynamics in chalk rocks. Along the coastlines, different stages of alteration and excavations along the fractures can be observed with the appearance of major karstic features. The large development of caves at base of the cliffs, like near Etretat, results from initial chalk fracturing and local expulsing of chalk alterite.

Comparative observations can be done between each chalk district to deduce a correlative analysis between chalk and fractures in view of characterizing the fractures network in terms of reservoirs behavior.

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GEONAS GNSS network for geodynamic observations of surface development in Czechia

BLAHUT J., BALEK J., FUCIK Z., KAPLAN Z., KLIMES J.
Institute of Rock Structure and Mechanics, ASCR, PRAGUE, CZECH REPUBLIC

GEOdynamic Network of the Academy of Sciences of the Czech Republic is a research infrastructure within the CzechGeo/EPOS project used to observe surface development using geodetic GNSS receivers. It consists of 20 permanent stations and 37 sites for campaign measurements. It was established in 2001 and the stations are placed along major tectonic lineaments in western and northern part of Czechia. Most of the receivers are registering NAVSTAR and GLONASS signals and some sites are already capable to start registering the GALILEO satellites. The processing of the data, together with their quality and reliability is presented. Interpretations of surface movements are shown with respect to other measurements (seismic, gravimetric, tectonic micromovements, etc.).

Regional vs. local morphological effects of the late quaternary deformation of ne Sicily

PAVANO F., CATALANO S., ROMAGNOLI G., TORTORICI G.
UNIVERSITA' DEGLI STUDI DI CATANIA, CATANIA, ITALY

The available geodetic data on the southern margin of the Calabrian arc, in NE Sicily, evidence that a discrete crustal mobile block (Peloritani Mobile Block; **PMB**), including the Peloritani region, moves towards the NNW, diverging from both the Calabrian sector of the arc, pointing to the NE, and the African domains of Sicily, shifting to the NW. The mobile block is characterized by a spectacular flight of Late Quaternary marine terraces that constrains an uplift rate of about 1.1 mm/a, almost constant since 600 ka B.P. A significant segment of the southwestern margin of the mobile block has been recognized along the Nebrodi-Peloritani boundary, in the region affected by the swarm of low-magnitude seismic events (M≤4.1) of June-August 2011. This consists of a 10 km wide fault zone, which is composed of several discrete, NW-SE oriented normal faults that have displaced the marine terraces at vertical displacement-rate of about 0.4-0.5 mm/a, also showing rejuvenated fault scarps, which evidence their Holocene activity.

A quantitative morphological analysis of the relief and of the drainage system, based on the calculation and the interpretation of the most relevant morphometric indexes, has been carried out, in order to discriminate the effects due to the regional uplift from those due to the tectonic deformation. The analysis of the relief evidenced an almost uniform behavior in the whole region, revealing rapid adjustments of the river entrenchment with respect to the rate of tectonic uplift. On the contrary, evident anomalous values of morphometric indexes of the drainage system, due to rivers diversions and captures phenomena triggered by the systematic NE-ward tilting of blocks across the active fault belt, have been recognized along the Nebrodi-Peloritani boundary. This evidence could represent a tool for localising the occurrence of low displacement-rate (0.4-0.5 mm/a) active faults within zones affected by more intense regional tectonic processes (1.1 mm/a).

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Morphotectonic analysis of Kozani Basin (Western Macedonia, Greece)

SIMOU E.(1), KARAGKOUNI V.(2), PAPANTONIOU G.(2), PAPANIKOLAOU D.(2), NOMIKOU P.(2)
(1) University of Athens, Faculty of Geology and Geoenvironment , ZOGRAFOU, GREECE ; (2) University of Athens, Faculty of Geology and Geoenvironment, ZOGRAFOU, GREECE

Kozani Basin is located in northern-central Greece and constitutes the southernmost of the Plio-Pleistocene basins of central Macedonia. Quantitative and qualitative analysis of morphological slope values, as well as the analysis of the drainage pattern in Kozani Basin confirms that the current topographic relief reflects intense neotectonic activity. Synthetic Morphotectonic Map of the under study area was carried out by means of the combined use of: (a) Digital Elevation Model (DEM), (b) Slope distribution Map, (c) Morphological slope Map and (d) Drainage Pattern Map. The composition of the digital modeling in conjunction with the regional geological setting, allows the identification of the main morphological discontinuities and lineaments that result from morphotectonic interpretation. The high morphological slope values indicate well-defined morphotectonic features, which mainly trend northeast - southwest (NE - SW) and, secondarily, northwest - southeast (NW - SE). Distinct tectonic structures are mostly recognized in the southwest (SW) margin of Kozani Basin, which is characterized by intense topographic relief. The main large-scale tectonic structure trends northeast - southwest (NE - SW) and corresponds to the major Aliakmonas marginal fault zone that bounds the Kozani basin to the south. On the other hand, the northwest (NW) margin’s features are indiscernible; Thus, the criteria for their recognition are based on the existence of the terraces which reflect the tectonic control. The results of our morphotectonic studies can be proposed following our 3D model of Kozani Basin.

Morphotectonics and Cenozoic Sedimentation on Aiuruoca Region - Mantiqueira Range (MG), Brazil

SANTOS M.
Unesp - Univ Estadual Paulista, Campus Experimental de Ourinhos, OURINHOS, BRAZIL

The Aiuruoca region involves part of Mantiqueira Range (1.800 to 2.350 m high) and Alto Rio Grande Plateau (900 to 2.000 m high) presenting a complex morphotectonic framework which resulted from two tectonic events (Paleogene and Neogene-Quaternary). The events were recognized by faults mapping and control on drainage rearrangement, relief anomalys and distribution and deformation of superficial deposits. The first one, extensional, is related to Atlantic opening processes, and the second one, transcurrent, to intraplate neotectonics. This Cenozoic tectonic activity modified the landscape by rearrangements of drainage and relief forms, preferencially along the reactivated dextral ENE-WSW and NE precambrian shear zones. The progressive advance of fragmentation towards the hinterland in the Paleogene implicated truncation, tilting and subsidence of ENE blocks. The extensional event (σ_3 NW σ_2 NE, both subhorizontal, and σ_1 NE subvertical) originated the Aiuruoca Basin (Eocene-Oligocene) and filled up by sediments here defined as Entre-Córregos Formation (lake facies) and Pinheirinho Formation (alluvial fan facies). Since Neogene the area has been submitted to transcurrent tectonics with transpressional component and reactivation of earlier structures, with differential uplift of ENE blocks and increasing tilting towards NNW. This neotectonic activity (σ_1 NW and σ_3 NE, both subhorizontal, associated to E-W dextral binary), envolved inversion of the relief, the Aiuruoca Basin and the pleistocene covers, promoting the drainage network rearrangement by capture, diversion and beheading processes, and progressive migration of regional devide towards the ocean. Two captures was dated by C^{14} of organic horizons and paleosoils on 30.070 ± 370 and 7.300 ± 80 y.B.P., and the palaeoenvironment was reconstituted by palynologic analysis. The area remains active tectonically as indicated by drainage and relief anomalys, and imminent process of stream piracy by the Aiuruoca river.

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Morphogenesis and Pedogenesis Relationship as Evidence of Neotectonics in Sedimentary Rocks in the Upper Cretaceous - Portion Center-South of the South American Plataform - Brazil

COUTO E.(1), SANTOS L.J.C.(1), GONTIJO A.H.P.(2)
(1) Federal University Of Parana, CURITIBA, BRAZIL ; (2) Rural Federal University of Rio de Janeiro, RIO DE JANEIRO, BRAZIL

The differentiated evolution and distribution of Oxisols and Alfisols in sedimentary rocks in the Upper Cretaceous, located in the Southern Brazil, in Paraná State, indicates different degrees of dissection of the relief and leads to the hypothesis that the morphotectonic action is changing the regional relief. For this work, we used remote sensing SRTM, drainage basinin Shapefile, and soil and geologic maps of this area. The data were processed in GIS, from where we extracted lineament topographic profiles and anomalies of drainage by using Hack Profile (SL index). The soils are often associated with the degree of indentation in the drainage basin, namely, in the relief of rolling hills, with predominance of Oxisols, the drainage is little indented, while in the south of the Ivai river (left margin) the relief is composed of medium hills, where the Alfisols becomes more predominant, the drainage basinis denser and more indented. These characteristics show that there are different degrees of relief dissection through the action morphotectonic which controls and orientates the organisation and the distribution of drainage basinand, consequently, of the systems Oxisol-Alfisol pedology in the region.From the analysis of the longitudinal profiles it is possible to identify anomalies in the profiles, the indices pointing to several parts and segments of drainage maladjusted by subsidence and raising. The Asymmetry Factor shows moderate rise in the main bays that compose the area. Moreover, larger values of anomalies can be observed by SL index, among them can be noticed abrupt widening of the canals. These can be associated with changes in the course of the rivers, forming orthogonal junctions, alternating between straight canals with narrow meanders and alignment of confluences.

Key Words: Structural Lineaments; Oxisols; Alfisols and drainage basin

SL index as indicator of anomalies in the longitudinal profile of the Alonzo River, Southern Brazil

COUTO E.(1), LUCIANE MARIA V.(2), FORTES E.(3)
(1) Federal University Of Parana, CURITIBA, BRAZIL ; (2) Federal of Paraná Technical Federal University, LONDRINA, BRAZIL ; (3) State of Maringá University, MARINGÁ, BRAZIL

This work principally uses morphometric analysis in the drainage net as indicator of neotectonicism in the hydrographic bay of the river Alonzo, in Parana State, Southern Brazil. The applied methodology consisted of the integration of SRTM data, morphometric variables in SIC environment (Geographic Information System). The set of SRTM data (90m) were used for achieving the following aims: a) preparation of Digital Models of Raising (MDEs) to identify and delimit the features of the relief, b) lineaments, c) identification of anomalies in drainage. The identification and vectorization of these features were based on visual interpretation, and comparison of morphometric indices, such as: Factor of Transversal Topography Symmetry, Asymmetry of Drainage Bays and RDE indexes, in order to obtain parameters of analysis of geomorphic anomalies with possible relations with morphotectonic processes. The drainage of the bay is strongly controlled by lineaments. The analysis of the longitudinal profile of the river Alonzo shows that it presents, in its first 20 km, a rise of about 500m above the line of better adjustment. Also in this stretch is located its biggest anomaly of Sl index, part whose value is 11,8. In this trajectory is the anomalous transition of the Teresina Formation with the Serra Alta Formation, a place where the drainage indented through a gap line and eroded all the lithology of the Teresina Formation, making the Serra Alta Formation outcrop along the canal. The high values of the indices, which represent morphometric anomalies in the equations adopted in this research, are located on the North and North East portions of the high course of the hydrographic bay of the river Alonzo. It is possible to observe that the hydrographic bay of the river Alonzo is strongly controlled by regional geologic structures.
Key words: morphostructure, morphotectonic, drainage net, river Alonzo

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Evolution of uplifted structural landforms in northeastern Brazil

GURGEL S.P.D.P.(1), BEZERRA F.H.R.(2), CORRÊA A.C.D.B.(3), MARQUES F.O.(4), MAIA R.P.(5)
(1) Universidade do Estado do Rio Grande do Norte, NATAL, BRAZIL ; (2) Universidade Federal do Rio Grande do Norte- UFRN, NATAL, BRAZIL ; (3) Universidade Federal de Pernambuco, RECIFE, BRAZIL ; (4) Universidade de Lisboa, LISBOA, PORTUGAL ; (5) Universidade Federal do Rio Grande do Norte - UFRN, CAICÓ, BRAZIL

Elevated areas on passive margins are considered to be the weathered remnants of zones uplifted following the breakup of continents. However, an increasing number of studies have contradicted the idea of permanent uplift and elevated remnants. The purpose of this study was to analyze the evolution of elevated areas in the continental margin of northeastern Brazil. We focused on the Pereiro Massif (PM), an 876-m-high plateau composed of Precambrian granites, surrounded by a low-lying surface, 200 m high, composed of Precambrian metamorphic rocks and Cretaceous rift basins. We mapped the area using GIS-assisted geomorphological and geological mapping. In addition we dated Quaternary sediments using optically stimulated luminescence (OSL) and the single-aliquot regenerative-dose (SAR) protocol. The maximum uplift rate of the PM is 34 m/My, as constrained by the age of flat topography capped by Miocene laterite, which represents the previous peneplain subsequently uplifted by ca. 600 m in a nearby area. The minimum uplift rate is 13 m/My, as constrained by fission-track data of differential crustal block movements across a nearby fault. Erosion of the PM occurred mainly by scarp retreat rather than by erosion of the top surfaces. The extreme soil erosion is concentrated mainly along the fault-controlled escarpments. The spasmodic nature of the processes that shaped the landscape ensures that soils and sediments reflect the last erosion and sedimentary cycle. Therefore, the observed colluviation process has been active in the last 46 ka. This process occurred mainly under a semi-arid climate setting similar to the present-day conditions. We conclude that the PM is an ancient horst, which has been repeatedly uplifted and faulted since the breakup of Pangea and especially in Cenozoic times. Our study indicate that the approach ofusing erosion surfaces as reference levels across fault lines is inadequate, even in seemingly stable continental areas.

The neotectonics and its impact on the evolution of the Yellow River at the northeastern margin of the Tibetan Plateau, China

LIANG H., LI S., ZHANG K.
Sun Yat-sen University, GUANGZHOU, CHINA

Northeastern margin of the Tibetan Plateau is a key area to understand the formation and evolution of the plateau. Four arc-form mountain ranges uplifted along the margin and the northernmost one, Niushou Mountains, located at south of the Yinchuan Basin, is cut by the Yellow River, forming the Qingtong Gorge on west side and by Kushui River (much smaller than the Yellow River) on east side, which records the evolution of landform in this area. The Pliocene fluvial and lacustrine deposits can be found both on east side and in half graben controlled by a North-South normal fault on west side of the Niushou Mountains. The deposits in west of the fault, representing lakes and small rivers and much differing from the present ones of the Yellow River, was folded, implying a North-South shortening which is about 10km by balance section measurement. However, the deposits along the Kushui River indicate lakes and larger rivers in the ancient Yinchuan Basin. The rivers on the west side were actually tributaries of the ones on the east side in Pliocene. A North-South thrust fault cut into the Quaternary deposits on southeast part of the research area, shows a East-West shortening afterward, leading to uplift of research area, westward shift of the late Pliocene to early Quaternary deposition and down cutting of the rivers, leaving a series of strait terraces. As a result, the Pliocene rivers on the east side shrank into the small Kushui River while the ones on the west side enlarged into the current Yellow River, which cut down into western part of the Niushou Mountains and formed the Qingtong Gorge. The Pliocene deposition retreated northward into modern Yinchuan Basin.

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Fracture density as a controlling factor of erosion and exhumation over glacial-interglacial cycles: Insights from low-temperature thermochronology (AHe & OSL) and remote sensing, Granite Range, AK

CHAMPAGNAC J.D.(1), VALLA P.(1), HERMAN F.(2), LOWICK S.(3), GURALNIK B.(1), FELLIN G.(1)
(1) ETH, Z?RICH, SWITZERLAND ; (2) UNIL, LAUSANNE, SWITZERLAND ; (3) UNIBE, BERN, SWITZERLAND

The Granite Range (GR) in Alaska presents an ideal setting to study the climate-tectonics-erosion system: its W-part shows preserved glacial landscape, whereas its E-part presents a strong fluvial / hillslope imprint, and only a few relicts of glacial surfaces. However, low-temperature thermochonometry data (AHe) displays rather homogeneous, yet largely scattered (~15Ma±7Ma AHe ages) throughout the massif. The recent development of luminescence thermochronometry (OSL-T) and its very low closure temperature (0-60°C) opens a new spatial and temporal window for the study of latest stages of rock exhumation and thus to address potential topographic relief changes during the late Quaternary. We sampled 4 elevation profiles over an 80-km E-W transect. The 15 feldspar bedrock separates from surface dated exhibit good internal reproducibility. Apparent ages vary from ~250 ka in the western part of the range, towards younger ages of ~30 ka in the East. On the field, the eastern part appears to be highly fractured, with many, large, penetrative faults, associated with km-thick fault gouges and cataclasites. The westernmost part shows massive bedrock, with minor, localised faults. Remote-sensed fracture mapping confirms this: fracture density is much higher to the east, where hypsometric parameters display anomalies, and where high post-glacial incision (up to 600m) is observed. We provide here an impressive case study for climate-tectonic-erosion interactions through rock crushing effect, and document that half of the sediments coming out of the range come from the ~10% of the most fractured area, all other being equal. Also, we are supporting the notion of high rates of erosion correlated with intense glacial / periglacial activity, confirmed by thermochonological data. We also demonstrate the great potential of OSL-T in resolving topographic evolution and surface processes over 100-kyr timescales and high-frequency climate modulations (glacial-interglacial oscillations).

Some remarks and additions tolegend about neothectonics map

BALYAN H.
Yerevan State University, YEREVAN, ARMENIA

For the preparation of neothectonic map it is necessary to have the precise idea about the using in the legendthemap with terms and nomenclatureswhich are characterized of neothectonical movement. For example: the term of raising. The raising: This term which gets the wide use in literature is imperfect. It includesthe different meaningsa just orographic or morphologic, as an existing raise of theland surface, which is fixed by the statistic position of the relief forms of the certain generation. b) neotectonical process of the raisingsite, its kinematics. In this case not all raisings can be neotectonical raisings. Neotectonical movement gets its reflectionin the relief forms e.u. in the statistical raisingswith the wholly oppositesigns of its kinematics. For example: the deep anticendental valleys. More precise reflection of the quantitive marks of temp, time and absolute raising we can get in the case of anticendental and epigenetics valley, where the theme about erosion in cisionspresicelyconformsthetemp of raising. And those are available in Armenia and can serve authentic reference points for reception of an assessment for raising in case of absence of geology-phacialpoints (marine, lagoon deposits which exist in flora and fauna). In this case the term of raisingin the neotectonical map (and in legends for map) should be put on the meaning of neotectonical kinematics of raising area that is an independent from its morphological reflection in relief. Differential isolation of temp of raising blocks, andstructure gets its moreprecise and brightreflection in the process of integration of the map scale 1:20000 and larger. In this case the raising can be reflected with the izogypses in the absolutely marks /metres/. It is possible to get the certain corrections in the legend of neotectonical map and the meaning of the morphologic and morphosculpture.

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Neotectonics of Jerba (S. Tunisia): A pull-apart on a NW-SE right lateral transtensive fault zone

GHEDHOUI r.(1), DEFFONTAINES B.(2), ZETRINI H.(3), RABIA M.C.(4)
(1) Université paris est marne la vallée, CHAMPS SUR MARNE, FRANCE ; (2) universit? paris est marne la vall?e, CHAMPS SUR MARNE, FRANCE ; (3) CERTE borj cedria, TUNIS, TUNISIA ; (4) Université de la manouba, TUNIS, TUNISIA

What is the neotectonic of the Coastal Jeffara (southern Tunisia)? We herein study the input of numerous seismic profiles at depth, combined with geomorphometric drainage network analysis, photo-interpretations from the Digital Terrain Model (SRTM), detailed optical images (Landsat ETM+) and air photos, all confirmed by field works.

Helped by the results of previous researchers, and new evidences developed in this study, we propose below a new structural geodynamic Jeffara model, due to the continuous post lower cretaceous northward migration of northern African migration toward the Eurasian plates.

Available data were then integrated within a GIS (Geodatabase) where Jerba, Zarzis and Jorf appear to be part of a simple pull-apart model within a NW-SE right lateral transtensive major fault zone.

Our structural geologic and geomorphologic analyses prove the presence of NNW-SSE right lateral en-echelon tension gashes, NW-SE aligned salt diapirs, numerous folds offsets, en-echelon folds, and so-on… that are associated with this major right lateral NW-SE transtensive major coastal Jeffara fault zone that affect the Holocene and Villafranchian deposits.

These evidences confirm the fact that the active NW-SE Jeffara faults correspond to the tectonic accident, located in the south of the Tunisian extrusion, in favour of the eastern migration of the Sahel block toward the free Mediterranean sea boundary. Therefore this geodynamic movement explains the presence, offshore, of small elongated NW-SE, N-S and NE-SW petroleum transtensive basins and grabens.

To conclude, at the regional scale, the structural geomorphologic approach combined with both field work and reflexion seismic profiles analyses appear to be an excellent tool to prove and confirm the NW-SE right lateral transtensive fault zone that is interpreted as the southern branch of the eastward Sahel block extrusion of Central Tunisia due to the northward migration of African plate.

Drastic late Pleistocene-Holocene faceting of the continental shelf off Central Venezuela by eustatism and local active tectonics

COLON S.(1), BECK C.(1), AUDEMARD F.(2), PADRON C.(3), DE BATIST M.(4)
(1) ISTerre UMR CNRS 5275 Grenoble University, LE BOURGET DU LAC, FRANCE ; (2) Venezuelan Foundation for Seismological Research FUNVISIS, CARACAS, VENEZUELA ; (3) Universidad Simon Bolivar, CARACAS, VENEZUELA ; (4) Renard Centre of Marine Geology, University of Gent, GENT, BELGIUM

The continental shelf north off Central Venezuelacomprisesthree physiographic provinces, from west to east: the Golfo Triste Platform, the Choroní Basin and the Guaira Platform. The Choroní Basinis a deep depression incised by submarine canyons prolonging the Mamo and Ocumare rivers mouths, named Mamo and Ocumare canyons, respectively. The Mamo River happens to be the longest and most powerful river in the Cordillera de la Costa, a coast range whose peaks are commonly over 2000 m high, which is bounded by the seismically active San Sebastián fault on its seaside. The Mamo and Ocumare canyons merge into a single north-trending canyon, probably running into the Bonaire basin. Apparently, these canyons seem to be related to turbiditic currents with greater flows during the Pleistocene wetter periods. Several authors have pointed out that these submarine canyons are partially or completely structurally controlled by major structures present in the north-central coastal range of Venezuela (e.g. San Sebastián and Tacagua faults). In particular, we have looked into the past with the help of high resolution seismic profilesacquired in 2007 by an international team (FUNVISIS in scientific collaboration with the Universities of Savoie–France-, Ghent –Belgium- and UDO –Venezuela-). Two regional unconformity-bounded seismic-stratigraphic units related with MIS 2 (Last Glacial Maximum) and MIS 6 have been identified and mapped throughout. The still visible and active Mamo and Ocumare canyons were carved during a sea-level lowstand, most probably during the MIS 2 stage. In addition, using a series of sedimentary features, subsidence model and the relative sea level history, we have reconstructed the shelf paleo-bathymetry for these lowstand stages. However, in the La Guaira platform, a major issue still to be solved is whether this shelf was sub-areal or sub-aquatic during lowstand–glacial- periods.

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The influence of tectonic movements upon river changes on the example of Lower Khazir river

ELIAS Z.
Institute of Geography and Spatial Management / Jageilloinan university, KRAKOW, POLAND

Lower Khazir river sets a good example of river changes connected with tectonic movements. The aim of this paper is to address the three following questions: 1- How big of an impact does the river has in the process of anticline growth? 2-Where are the largest geomorphic changes along Khazir River course and how are they connected to the sinuosity of Maqlub and Ain Al-Safra and Makhmore anticlines?

In order to draw the dry gaps on the anticlines, analyzes of two and three dimensional images are included in this research. Growing anticline exerts an influence upon the latitudinal throw over of the river bed to the east. Soft rocks also play a role in the river morphology. The present gap (water gap) is shaped by the river flow after the drainage of old gap (dry gap) located on the limbs of the anticlines.

Morphology of the river changes along with an increase of sinuosity in the Maqlub and Ain Al-Safra anticlines. The distance of intense morphologic changes of the old gap reaches 2.5 km and 3.5 km in case of the water gap. Morphology of this river is more straightforward in the Makhmore anticline than the Maqlub and Ain Al-Safra anticlines. Considerable changes in the river's morphology continue in the Makhmore anticline through 11.5 km from old gap to the water gap.

Key words: dry gap, water gap, digital elevation model, Lower Khazir River.

Geological and geomorphological effects induced by the Emilia seismic swarm of May 2012 (northern Italy)

CASTALDINI D.(1), DI MANNA P.(2), GUERRIERI L.(2), VITTORI E.(2), PICCARDI L.(3), BERLUSCONI A.(4), LIVIO F.(4), MICHETTI A.M.(4), COMERCI V.(2), TOSATTI G.(5)

(1) Dipartimento di Scienze Chimiche e Geologiche, Universite di Modena e Reggio Emilia, MODENA, ITALY ; (2) Istituto Superiore per la Protezione e la Ricerca Ambientale, ROMA, ITALY ; (3) CNR, Istituto di Geoscienze e Georisorse, FIRENZE, ITALY ; (4) Dipartimento di Scienza e Alta Tecnologia, Università Insubria, COMO, ITALY ; (5) Dipartimento di Scienza Chimiche e Geologiche, Università di Modena e Reggio Emilia, MODENA, ITALY

Since May 16th 2012, a seismic swarm has affected the central-southern sector of the Po Plain. A first main shock occurred on May 20 (M = 5.9; focal depth: 6.3 km; epicenter: N of Finale E.) and a second one on May 29 (M= 5.8; focal depth: 10.5 km; epicenter: about 12 km W of the first one). This seismic swarm has consisted of another five M>5 quakes and about 2,500 minor shocks till the end of November 2012. The subsurface is made up of marine and continental deposits overlying compressional northverging faulted folds of the Apennines ("Ferrara Folds") which caused the quakes.

The geomorphological setting is characterized by a complex drainage and ancient drainage pattern of the Rivers Po, Secchia, Panaro and Reno.

The most relevant effect caused by the two stronger earthquakes was the 10-15 cm uplift of the epicentral area detected by InSAR interferometry.

On the whole, more than 500 geological and geomorphological effects were recorded over an area of about 700 km^2. The effects are mainly due to liquefaction with ejection of sand from ground fractures, sand-boilsand wells.In some placesthe bottom of artificial canals showed uplifting, bulging and cracks and fractures and landslides were mapped on the banks. About 80% of the effects were induced by the May 20 main shock, while 20% of the effectswere triggered by the second main quake.Many cases of liquefaction triggered by the first main quake were reactivated by the second one, with jets of water up to 1.50 m high. The material erupted reached in many cases a thickness of more than 30 cm and, inside some buildings, from pavement cracks it uplifted up to 1 m.

Hydrogeological anomalies, such as strong water-table fluctuations, water level variations in some tracts of Po and Secchia rivers, emission of hot water from ground cracks and water wells, were also recorded.

The co-seismic effects appear to be caused not only by the local stratigraphic characteristics but also by the network of abandoned riverbeds.

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Morphotectonic analysis and some geo-environmental implications of the Gai River basin, North-East India

GOSWAMI U., BEZBARUAH D.
Dibrugarh University, DIBRUGARH, INDIA

The Gai River basin in the North East India, extending from the hilly West Siang district of Arunachal Pradesh to the alluvial plains of Assam, encompasses an area of 863 km2 out of which about 82% falls within Assam. It is a sixth order stream flowing along the mountainous course through the Siwaliks for 50 km, whereas its total main stream length is 133 km. The hilly catchment of the Gai River basin is confined within the frontal fold thrust belt of Arunachal Himalaya comprised of Siwalik Group of rocks of Mio-Pliocene age which were subsequently uplifted during the last phase of Himalayan orogeny. The Gai river basin has developed as a network of streams for draining the uplifted area. Therefore, morphology of the Gai River basin evolved contemporaneously with the last phase of Himalayan upheaval.

Drainage basin characteristics indicate the form-form relationship of morphological system and also the form-process relationship. Study of the basin characteristics like bifurcation ratio, basin elongation, drainage density, channel slope, relief ratio etc. of the Gai River indicates the influence of active tectonics on the form-process relationship. Furthermore, study of the morphotectonic indices like mountain front sinuosity, drainage basin asymmetry, valley floor width to height ratio, stream length gradient index of the basin indicates the prevalence of neo-tectonic movements. The neo-tectonic activity and the soft and friable nature of the Siwalik Group of rocks make the basin more prone to landslides leading to high sediment yield and aggraded river bed. As a result, carrying capacity of lower reaches of the river has decreased considerably making the channel more vulnerable to frequent channel migration and flood. A number of devastating floods have occurred in recent years, of which the flood of 15 August 2011 was caused by bursting of a landslide dam formed in mountainous part of the Gai River basin.

The earthquake of Van on 23 october 2011 and its geomorphological effects

AKKOPRU E.(1), SENGUL A.(2), GURAY E.(3)
(1) University of Van-Turkey, VAN, TURKEY ; (2) University of Istanbul, ISTANBUL, TURKEY ; (3) Maps Engineer, VAN, TURKEY

In the Van Lake Basin,tectonic activity and the geological structure of region has a direct effect on topography. In this sense, as a result of continent- continent collision that occurred in middle Miocene, Eastern Anatolia region and Lake Van basin have a topographic height above average 2000m. Thickening and shortening of the crust as a consequence of the N-S compression forces, caused re-shaping the entire morphology. In this way, many new structural elements have re-appeared. One of these structural elements is the thrust faults which still maintain their activity. Earthquake, that occurred M=7.1 magnitudein Van at13. 41 local time on October 23, has left many morphological traces in the region. According to geological and seismological data, earthquake which occurred along approximately 40km long thrust fault affected a large area. Aftershocks still continue. The earthquake has an excessive impact on the surface. Displacements have been measured on the main fault up to 10cm on the surface. However, lateral spreading, big mass movements, creeps were marked in many areas. Soil liquefaction has been observed in water saturated lowland areas by effect of earthquake, and the morphological structures were also affected. The majority of these structures are sub-structures changing morphology rather than being surface rupture of earthquake. Approximately 80cm ruptures and splits occurred in vertical directions on surface. This is especially observed in water-saturated areas of Erciş,the biggest town of Van.

Besides, vdata were obtained with researches in about relationship between lake level changes and tectonic controls are examined comparatively with the data obtained after the earthquake. Morphological studies and DGPS measurements carried out in Van lake Basin and especially old lake terraces in Van and Erciş areas renewed in this study and changes on the vertical direction of region were tried to be determined. In this context, we tried to reveal changes after earthquake on topography.

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The Effect of Tectonics on Geomorphologic Evolution of Kalkım Basin (NW Turkey)

EFE R., SOYKAN A., CUREBAL I., SONMEZ S.
Balikesir University, BALIKESIR, TURKEY

Geomorphologic indicators present important data in the identification of active tectonic areas. There is a close relationship between the age of geomorphologic units and tectonic movements. Tectonic movements were very effective in Biga Peninsula and generated important landforms in NW Turkey.

The current study investigates the effect of neo-tectonic movements in the geomorphologic formation and development of Kalkım Basin situated in the northwestern part of Turkey. Topography maps of 1/25000 scale were used in the study and digitization was completed with 10 m contour lines in ArcGIS Desktop Program. Contour curves identified in ArcMap program were transformed into a digital elevation model by utilizing 3D Analyst application program. Profiles and geological sections were developed with the help of this model. 3D model, profiles and sections helped in the identification and interpretation of tectonic and morphological units. Geological data was taken into consideration during interpretation and tectonic lines were specifically correlated with geomorphologic data.

The Basin forms a morphological unit along with Kalkım plain, hills, plateaus and the mountains surrounding it. Kalkım Basin was shaped by the tectonic, structural and morpho-climactic processes that started in Upper Oligocene and Lower Miocene and continued. These tectonic movements which were observed as faulting, uplifting and subsidence and fluvial processes shaped the area. Climate changes were effective in the landforms of Pliocene, Pleistocene and Holocene periods.

Tectonic movements effective in the area and N-S and E-W directional faulting have played an important role in the development of the Basin. As a result, depression has started in the basin and a graben was formed. Later, the impact of fluvial processes increased and the basin gained its current form. The graben is a tectonic based pull-apart depression stuck among mountains.

Key words: Turkey, Kalkim basin, tectonics, geomorphology

Geomorphic development of an actively uplifting footwall: integration of short-term co-seismic deformation (InSAR) and river network evolution. Examples from l'Aquila eartquake (April 2009), Italy

BERTI C.(1), PAZZAGLIA F.J.(1), RAMAGE J.M.(1), MICCADEI E.(2)
(1) Lehigh University, BETHLEHEM, PA, UNITED STATES ; (2) Università degli Studi ?G. d?Annunzio?, CHIETI, ITALY

Central Italy is a well know region of frequent extensional earthquakes focused along the topographic axis of the Apennines. The integrated effect of these earthquakes is recognized as an important, although poorly understood process in shaping the long term regional landscape evolution. The M. 6.3 L'Aquila earthquake of 06 April, 2009 ruptured a fault in a region of well-known constraining data including hanging wall continental basin Quaternary deposits, footwall stream networks with distinct knickpoints, a dense GPS network, and InSAR interferometry. Envisat and ALOS derived interferograms generated using ROI PAC show close spatial overlap of the InSAR-determined rupture and the Paganica fault, separating a deeply incised, uplifted carbonate footwall block and an actively subsiding Quaternary continental basin. We note, that the longitudinal profiles of streams in the footwall are marked by distinct knickpoints that do not correspond to known or obvious lithologic or structural controls. Rather, the elevation distribution of knickpoints, their distance from the Paganica Fault, and the magnitude of incision can be explained by a repeated history of deformation consistent with the co-seismic InSAR deformation pattern.

Knickpoints elevation is consistent with detachment-limited stream-power erosional retreat processes instigated by base level fall. The timing of the base level falls can be estimated assuming a model for knickpoint retreat rate and through correlation of knickpoints to lithostratigraphic packages of sediment found in the footwall block. Results of the modeling are consistent with periods of tectonic activity recognized in the area and suggest that the Paganica fault has a characteristic rupture geometry, but an unsteady behavior punctuated by periods of frequent activity interspersed with periods of relative quiescence that persist for several millennia.

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The Pliocene basalt and the history of the modern Longchuanjiang River in Tengchong, SW China

LIU F., ZHAO Y., YANG Z.Y.
Institute of Geomechanics, Chinese Academy of Geological Sciences, BEIJING, CHINA

River is a time-intergrated product of landscape evolution. Thus its history documents changes of landscape. Geomorphic marker is an important precondition for decoding history of a river. However, significant uncertainties remain an outstanding research challenge for the history of a river,largely due to a lack of the age of a geomorphic marker. In our study area, the basalt in the Longchuanjiang River, as a geomorphic marker, offer an excellent opportunity to constrain the history of the river. The Longchuanjiang River is a tributary of the Irrawaddy River, one of the ten drainage systems originating from the Tibetan Plateau. We focused on the reach of the Longchuanjiang River in Tengchong, SW China. The river enter the late Pliocene basaltic area in its upper reach for tens of kilometers. It have carved its course and cut gorges on the scale of tens of meters through the basalt flow. The present river bed sit on the exposed basalt rock. The height of the basalt flow is almost the same on both sides of the river valley based on the RTK-GPS measurements. In addition,the present river flow through the early Pleistocene basalt in the middle reach of the Longchuanjiang River. From these observations above,we can infer the maximal history of the present Longchuanjiang River is not older than the late Pliocene.

Morphotectonic indicators of late Quaternary faulting in the Mercure River basin, southern Italy

GIOIA D.(1), DANESE M.(1), LAZZARI M.(1), SCHIATTARELLA M.(2)
(1) Consiglio Nazionale delle Ricerche - Istituto per i Beni Archeologici e Monumentali, TITO SCALO (POTENZA), ITALY ; (2) (2) Dipartimento di Scienze, Università della Basilicata, POTENZA, ITALY

Morphometric analyses of both topography and drainage network are valuable tools to investigate the influence of Quaternary tectonics on landscape evolution. A detailed quantitative analysis of topography combined with the study of drainage pattern was performed in the Mercure basin (southern Italy), a mid-Pleistocene tectonic basin located to the north-western sector of the Pollino Ridge, southern Italy, and filled by a fluvio-lacustrine succession. The genesis and evolution of the endorheic depression have been commonly related to the reactivation with normal and oblique kinematics of a pre-existing, N120° trending strike-slip fault system. Basin and ranges have been studied by means of both traditional and innovative methodologies in the field of morphostructural analysis. We calculated statistical properties of landscape and estimated some geomorphic indices that reflect the interaction between erosional and tectonic processes. Studies on topographic attributes and morphometric indices were integrated with classical (*i.e.* field survey and photo-aerial interpretation) morphostructural analysis, focused on both relict and active landforms. Two orders of erosional surfaces, wineglass-shaped valleys, and fluvial knickpoints arrangements permitted us to recognize the amount of the recent uplift of the ridge bordering the basin in its northern sector and the effective response of the hydrographic networks to late Quaternary block-faulting. As a matter of fact, morphometric indices of drainage basins, drainage network pattern, and analysis of longitudinal river profiles suggest a strong influence of tectonics on landscape evolution. Morphotectonic markers such as fluvial elbows, right angle confluences, and anomalous bend of channels are generally investigated just in a qualitative way. We developed a GIS-aided methodological approach aimed to a quantitative approach, tested as a tool to individuate spatial distribution of faulting-related drainage network anomalies.

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Erosion-induced isostatic rebound triggers extension in Pyrenees: insights from numerical modeling

GENTI M., CHÉRY J., CATTIN R., VERNANT P.
Geosciences - UM2, MONTPELLIER, FRANCE

Present day convergence rates across Western Alps and Pyrenees are very low (< 0.5 mm/yr, e.g., Nocquet, 2012), whereas continuous GPS measurements as well as geomorphic observation indicate significant active uplift (≥ 1 mm/yr) in the Alps. Previous studies (Champagnac et al., 2007; 2008) suggest that this uplift likely results from isostatic rebound due to erosion and deglaciation processes. These mountains are also underlined by moderate but frequent instrumental seismicity (0-15km depth). Available focal mechanisms show normal faulting in regions of moderate to high elevations, with an extension direction normal to the main ridge axis of these mountain ranges, and compression in the Western Alpine foreland (Sue et al., 2007, Larroque et al., 2009, Chevrot et al., 2011).This extensional strain pattern, associated to minor horizontal motion, is usually interpreted as the effect of a gravitational collapse (eg. England and Houseman, 1989). Previous studies have shown that there is a trade-off between gravitational collapse, erosion and mountain growth (Avouac and Burov, 1996). However, the impact of erosion on tectonics in low convergence mountain ranges is still poorly studied.

Following Vernant et al., (Geology, in press), we use a 2D finite element thermo-mechanical modeling, to assess the relationship between surface processes and the pattern of both extension and uplift across the Pyrenees. The present-day Pyrenean range has a deep crustal root related to the under-thrusted Iberian crust and several large fault zones. The erosion-induced isostatic exhumation of this geological setting crust might have an impact on the regional strain regime. Here we quantify the impact of this structural heritage on the vertical and horizontal displacements associated to the distribution of the erosion rates across the Pyrenees.

Geomorphic evidence of active fold growth along the Ainos Thrust Fault (Cephalonia Island, Greece)

TSODOULOS I.(1), GALLOUSI C.(2), KOUKOUVELAS I.(2)
(1) Department of Physics, University of Ioannina, IOANNINA, GREECE ; (2) Department of Geology, University of Patras, PATRAS, GREECE

We document the active fold growth of the southern segment of the Ainos Thrust Fault (ATF), in the Cephalonia Island, Greece, based on tectonic geomorphic analysis using several indices of active tectonics along with geomorphic criteria. The Cephalonia Island is located at the external edge of the Hellenic fold-and-thrust system, one of the most active seismic regions worldwide, characterized by the frequent occurrence of large magnitude earthquakes. The approximately NW-SE-trending ATF is one of the most prominent tectonic features of the island. The southernmost ~20 km of the fault, which is the focus of this work, exhibits up to ~1600 m of topographic relief.

Quantitative measurement of geomorphic indices such as the stream length-gradient index (S_L), the mountain-front sinuosity (S_{mf}), the valley floor width to valley height ratio (V_f) and the hypsometric integral (H_i), extracted from the DEM using standard GIS methods, were analyzed in order to identify the level of tectonic activity.

Several geomorphic criteria were employed in order to demonstrate the lateral propagation of the fault related fold. Drainage patterns of fold fore-limb, back-limb and of the nose ramp were analyzed in order to evaluate the drainage density and the degree of dissection of the surface. Two wind gaps of varying depth are preserved across the southeastern part of the fold. Topographic profiles along the crest of the fold indicate the decrease in elevation of the wind gaps as well as the elevation of the crest of the ridge. Back limb rotation measured by the dip of strata along the southernmost ~5 km of the fold, decreases from NW to SE, from ~38^0 to ~15^0.

The combined geomorphic indices and geomorphic criteria suggest that the analyzed fault-related-fold is active and propagating laterally to a southeastern direction. Evaluation of the rate of lateral propagation needs to be established through chronology of the deposits or landforms being folded.

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Tectonic evolution of the Paleogene to Quaternary Rio Santana Graben in the Ribeira Belt, continental margin of Brazil

GONTIJO-PASCUTTI A.(1), BEZERRA F.H.R.(2)
(1) UFRRJ UNIVERSIDADE FEDERAL RURAL DO RIO DE JANEIRO, RIO DE JANEIRO, BRAZIL ; (2) UFRN UNIVERSIDADE FEDERAL DO RIO GRANDE DO NORTE, NATAL, BRAZIL

Paleogene to Quaternary reactivation of basement shear zones led to the development of several grabens in the Ribeira Belt, continental margin of southeastern Brazil, along a 900 km long and 1,000 km wide area. We investigated one of these grabens, the Rio Santana Graben, which is located along the Arcadia – Areal shear zone in the State of Rio de Janeiro. This shear zone separates different Precambrian terrains and forms the largest Moho gradient in the region. We carried out a multidisciplinary investigation that included geological–geomorphological mapping, controlled-source audiofrequency magnetotelluric and resistivity surveys, and luminescence chronology. Our study indicates that the graben is limited on both sides by NE-trending subvertical normal faults, which are related to the reactivation of the Arcadia-Areal shear zone.This graben is 15 km long and 2 km wide and consists of two main depocenters. The depocenters are linked by a relay rampand have a left-bend, en echelon geometry. Alayer of Quaternary sediments occurs at depths of 1–30 m and several layers of Paleogene–Neogene sediments occur at depths of 30 to 300 m. These sediments consist of Paleogene alluvial deposits, Quaternary alluvial deposits, and Quaternary colluvial deposits. The Quaternary sediments yielded luminescence ages at 49,200 ± 6200 yr, 17,500 ± 2100 yr, and 13,000 ± 1600 yr. The age of first sediments is constrained by bauxite weathering profiles, which has an estimated Paleogene age according to stratigraphic correlations. The Rio Santana Graben presents evidence of Cenozoic faulting. The present-day offset between the central plain in the graben and the adjacent blocks in the lateral horsts is roughly 500 m. NE-trending faults control river incision and triangular facets occur at the border of the graben. Small and narrow waterheads are offset by the facets. These river incision and fault scarps are consistent with Quaternary faulting events in the graben.

Neotectonic activity hypothesis in the SE Brazilian highlands supported by morphometric and statistical analysis: an initial approach

LAVARINI C., MAGALHÃES JR A.P., OLIVEIRA F.S.
Universidade Federal de Minas Gerais, BELO HORIZONTE, BRAZIL

Several researchers have pointed out that the Quadrilátero Ferrífero region, in the SE Brazilian Highlands, has had a Cenozoic morphogenesis controlled by uplift of regional scale with interference of faults located at the contacts of morphostructural and lithological compartments. These compartments are strongly adapted to the Precambrian litostructural domains which have controlled the geomorphological evolution of different parts of the valleys. In order to evaluate and testing the neotectonic activity hypothesis we carried out an initial approach research based on the Stream-Gradient Index associated to Transverse Topographic Symmetry Factor, Basin Asymmetric Factor and statistical analysis in the Ribeirão Mata Porcos Watershed. This watershed might be considered as a representative study area of Quadrilátero Ferrífero's geomorphological complexity, comprising the main regional lithologies and a typical geosyncline structure. The results indicated that the neotectonic activity hypothesis cannot be rejected as well as supported the existence of many drainage patterns probably associated to different litostructural compartments. Thus, the Stream-Gradient Index exhibited second and third order anomalies in 72% and 11% of fluvial reaches, respectively, while only 16% did not achieved the threshold value to be considered an anomaly. The Transverse Topographic Symmetry Factor evidenced that the tectonic tilting was not equal in the whole watershed but much more effective in the Lower and Middle-Lower Course of Ribeirão Mata Porcos, according to the significance levels of statistical analysis. Summarizing, although we are not able to exclude other external influences such as the lithology, the location, values and statistical significance levels of morphometric patterns and their relation to Precambrian faults are strong evidences for supporting the regional neotectonic activity hypothesis.

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Neo-Tectonics and Landform Assemblage in the Middle Valley of Ramganga River (W), Kumaun Lesser Himalaya, India

TRIPATHI M.
KUMAUN UNIVERSITY, NAINITAL, NAINITAL, INDIA

The Quaternary geomorphological study has been undertaken in the middle part of Ramganga (W) valley covering an area of ~200 Km^2 (study area 94.8 Km^2) from Chaukhutia to Bhikiyasain in the Kumaun Lesser Himalayan terrain of Almora district, Uttarakhand to study how the structure controls the landforms and to understand the various geomorphic features of the study area where the fluvial erosion is dominant, as this region offers a variety of structural landforms modified by fluvial action. Knowledge based semi-automated method has been carried out to define geomorphological units and mapping of major geomorphic features in the form of landforms and their analysis in conjunction with structures. The study is intended to mainly understand the role of tectonic movements on morphological variations and landscape development along the middle Ramganga (W) valley. The neo-tectonic movements have affected various Quaternary landforms in the Ramganga river basin. Signatures of neo-tectonic movements in the area are documented in the form of; sharp bends, elbow turning, narrow and straight course of the Ramganga (W) River etc. Indirect evidence of recent epirogenic movements is available in the area. The presence of different levels of river terraces and break in slopes along the Ramganga valley is indicative of lowering of base level of erosion. The basal thrusts of Crystalline Nappes as well as Transverse Faults of the region are neo-tectonically active.

Considering the geomorphology, constituent materials, movements (neo-tectonic) and morphometric analysis it has been inferred that the landscape of middle Ramganga valley is dynamic and complex with geomorphic thresholds resulting from the progressive change of landscape component as well as complex response of drainage systems.

Keywords: Himalaya, Geomorphology, Neo-tectonics, Structural control, Landforms.

Using detrital thermochronologic and cosmogenic data to understand the evolution of modern Himalayan megafans

ABRAHAMI R.(1), HUYGHE P.(1), VAN DER BEEK P.(1), CARCAILLET J.(1), CHAKRABORTY T.(2)
(1) Institut des sciences de la Terre, Université Joseph Fourier - CNRS, SAINT-MARTIN D'HÈRES, FRANCE ; (2) Geological Studies Unit, Indian Statistical Institute, KOLKATA, INDIA

Megafans are very large (10's to 100's of km^2) alluvial accumulations deposited by laterally mobile river systems and are common in several foreland basins across the globe. They are located at the topographic front of large mountain belts and are postulated to be common in areas subjected to marked seasonal rainfall such as the Himalaya. Thus their recognition in the ancient rock record could denote a drainage system emanating from a high mountain belt and monsoonal climate in the area (Horton and Decelles *2001*, Leier et al. *2005*). Several megafans are present in the Ganga plain, associated with rivers draining vast catchments of the central Himalaya. Of these, the two easternmost ones are the Kosi and the Tista megafans. While the Kosi megafan is currently still aggrading (Chakraborty*, 2010*), the Tista megafan located 150 km further east is presently incised about 30 meters (Chakraborty & Ghosh, *2010).* Many questions arise from the comparison of their catchment area (size and elevation), their sedimentary characteristics (mean grain size) and their recent evolution. Wecombine several methods to answer these questions and to understand the tectonic and climatic parameters that impose the major controls on the development of modern Himalayan megafans. Cosmogenic isotopes (^{10}Be, ^{26}Al) are used to date the abandonment of the three different lobes of the Tista megafan and determine both present-day and paleo-erosion rates averaged over the source area. These data are combined with existing and new ^{14}C and OSL ages of the deposits in order to compare erosional and depositional fluxes through time. To constrain long-term exhumation and erosion rates in the source area, detrital and in-situ thermochronological studies (using the Apatite Fission-Track system) are used. In addition, isotope geochemistry ($\varepsilon_{Nd}$and ^{87}Sr/^{86}Sr) from the Tista megafan deposits provides information about sediment provenance through time and its variation in response to climatic conditions.

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The application of the slope x lenght index at the riacho griande watershed, northeast of Brazil

BARROS A.C.M., TAVARES B.A.C., MONTEIRO K.A., CORRÊA A.C.B.
Universidade Federal de Pernambuco, RECIFE, BRAZIL

The geomorphological analysis based on the study of watersheds can reveal physical indicators which organise the landscape caused by the watercourse's capacity of adjustment, registering geomorphological phenomena. The analyses of Slope x Length Index provide data that allow the identification of knickpoints along the longitudinal profiles, due to its sensitivity towards slope changes, which might be related to possible recent crusts deformations. Its contribution lies in the identification of areas with abnormal features in the longitudinal profile of the river, permiting to identify andnormatise these amounts in the gradient of the longitudinal profile. The Riacho Grande's watershed is located in the province of Borborema, in a relief classically designated a plataformal one. The structural context is associated to the "median shear corridor", featured by faulting and shear zones from the Meso and Neoproterozoic. Anomalies of first order with 13,9 and 11,9 were found, as well as anomalies of second order, standing out the ones with 9,8 and 9,3 in the lower third of Riacho Grande. The SL analysis together with the sctructural map data and *in loco* observations enabled to observe knickpoints marked by lithological discontinuities, these ones producing a level difference less steep. Also it was possible to find linear segments with rocks of the substrate, with striae filled with supergene material (oxy-hydroxides of Fe and Mg). The greatest index is found in a Contractional Shear Zones context, where it was observed the presence of faulted quartz veins and scaling of the substrate with the occurrence of striae along some likely fault planes, which implies the reactivation of these ancient shear zones, indicating a brittle tectonism of the ductile shear zones. Therefore, these structural controls have been acting as the main engine in the morphotectonic dynamic of the area.

Drainage rearrangement and sediment production in response to uplift of the Andean Eastern Cordillera, NW Argentina

HARBOR D.(1), RAHL J.(1), BOVAY A.C.(1), GALLI C.(2), SBERNA D.(1), HARTMAN R.(1)
(1) Washington & Lee University, LEXINGTON, VIRGINIA, UNITED STATES ; (2) Universidad Nacional de Jujuy, SAN SALVADOR DE JUJUY, ARGENTINA

Dynamic erosion of the Eastern Cordillera (EC) in Northwest Argentina supplies a rapidly growing sediment load to the foreland. Divide migration, knickpoint retreat, capture, and drainage reversal undercut a low-slope, high elevation Puna-level surface to create valleys with up to 2.5 km relief. The foreland basin sedimentary record suggests that vigorous erosion of the EC basement began ~ 4 Ma with the arrival of cobble conglomerates, whereas a cosmogenic burial date from the base of a valley fill implies that the deeply incised, reversed drainage in the headwaters of the Río Iruya was already established by 1.3 Ma. Sediment from the deep incision, headward erosion and capture caused a complex response leading to a valley filling episode lasting until 200 ka. Removal of the valley fill and subsequent bedrock incision occurs today at rates exceeding 1 mm/a. Modern cut/fill cycles reflect the removal of the valley fill and deepening of the valleys. Cutting of epigenetic gorges and bedrock reaches demonstrates that the stream power is sufficient to promote valley deepening, but is locally insufficient to remove the sediment supplied by oversteepened tributaries. Likewise, propagation of > 500 m knickpoints into the headwaters of the Río Nazareno induces valley aggradation downstream of gorges cut into low-relief uplands. Current and former fluvial systems parallel to the strike of the Eastern Cordillera are cut by deep, modern transverse drainage as the basin propagates headward toward the Puna. The modern Río Iruya transports the highest sediment load in the region, which is even greater than geologic rates determined from the valley filling and cutting episode. The response in this basin illustrates the positive feedback in response to Neogene uplift that is capable of producing increasingly coarse and voluminous sediment for piggyback basins and megafans of the foreland to the east.

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Strutural controls landscape in the south of Rio de Janeiro (Brazil): Morphotectonics evidences

SILVA S.L.S., SILVA T.M.
UFRJ, RIO DE JANEIRO, BRAZIL

The southern state of Rio de Janeiro characterized by steep features arranged parallel to general direction of the shoreline (generally oriented to E-W), corresponds to stretch where the Serra do Mar is closest to the coast, resulting in an abrupt transitional forms between lowered and very soft sedimentary coastal and/or river plains, with extremely high slopes, this fact associated with high rainfall sets a high energy environment, emphasizing the conditions of environmental fragility and occurrence of dense drainage network characterized by numerous basins that strongly dissect the escarpment mountainous and favor the triggering of various erosive processes. Retaking its geological and geomorphological evolution (GONTIJO, 1999, SANTOS 1999; HIRUMA*et al.* 2001) we can note that orientation, clearly marked topography, is directly associated with controlling geological structures, and its evolutionary history associated with the formation of a System of Rifts the Serra do Mar, described as a compensation model isostatic between the continental and oceanic (SILVA, 2012).Considering the strong geological substrate influence on water flows orientation, the identification of lineaments drainage is essential to understanding structural control on drainage systems and on relief morphology. Thus, we propose further discussion about relief structural orientation, extracted from drainage segments, and morphotectonics features, identified from satellite imagery (Geo Eye 2011) interpreted at GIS - System Geographic Information (ArcView 9.0), these morphotectonics features have been identified as: ridge alignments, spurs ridges, triangular facets or shutter ridges. It is expected indicating possible areas fault reactivation,considered potentially more unstable, however, such information should be evaluated in combination with data about seismicity of southeastern Brazil, where great magnitude events are commonly associated with reactivation of old zones of weakness.

Geomorphometric Insights into Tectonically Active Intraplate Gavilgarh Fault Zone, Central India

GHATAK S.(1), GHATAK M.(2)
(1) Geological Survey of India, NEW DELHI, INDIA ; (2) Saarc Disaster Management Centre, NEW DELHI, INDIA

The crescent shaped Purna basin located to the south of Satpura foothills in Central Indian Tectonic Zone (CITZ) is a tectonic half graben, bound to its northern margin by regional scale ENE-WSW trending Gavilgarh Fault Zone (GFZ) and by Ajanta-Buldana plateau to its south. In order to assess the tectonic geomorphology, tectonic activity and consequent sedimentation in this basin along the 230km stretch of GFZ,morphometric analysis and data integration in GIS have been carried out and validated with field data. Digital terrain model (SRTM, 90m) was processed to analyze the elevation, slope and aspect data for characterization of morphotectonic features and alluvial fans of Purna basin. Mountain Front Sinuosity (Smf) of 165 mountain front segments and Stream Length Gradient (SL) index of Purna River and its transverse tributaries derived from topobase data of 1:50K scale were analyzed to identify the relative rates of uplift along the fault zone. The elevation pixel distribution shows GFZ is marked by a salient mountain front. Surface breaking fault segments are aligned at higher elevations in the east and the blind faults are disposed at lower elevations in the west. Slope of 4^{o} in the east and 2^{o} in the west with uniform southerly aspect define this fault zone. Smf values range between 1.0 and 3.5 while SL index varies between 0 & 950. The activity classes defined by Smf and SL values match well with each other to underline the stretches of this fault zone that have experienced relatively higher rates of uplift in Quaternary times. The study helps in characterizing the nature and pattern of sediment flux controlled by foothill Gavilgarh fault, Purna North Fault (PNF) and younger transverse faults to the south of intraplate GFZ. Corroborating uplift rates with sediment architecture and depth distribution of the alluvium along the fault zone, an overall low tectonic subsidence and creation of maximum accommodation space at the central part of PNF are conceived.

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Tracking tectonics in relief in selected model areas in the Bükk Mountains, NE Hungary

MCINTOSH R., KOZÁK M.
Department of Mineralogy and Geology, University of Debrecen, DEBRECEN, HUNGARY

Who would be not interested in how the landscape we see in a mountain was formed? Why the peaks are there where they are, why ridges have the form we see and what made the valleys run in the (sometimes curious) direction they do?

The authors carried out structural geological analyses in an area composed of a relatively diverse geology with Triassic carbonates, Triassic and Jurassic siliciclastic sediments and Triassic igneous rocks. Structural elements of both brittle and ductile deformations have been identified and measured in the form of frontal thrusts, transverse (tension) joints, conjugated lithoclases, cleavage planes, fold limbs and fold axes. Based on the results, the orientation of two major stress fields acting in several phases (mostly in the Cretaceous) have been identified as responsible for the production of the major structural elements.

Observing the interesting orientation of valleys and the appearance of peculiar landforms both in field and on topographic maps / satellite images made the authors curious to find their explanation.

The orientation of valleys was correlated to the orientation of the prevailing brittle structural elements in selected areas in the Bükk Mountains. Even smaller valley sections were correlated to joint directions. Correlation between the directions of ridges and structural elements was also found. Strong correlation between the morphological and structural features was detected even underground as the direction of the passages of caves also matched the direction of brittle structural elements.

Appearance of unusual relief forms could be explained by the occurrence of special structural features produced by the interaction of the two dominant stress fields, i.e. by special superposed structural elements.

Based on the results, morphology may prove to be a useful tool in detailed structural analyses in certain areas.

Geomorphologic analyses of coastal Uplift coupling the marine terraces and the drainage pattern : the case of the Sahel ridge, Algeria

AUTHEMAYOU C.(1), PEDOJA K.(2), HEDDAR A.(3), YELLES K.(3), DJELLIT H.(3), DEVERCHERE J.(4), BOUDIAF A.(3)
(1) LDO UMR 6538 IUEM Universit_ Brest, PLOUZANE, FRANCE ; (2) MC2 Université Caen, CAEN, FRANCE ; (3) CRAAG, ALGER, ALGERIA ; (4) LDO UMR 6538 IUEM Universit? Brest, PLOUZANE, FRANCE

The Algerian Cenozoic passive margin is presently reactivated in compression along the plate boundary between Africa and Europeproducing the uplift of the coast. The uplift rate is moderate that implies to use several methods to document the coastal landscape evolution. We chose to couple quantitative geomorphologic analyses of the drainage pattern with the analysis of marine terraces. The coast selected for the study runs along the NE-trending Sahel ridge whose emersion is associated with fault-related folding. We proceeded to a detailed mapping of Quaternary marine terraces using field data and DEM analyses. The lower terraces were dated to estimate uplift rate. Then, we sampled 148 alluvial basins to calculate geomorphic parameters used as indicators of stages in landscape evolution. The results of the two methods are in agreement showing a spatial gradient of deformation inversely correlated with the gradient of basin maturity.

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Miocene Tectono-geomorphic evolution of the eastern Tibetan plateau and the course change of the Yangtze River

YANG Z.(1), LIN A.(2)
(1) Institute of Geomechanics, Chinese Academy of Geological Sciences, BEIJING, CHINA ; (2) Division of Earth and Planetary Sciences, Kyoto University, KYOTO, JAPAN

The major rivers of the eastern Tibetan Plateau have attracted considerable attention due to the topographic and morphologic features of peculiar drainage systems. The major river courses, including the Yangtze River, the Lanchangjiang and Nujiang, developed in the southeastern margin of the Tibetan Plateau provide an interesting place to test the link between the geometric and fluvial patterns of drainage system and the uplift of the Tibetan Plateau.

The erosion sedimentary facies (e.g. alluvial, fluvio-lacustrine sedimentation) and regional tectonics in the large-scale drainage basins of southwest China are analyzed, which provide some key evidences to demonstrate why the Lanchangjiang and Nujiang flow southward into the Indian Ocean along the eastern margin of the Tibetan Plateau, however, the Yangtze river flows south-southeastward to northeast-eastward with a sharp right-angular bend in the Jianchuan-Dali area of Yunnan province.

Morphotectonic study of the north Evia Island, Central Greece

VALKANOU K.(1), KARYMBALIS E.(1), PAPANASTASSIOU D.(2), CHALKIAS C.(1), GAKI PAPANASTASSIOU K.(3)

(1) Department of Geography, Harokopio University, ATHENS, GREECE ; (2) Institute of Geodynamics, National Observatory of Athens, ATHENS, GREECE ; (3) Department of Geography-Climatology, Faculty of Geology & Geoenvironment, National Kapodistrian University of Athens, ATHENS, GREECE

In tectonically active areas drainage systems are often controlled by the type, geometry, and recent activity of regional and local faults.

The aim of this study is to investigate the contribution of neotectonic processes in the development of the fluvial landscape in North Evia Island, in Central Greece. For this purpose various quantitative geomorphological indices of the drainage networks and associated basins like bifurcation ratio, basin area, hypsometric curve, basin slope, Melton' s ruggedness number, basin circularity, asymmetry factor were estimated using a DEM derived from topographic maps at 1:50,000 scale with 20m contours. Furthermore, the longitudinal profiles of the drainage networks' main channels were drawn and analyzed while field qualitative observations and geomorphological mapping were also performed.

Quantitative analysis and field observations showed that the development of the present drainage systems of the study area has been influenced by the fault tectonism of the two NW-SE trending offshore active normal fault systems of the North Evoikos Gulf (Kandili fault) and the Aegean Sea (Dirfys fault) respectively.

The north part of the Evia island demonstrates a contrast between footwall- and hangingwall- sourced drainage. In the northwest part of the island the steep, short and small drainage basins of the footwall of the North Evoikos Gulf coastal fault flow southwest, whilst a large drainage basin eroded into Neogene sediments dominates the NE-facing backtilted dip slopes. A 20km wide zone in the central part of the island where fault polarity reverses also shows a complete reversal of drainage basin type, with the footwall drainage of the Aegean fault flowing towards the north or northeast, and the large dip slope drainages flowing towards the SW.

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Proposition of a morphotectonic subdivision of Sepetiba's Bay (Guanabara Graben, Rio de Janeiro, Brazil) based upon MDT of nautical charts and high resolution seismic profiles

SAMPAIO A.(1), GONTIJO-PASCUTTI A.(1), MOURA J.R.(2)

(1) UFRRJ - Universidade Federal Rural do Rio de Janeiro, RIO DE JANEIRO, BRAZIL ; (2) UFRJ - Universidade Federal do Rio de Janeiro, RIO DE JANEIRO, BRAZIL

The combinated use of nautical charts as a historical series projected in MDT and the interpretation of high resolution seismic profiles allowed the understanding of the recent evolution of Sepetiba's Bay, revealing structurals lineament's that conditioned the bottom shape and the contour of the bay, evidencing the control of ancient axis over present sedimentary processes and suggesting morphotectonic compartments.

The charts highlighted the main morphosculptural lineaments and the evolution of the erosive processes at the Marambaia's barrier island (an east-west feature at south border which is an extension E-W lineament that defines the center and south sector of Rio de Janeiro coast). These lineaments matched with deep structures revealed by the seismic profiles.

At the north border (continental face), the silting up processes are related to the increased flow of sediments. Nevertheless, the NW-SE coastal line direction is related to a significant subsurface shift with the same axis suggesting features of Quaternary period activity.

The Sepetiba Bay is part of the western sector of the Guanabara Graben (a Mesozoic-Cenozoic structure), named Sub-Graben Guandu-Sepetiba, characterizing its submerged segment. In the regional geology predominate Migmatites truncated by shear zones (NE and ENE), dikes and tertiary alkaline. Neotectonics reactivations are identified in faults with NE, NE, NW, SW and EW directions, normal character, oblique and directional, high and medium deep, controlling the relief forms, drainage and erosional and sedimentation areas. There are also identified deformations into Cenozoic deposits.

Although the seismic studies didn't allow the crystalline basement rock complete visualization in the majority of the profiles, the pre-holocene subsurface stratums drainage axis exerts a clear control on the outline and bottom morphology with many recent features suggesting related tectonic period activity.

Neotectonic control on evolution of quaternary lake systems in southeastern Brazil

MELLO C.(1), SILVA C.G.(2), METELO C.M.S.(3), HATUSHIKA R.S.(3), SUGUIO K.(4)
(1) UNIVERSIDADE FEDERAL DO RIO DE JANEIRO, RIO DE JANEIRO, BRAZIL ; (2) UNIVERSIDADE FEDERAL FLUMINENSE, NITEROI, RJ, BRAZIL ; (3) PETROBRAS, RIO DE JANEIRO, BRAZIL ; (4) UNIVERSIDADE DE SÃO PAULO, SÃO PAULO, BRAZIL

The present study includes geomorphologic, structural and seismic stratigraphic analysis in order to discuss neotectonic influences on evolution of two barred lake systems in the Doce River Basin, one of the most important fluvial basins at Southeastern Brazil Atlantic margin. One of the studied lake systems is located at the Middle Doce River valley and the other is located very near the river mouth. Previous studies of these lake systems have respectively considered paleoclimatic controls and Quaternary relative sea level changes to explain their evolutions. Stratigraphic analysis confirm the beginning of the lacustrine sedimentation in early Holocene, simultaneously with a very important regional alluvial sedimentation that influenced the damming of the lakes. The lake morphology is controlled by a NW-oriented structural trend. A NE-oriented trend controls the alignment of the lake mouths. Two sets of brittle tectonic structures (joints and faults) affect the Cenozoic deposits in the two studied areas: 1) NW-SE normal faults and WNW-ESE to ENE-WSW transtensive faults are related to a regional Pleistocene-Holocene E-W dextral transcurrent regime; 2) NE-SW to ENE-WSW normal faults are related to a regional Holocene NW-SE distensive regime. The first set of neotectonic structures controls the orientation of the lakes. The second set has a strong correlation to the alignment of the lacustrine mouths and is related to expressive disruptions in lake bottoms. As seismic profiles show, NE-SW to ENE-WSW normal faults also affect Holocene alluvial deposits located at the lake dams and, thus, is supposed that the Holocene NW-SE distensive regime controls the evolution of the Doce River Basin lake systems.

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Late Quaternary faulting on the Sudetic Marginal Fault in intraplate Bohemian Massif (Central Europe)

STEPANCIKOVA P.(1), NYVLT D.(2), ROCKWELL T.(3), HARTVICH F.(1), HOK J.(4), TABORIK P.(5)
(1) Institute of Rock Structure and Mechanics, Czech Academy of Sciences, PRAGUE 8, CZECH REPUBLIC ; (2) Czech Geological Survey, Brno branch, BRNO, CZECH REPUBLIC ; (3) Geological Sciences, San Diego State University, SAN DIEGO, UNITED STATES ; (4) Faculty of Natural Sciences, Comenius University in Bratislava, BRATISLAVA, SLOVAKIA ; (5) Faculty of Science, Charles University on Prague, PRAGUE 2, CZECH REPUBLIC

The Sudetic Marginal Fault (SMF)forms a part of the north-eastern limit of the Bohemian Massif (central Europe) and controls the pronounced mountain front of the Sudetic Mountains for a length of 130 km. As the SMF does not show present-day seismicity and only small to moderate historic earthquakes (I=4-7 MSK), paleoseismic search for larger prehistoric earthquakes responsible for the origin of the mountain front was initiated.

Ten fault-crossing trenches were excavated at the SMF at Bila Voda (Czech Republic) to study the fault activity. The trenches revealed a subvertical fault zone (striking 135-150°/75°NE) with a flower structure, suggesting strike-slip motion. The SMF juxtaposed deposits overlying warped Miocene sediments on the downthrown hanging-wall. The colluvial deposits near the fault show characteristics of fault-derived colluvial wedges. The alluvial deposits show a fan-like geometry. Six fault-parallel trenches were excavated to find a source and piercing points of the alluvial fan deposits, and to specify the geometry of the fan cut by the fault. Trenching was accompanied by geophysical survey (electrical resistivity tomography, GPR) to catch continuation of the fault trace and sedimentary bodies. The fan apex appeared to be offset about 60 m left laterally from the only source drainage.

The results completed by OSL and radiocarbon dating show that during Late Pleistocene, at least 4 to 5 large morphogenic earthquakes occurred at the SMF, along with at least one during Holocene (?). Left lateral horizontal motion with 60 m offset of displacement in as little as the past 25 ka yields an average slip rate of 2.4 mm-yr. However, with little or no Holocene displacement, this may imply that most of this displacement occurred at higher rate in the late Pleistocene. This suggests that ice loading may have been a factor in accelerating the slip rate, as our trench site lies less than 100 km from the ice front during the last Weichselian glaciation.

Geomorphology along Major Continental Faults: Slip rate constraint from climatic fluctuations

FERRY M.(1), AKSOY E.(2), MEGHRAOUI M.(3)
(1) Equipe Risques, Geosciences Montpellier, MONTPELLIER,, FRANCE ; (2) Dept of Engineering, University of Mugla, MUGLA, TURKEY ; (3) EOST - Institut de Physique du Globe, STRASBOURG, FRANCE

We construct the slip history for the DSF and NAF based on the interaction between stream offsets along faults and alluvial and lacustrine deposits. Our analysis focuses on the geomorphology of active faults and paleoclimate history of the Eastern Mediterranean for the last 140 kyr with an emphasis on Intense Precipitation Episodes (IPEs) likely to have triggered systematic stream gully erosion and alluvial fan aggradation. IPEs are documented by the occurrence of sapropel layers, high lake stands and significant changes in vegetation and dated by multiproxy approaches. The 45-km-long co-seismic 1912 surface ruptures and related slip along the Ganos segment of NAF have been investigated to document cumulative right-lateral displacements. The classification of stream offsets at 69 localities and correlations with climatic events deduced from Black Sea sea level curves reveal the correlation between consecutive 5 cumulative slip groups (from 70 to 300 m) and subsequent sea level rise periods at 4 ka, 10.2 ka, 12.5 ka, 14.5 ka and 17.5 ka BP. Slip rate estimations yield a constant slip rate of 17.9 mm/a for the last 20.000 years. Along and 120-km-long Jordan Valley segment of the DSF the isotopic dating of six paleoclimatic events yields a precise chronology for the onset of six generations of gully incisions at 47.5 ka, 37.5 ka, 13 ka, 9 ka, 7 ka, and 5 ka BP. The cumulative slip of 20 dated incisions along the DSF consistently fall into six distinct classes yielding an average constant slip rate of 4.7 to 5.1 mm/a for the last 47.5 ka. These estimates of long-term fault slip rate are consistent with the 16 – 18 mm/a and 4.5 – 5.5 mm/a from paleoseismology and with the 22 – 26 mm/a and 4 – 5 mm/a from GPS velocities, for the NAF and DSF, respectively. The timing of cumulative offsets also reveals slip rate variations critical to our understanding of the slip deficit and seismic cycle along major continental faults.

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Morphostructutal analysis of a subarea of Haiti, struck by the 2010 Earthquake, seated along the the Enriquillo-Plantain Garden Fault

KANAKAKI S.(1), CAMIZ S.(2), POSCOLIERI M.(3), PARCHARIDS I.(1)
(1) Dept. of Geography, Harokopio University of Athens, ATHENS, GREECE ; (2) Dept. of Mathematics, Sapienza University of Rome, ROME, ITALY ; (3) CNR - Institute of Acoustics and Sensor O.M. Corbino, Rome, ROME, ITALY

A landscape may be characterized by the relief representing its major component, while significant changes on its shape are often determined by the tectonic activity.

The main purpose of this study is to define possible relationships between morphological information, collected by analyzing satellite data and classifying terrain units on the basis of a DEM, and structural features gathered considering the geological and structural setting of the study area.

As test site was chosen the Haiti area struck by the strong earthquake occurred on January 12th 2010. The epicenter was located few kilometers away, in SSW direction, from the capital Port-au-Prince that is crossed by the major Enriquillo-Plantain Garden Fault. The earthquake caused considerable damages in buildings and many casualties.

In this study, ASTER multispectral images covering the broader area as well a subset of a ASTER GDEM tile were used to investigate the morphostructural pattern along the segment of Enriquillo-Plantain Garden Fault, where the Earthquake epicenter was located. The area is characterized by a system of two rivers Froide and Momanche whose flows are split up by sectors of the Enriquillo-Plantain Garden Fault.

The methodological approach for the morphometric classification is based on statistical multidimensional analysis of local elevation gradients, extracted considering each pixel of the DEM and its nearest neighbours.

The spectral data are, instead, represented by an ASTER scene, acquired on January 21th 2010, which exhibits visible, near-infrared (VNIR) and thermal bands (TIR), and is cloud free. The VNIR bands were transformed by applying the Principal Components Analysis (PCA); then, the first component, where the morphology is well displayed, was filtered using a high pass kernel in order to enhance the high frequency information.

Cosmogenic CL-36 dating of alluvial fans: implications for the late quaternary slip rates of the Ecemis fault in Turkey

SARIKAYA M.(1), YILDIRIM C.(2), CINER A.(3)

(1) Fatih University, Department of Geography, BUYUKCEKMECE-ISTANBUL, TURKEY ; (2) Istanbul Technical University, Eurasia Institute of Earth Sciences, MASLAK-ISTANBUL, TURKEY ; (3) Hacettepe University, Geological Engineering Department, BEYTEPE-ANKARA, TURKEY

Alluvial fans are very useful geomorphic markers to date and estimate the timing and rate of active tectonic deformations. In the central Taurus Mountains of Turkey, we used excellent exposures of alluvial fans along a ~15 km long, NNE trending linear valley to understand the Late Quaternary tectonic activity of the left-lateral oblique slip Ecemiş Fault. Although the geomorphic expression of the fault is very distinct, the rate of active slip is not well-known due to the constraints of explicitly dating offset markers along the fault line. In this study, we have determined the slip of the Ecemiş Fault by remote sensing and in-situ measurements and the alluvial fan ages associated with the Ecemiş Fault by cosmogenic Cl-36 dating. Finally, we calculated the Late Quaternary slip rates of the fault based on the cosmogenic age results. According to the digital terrain model obtained from high-resolution airborne survey, we determined the horizontal slip amount to be in between 20 to 40 m, and the vertical slip to be 15-20 m. Our cosmogenic Cl-36 geochronology analysis revealed that the surface age of the alluvial fans cut by the Ecemiş Fault is 84.3 ± 7.4 kyr (kilo years). Depending on our preliminary slip measurements, we propose horizontal and vertical mean slip rates in between 0.24 and 0.47 mm/year and 0.18 and 0.24 mm/year, respectively.

Keywords: Ecemiş Fault, slip rate, alluvial fan, cosmogenic chlorine-36 surface exposure dating, Turkey

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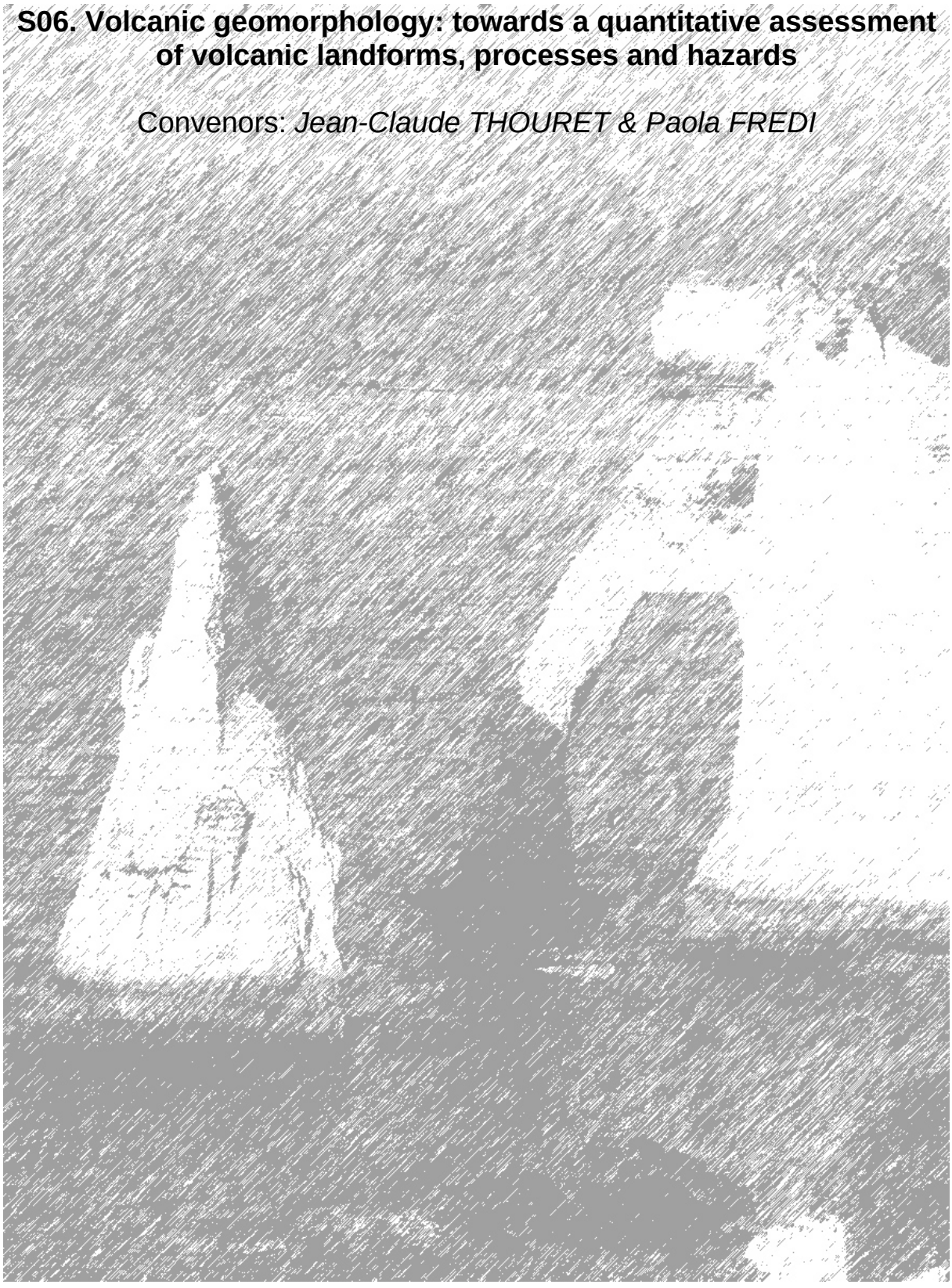
S06. Volcanic geomorphology: towards a quantitative assessment of volcanic landforms, processes and hazards

Convenors: *Jean-Claude THOURET & Paola FREDI*



Oral presentations:

Geomorphic analysis of eruptive vents, landslide and debris flows of the 2012 Te Maari eruption from Mt. Tongariro, New Zealand

PROCTER J.(1), ZERNACK A.(1), CRONIN S.(1), PATRA A.(2), SHERIDAN (2), LEONARD G.(3), JOLLY G.(3), KEYS H.(4)

(1) Massey University, PALMERSTON NORTH, NEW ZEALAND ; (2) SUNY, BUFFALO, UNITED STATES ; (3) GNS, WAIRAKEI, NEW ZEALAND ; (4) Department of Conservation, TAUPO, NEW ZEALAND

The 6 August 2012 Te Maari eruption from Mt. Tongariro was an event that had not been considered in recent hazard analysis of the Tongariro Volcanic Centre. While scarce historic reports describe similar events occurring during the last eruptive episode at Te Maari craters from 1869-1896, they lack any information on geomorphic changes to the crater configuration. Similarly the products of these historic eruptions, such as debris flows or pyroclastic flows, are not preserved in the geologic record. In response to seismic activity in July 2012 and a possible eruption threat from Mt. Tongariro, there was need to develop likely scenarios of mass flows prior to the event. However, due to the lack of accurate historic information the location of possible vents, volumes and flow rheologies were complete unknowns. With no validation available from past events, the Titan2D computation flow model was applied to scenarios developed around historic eruptive centres to create a mass flow hazard zone for public hazard maps. The subsequent 6th August phreatic to phreatomagmatic explosions altered the landscape with newly established volcanic vents and potentially unstable craters. The eruption also displaced 320,000 m^3 of material from the flanks of the vent area in the form of a landslide, generating a small debris flow that flowed 2.5 km from source and blocked a valley system. These geomorphic changes were characterised by RTK-GPS surveys and LiDAR. A combined analysis of the newly acquired high-resolution surface data with sedimentological data provided insights into how this mass of material was emplaced. The damming of the valley and the formation of a lake behind the dam presented a changing hazardscape. The dam collapsed on 14 October remobilising material. This rapidly evolving landscape and the ever-changing geomorphic conditions continually alters the hazardscape requiring careful monitoring and providing challenges for hazard simulation analysis.

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The geomorphology of the Rinjani volcanic complex, Lombok Island, Indonesia: a result of a major historic eruption

LAVIGNE F.(1), DEGEAI J.P.(2), LAHITTE P.(3), ROBERT V.(1), KOMOROWSKI J.C.(4), VIDAL C.M.(4), METRICH N.(4), SRI HADMOKO D.(5), ARYA DIPAYANA G.(5), PRATOMO I.(6), WASSMER P.(7), DE BÉLIZAL E.(1)

(1) Université Paris 1 Panthéon-Sorbonne, Laboratoire de Géographie Physique, UMR 8591 CNRS, MEUDON, FRANCE ; (2) CNRS, UMR5140 Archéologie des sociétés méditerranéennes, LATTES, FRANCE ; (3) Université Paris-Sud, Département des Sciences de la Terre (IDES), ORSAY, FRANCE ; (4) Institut de Physique du Globe de Paris (IPGP), CNRS UMR7154, PARIS, FRANCE ; (5) Gadjah Mada University, Faculty of Geography, YOGYAKARTA, INDONESIA ; (6) Geological Museum, Center for Geological Survey, BANDUNG, INDONESIA ; (7) Université de Strasbourg, Laboratoire de Géographie Physique, UMR 8591 CNRS, MEUDON, FRANCE

Rinjani volcanic complex is located in Lombok Island, east of Bali, Indonesia. Rinjani volcano (3,726 m above sea level a.s.l.) towers ca. 1,700 m above a 6×8.5 km caldera. This caldera hosts a 11 km^2 crater lake (2000 m elevation) called Segara Anak (Child of the Sea in local language), enclosed by 500-800 m high walls. The lake is about 200 m deep and its water volume is estimated at 1 billion cubic meters. Lava flows and scoriaceous tephra from recent post-caldera eruptions of Gunung Baru (New Mountain) have formed an intracaldera cone.

The caldera rim is comprised of lava domes and their residual structures as well as proximal pyroclastic deposits from past eruptions. The eastern flank of the Rinjani volcano descends abruptly to the Sembalun plain, a remnant of an older caldera. The Holocene caldera-forming explosive eruption produced extensive and voluminous Plinian pumice fallout deposits and multiple units of massive unwelded pumiceous pyroclastic density current (PDC) deposits that reach up to 35-40 m in thickness. North and south of the Segara Anak caldera, these deposits form a pyroclastic apron that descends gradually from the caldera rim and terminates in the sea up to 35 km from source. Emplacement of the PDCs entirely modified the pre-caldera topography. Post-eruptive dissection of the 35-40 m thick PDC deposits has resulted in the formation of the northern valleys of Lombok Island and relief inversion. The minimum bulk volume of the on-land mapped PDC deposits is 14.5 ±0.7 km^3, corresponding to 8.0 ±0.4 km^3 of magma DRE (dense rock equivalent). Our study aims to reconstruct the very large recent eruption at the origin of one of the most beautiful volcanic landscape of the world.

Using volcanic landforms, their ages, bedrock and tectonic setting across the very large monogenetic field of the Newer Volcanic Province of southeastern Australia to assess future eruptions

JOYCE E.B.
Earth Sciences, The University of Melbourne, PARKVILLE, AUSTRALIA

Young monogenetic volcanoes of the Newer Volcanic Province (NVP) of central and western Victoria and adjacent southeastern South Australia provide a detailed story of activity over the last 5 Ma which continues up to just a few thousand years ago. Some 400 large and small scoria cones, lava shields and maar craters have been catalogued and the distribution of lava flows and ash deposits mapped. Many volcanoes are on the western plains, but the greatest concentration of some 100 scoria volcanoes, often as little as 2 km apart, are clustered in an upland area, with similarities to parts of the Auvergne region of France. K/Ar dating and newer techniques including cosmogenic exposure dating have provided a detailed story of the youngest activity, and geomorphic and regolith mapping have been used to fill gaps. Geostatistical modelling has allowed an analysis of activity over time, identifying cycles of activity and periods of little or no activity. In a period of greater activity over the last 20,000 to 30,000 years on the plains in the far west of the NVP, perhaps a dozen volcanoes may have erupted – and if not clustered these indicate a repose interval or recurrence rate (i.e. eruption frequency) of some 2,000 years. The recent redating of the Mt Gambier volcanic complex at ~5,500 years BP demonstrates the need to consider long term volcanic risk and hazard. Among the hazards which may need to be dealt with in any future eruption in this closely-settled region are local effects of scoria cone eruption or lava shield construction, maar eruptions and local (but possibly extensive) ashfall and base surge ash flows, and the longer term and more broadly distributed problems of lava flows, which can be seen to have followed valleys in the past for tens of kilometers and so are potentially a hazard to modern infrastructure such as bridges, road and railways, and a major fire hazard on the dry grassland plains of Western Victoria in summer.

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Lahars at Merapi Volcano following 2010 eruption: geomorphic impacts and hazards assessment

HADMOKO D.S.(1), DIPAYANA G.A.(1), SARTOHADI J.(1), LAVIGNE F.(2), MARFAI M.A.(1), SURATMAN S.(1)
(1) Faculty of Geography, Universitas Gadjah Mada, YOGYAKARTA, INDONESIA ; (2) Institut de Géographie. Université Paris 1 Panthéon-Sorbonne, 191, rue Saint-Jacques 75005 Paris, France, PARIS, FRANCE

Lahars are the most frequent hazardous events on Merapi Volcano since 2010 centennial eruption. Over 290 lahars have been documented at 13 rivers coming from Merapi and 20 % of them have been observed at Kali Putih. The devastating lahars at Kali Putih in January 9th, 2011 caused the extensive damaged on infrastructures, agricultural lands and abrupt channel evolution at the downstream areas. The aims of this research are twofold: (1) understanding the lahars dynamics and its geomorphic impact on channel and (2) assessing the spatial extension of the hazardous area at the downstream of Kali Putih. A threefold of methodological approach has been applied in this research namely: (1) remote sensing approach has been used in order to understand the river dynamic before and after lahars through visual interpretation. Three different kinds of very high resolution images have been used in order to identify the evolution of river morphology. We identify the pre-event morphology through Quickbird Images taken at April 22, 2010 while the post-event morphology has been studied from GeoEye Image taken at June 11, 2011 and orthophoto images recorded at January 22th, 2012; (2) numerical simulation of lahars extension has been done through Titan2D model. High resolution DEM of Airborne Lidar has been used to simulate the spatial extension of lahars with several scenarios of volumes, (3) field measurement coupled with real-time video recording of lahars allow us to understand the dynamic and mechanism of erosion and depositional process of lahars along the channel. The hazard map is useful for developing the lahar risk micro-zonation for anticipating the potential damage and loss caused by the future lahars.

Keywords: lahars, geomorphic impacts, hazards, DEMs, dynamic.

Intrusion generated topography in monogenetic volcanoes

VAN WYK DE VRIES B.(1), MARQUEZ A.(2), PETRONIS M.(3), DELCAMP A.(4), KERVYN M.(4), PABLO G.(5)
(1) Laboratoire Magmas et Volcans, CLERMONT-FERRAND, FRANCE ; (2) Universidad Juan Carlos, MADRID, SPAIN ; (3) New Mexico Highlands University, LAS VEGAS, NM, UNITED STATES ; (4) Vrije Universiteit Brussel, BRUSSELS, BELGIUM ; (5) CONICET & Fundación Miguel Lillo, TUCUMAN, ARGENTINA

Monogenetic volcanoes are produced by short (< decades) and low volumes (<1 km3) eruptions of usually one magmatic event. They are usually described by their lavas and eruptive products, but in certain eroded or quarried cases, it has become clear that intrusions can play a major roll in their evolution. In other cases it has become clear that the surface morphology has been extensively controlled by late stage intrusions. This presentation describes intrusions seen in several volcanoes, in the Châine des Puys, Central France, either in exposures in quarries, or interpreted after an analysis of the surface morphology and structure. We show that large-scale surface modification can occur at any time before, or during, an eruption and that subsequent intrusion into a previous edifice can also cause large scale-topographic changes. In particular we show: 1) the internal structure of intrusions exposed in the Lemptégy Scoria cone, 2) the large scale topographic remodelling of the Petit Puy de Dôme scoria cone during a latter trachytic intrusion phase, 3) the formation of a lacolith-related bulge before the Killian Plinian eruption, and the collapse of the Puy de Gouttes cone related to a shallow intrusion that formed the Puy Chopine Trachytic eruption. While we concentrate on small-scale monogenetic events, we will compare these with cases from larger stratovolcanoes, such as Teide, Tenerife, and Momotombo, Nicaragua which indicate that such large scale topographic changes can occur at all scales and can significantly alter the shape of a volcano.

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Morphological changes associated with the emplacement of lava flows in coastal environments on the island of El Hierro (Canary Islands)

GUILLÉN-MARTÍN C.(1), ROMERO-RUIZ C.(2), ROBERT A.(3), DÓNIZ-PÁEZ J.(2)
(1) Instituto Volcanologico de Canarias (INVOLCAN), GRANADILLA DE ABONA, TENERIFE, SPAIN ; (2) Department of Geography, University of La Laguna. Tenerife/Spain., LA LAGUNA TENERIFE, SPAIN ; (3) Département de Sciences Humaines et Sociales, Université de La Rochelle, LA ROCHELLE, FRANCE

In the Canary Islands, the existence of specific lava forms generated as a result of the emplacement of lava flows into the sea, with the development of hydrovolcanic explosions within it, has been highlighted by authors such as Bravo (1964), De la Nuez et al (1997) and Romero (2003). Most of these authors deduce the existence of hydrovolcanic explosions from the presence of small scoriaceous mounds on the surface of the lava flows; these morphologies have been described in lava flows of the islands of Lanzarote, Fuerteventura, La Graciosa and Alegranza. Despite its importance for the establishment of the potential risks associated with the emplacement of lava flows, detailed studies or research analyzing the morphology or traits lava deposits associated with these forms do not exist yet. On the other hand, mention of surface morphologies of this same type has not been carried out on the island of El Hierro yet. In oceanic volcanic islands, the possibility of lava flows reaching the sea is relatively high. In the Canary Islands this has happened at least nine times during the past 600 years, confirming the arrival of lava flows to the sea during the Timanfaya eruption in 1730/36 and the New Volcano of Fire in 1824 in Lanzarote; in 1706, in Tenerife, and during the 1585, 1646, 1677-1678. 1712, 1949 and 1971 eruptions in La Palma. This means that lava has entered the ocean at more than 60% of developed eruptions at historical times, although there is no evidence of the development of significant explosions in the lava fronting during lava emplacement in shallow marine environments. This work carries out the study of the flows belonging to the eruptive zone of Punta de la Dehesa, in the northern area of the lava platform of El Verodal. The establishment of forming sequences of the lava flows in the platform of El Verodal has been carried out from the stratigraphic analysis of individual lava flow units present in natural breaks in the cliffs around this sector.

Evaluation of mechanical erosion and volcanic construction rates in the Basse-Terre Island (Guadeloupe, Lesser Antilles)

RICCI J., LAHITTE P., QUIDELLEUR X.
UMR 8148 CNRS, IDES, ORSAY, FRANCE

The current topography of the volcanic island of Basse-Terre highlights the complex interaction between construction and dismantling processes having marked its history. Even if this island may have sometimes been affected by flank collapses event, the geomorphologic evolution of massive volcanic remains dominated by the important erosion resulting of the tropical climate. To better constrain its origin, evolution and influence, it is necessary to characterize and quantify the dynamics of both construction and destruction of each volcanic edifice.

In this study, we combine a wide K/Ar geochronological coverage obtained by the Cassignol-Gillot technique with DEM geomorphological analyses that allow us to numerically model the evolution of paleo-surfaces in order to quantify the successive eroded volumes. For this purpose, we extract from the present-day numerical topography the key-points whose current altitudes constrain the upper surface of the different edifices at the end of their volcanic activity. The complete paleo-surface obtained by interpolation of these key-points is then subtracted to the current DEM to deduce the altitude lost at each location of the grid. The integration of these differences over the whole surface quantifies the total erosion affecting each edifice since its activity ended. Erosion rate deduced are then compared between different geographic sectors with contrasting climates. Moreover, the obtained erosion rates will allow us to propose new constraints on the mechanical versus chemical erosion rates budget having affected the Basse-Terre volcanic island for the last million years.

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Comparison of Andean Volcanoes landforms through geomorphometric analysis

CAMIZ S.(1), POSCOLIERI M.(2), ROVERATO M.(3)
(1) Sapienza Università di Roma, ROMA, ITALY ; (2) CNR - Istituto di Acustica e Sensoristica, ROMA, ITALY ; (3) UNAM - Centro de Geociencias, QUERETARO, MEXICO

The comparative studies of volcanoes structure can highly benefit from the increasing availability of DEM models, since most morphometric characters may be extracted by the analysis of the data they produce. Studies in this sense have been performed on the Andean volcanoes by Grosse et al. (2012) that developed a data base of volcano edifices morphometry, describing their most relevant landforms.

In Camiz and Poscolieri (2010) a new geomorphometric analysis method has been introduced, able to classify ground pixels according to their local relation with the neighboring ones. This way, two main targets may be reached: a fine tuned description of the morphological features and the possibility of their direct comparison among volcanoes. In addition, the associated coloring technique gets possible a direct visual comparison.

The technique is based on the so-called Tandem Analysis, composed by the pairing of a Principal Components Analysis, and a mixed classification that alternates K-means and Hierarchical clustering (Lebart et al., 1995), applied on the eight gradients of each DEM pixel, computed as the difference between the pixel's altitude and that of the eight surrounding ones.

In this paper we apply this technique to a sample of Andean and other American volcanoes, in order to ascertain to what extent some similarities in the slopes orientation, already observed in some of these apparatuses, may be generalized to a larger sample.

References

Camiz S. et al. (2011). Actas E-ICES 6, ISBN 978-987-1323-21-0: 19-29

Grosse P. et al. (2012), Geomorphology, 136: 114-131

Lebart L. et al. (2006), Statistique Exploratoire Multidimensionnelle, Paris, Dunod.

Quantitative assessment of external environmental controls on the style of monogenetic volcanic eruptions

NEMETH K., KERESZTURI G., AGUSTÍN-FLORES J., CRONIN S.
Massey University, CS-INR, PALMERSTON NORTH, NEW ZEALAND

The external environment, where volcanic field-forming magmas intrude plays an important role to control the style of monogenetic volcanism. The external environment could be the source of the amount and type of ground or surface water that determines the style and length of magma-water interactions. Due to its hazardous nature, the phreatomagmatic volcanism in the Quaternary Auckland volcanic field (AVF) is the most dangerous volcanic hazard we need to deal with. In order to assess the susceptibility of a phreatomagmatic eruption in the future, the external-forcing factors should quantitatively be determined using the best possible geological data set on the volcanoes erupted in the past and their eruptive environment. A combination of Dense Rock Equivalent (DRE) eruptive volumes with stratigraphic-positions were used to discriminate the total amount of magma fragmented in a phreatomagmatic way in the AVF. Out of the total DRE eruptive volume of the field (1.5 km^3), only small fraction were emplaced by phreatomagmatic eruption forming tuff rings (0.1 km^3). The rest of the magma output (1.4 km^3) was emplaced as spatter/scoria cones and lava flows, controlled mostly by the magma "*internal*" physical-chemical parameters. Important external factor were found to be the hydrogeologic condition of encountered country rocks, which is in functions of thickness, porosity and permeability of alluvium deposited upon differentially subsided blocks of the Miocene, variously fractured hard rocks (Waitemata Group), the fracture pattern of the deep hard rock aquifers, the fluctuation of sea level and the changes of fluvial network over the evolution of the field. Due to the young age of the AVF (<250 ka), the eruption history of each volcano and the way of interaction between the magma and the external environment can be used as an input data to develop "*scaled*" and quantitative volcanic hazard scenarios for future eruptions.

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Towards a comprehensive morphometric classification of composite volcanoes

GROSSE P.(1), KERVYN M.(2), VAN WYK DE VRIES B.(3)
(1) CONICET & Fundación Miguel Lillo, TUCUMÁN, ARGENTINA ; (2) Department of Geography, Vrije Universiteit Brussel, BRUSSELS, BELGIUM ; (3) Laboratoire Magmas et Volcans, Université Blaise Pascal, CLERMONT-FERRAND, FRANCE

Shape and size are fundamental properties of a volcano. This is reflected in the fact that most volcano classifications are based entirely or partially on morphology. However, most existing classifications are qualitative and unsystematic, based on vague morphological characteristics and sometimes also using other data (e.g. composition). This has led to classification schemes that are ambiguous or inconsistent, containing different and in some cases overlapping terminology such as simple, composite, compound, complex, cluster, multiple, twin, shield, shield-like, somma, collapse-scarred, etc. In order to obtain a comprehensive classification, quantitative and comparable morphometric data for all volcanoes at a global scale should be analyzed. To this end, we have used the near-global SRTM DEM to compile a database of morphometric parameters of approximately 800 composite volcanoes that are listed in the Smithsonian Institution Global Volcanism Program database. The parameters were obtained using a specifically developed code (MORVOLC) which computes several parameters that thoroughly and quantitatively describe the morphology of volcano edifices. Analysis of the database indicates that edifice shape can be reasonably summarized by a number of independent parameters: height / basal width ratio, summit width / basal width ratio, ellipticity index (*ei*), irregularity index (*ii*), average slope, number of main vents and presence of large summit crater or caldera. More detailed characterization can be obtained considering the variation with height of *ei*, *ii* and slope. Edifice size can be summarized with height, basal width and volume. Statistical cluster analysis of these parameters via different algorithms results in a set of possible classification schemes. The usefulness and validity of the obtained categorizations are discussed in terms of their links with the dominant constructive and destructive processes controlling edifice morphologies.

Mapping and quantifying the morphometry of volcanic features using high resolution Tandem-X DEM: the Virunga Volcanic Field, DR. Congo

KERVYN M.(1), POPPE S.(1), ALBINO F.(2), SMETS B.(3), KERVYN F.(2)
(1) Vrije Universiteit Brussel, BRUSSELS, BELGIUM ; (2) Royal Museum for Central Africa, TERVUREN, BELGIUM ; (3) European Center for Geodynamics and Seismology, WALFERDANGE, LUXEMBOURG

Detailed morpho-structural mapping of volcanoes is essential to understand the structure of a volcanic system and the spatial distribution of eruption probability. Quantifying the volume of pyroclasts and lava emitted by a given eruption further enable to constrain the eruption dynamics, the volcano long term magma production rate and to constrain hazard models. Here we present a new volcano-structural map of the Virunga Volcanic Province (VVP) based on high-resolution topographic and multispectral remote sensing data. The VVP located within the Western branch of the East African Rift system at the boundary of D.R.Congo, Rwanda and Uganda, hosts 8 volcanoes, including two active ones, Nyiragongo and Nyamulagira. The latter one, with one eruption every 1-4 year requires frequent update of the geological map. Panchromatic and multispectral images from sensors of SPOT and Pléiade constellations were used to systematically map the hundreds of volcanic spatter-and-scoria cones, lava flows, eruptive fissures and other lineaments in the VVP. Using bistatic images from the Tandem-X mission, a high-resolution DEM at 5 m resolution was produced by radar interferometry. This DEM, which is 6 times more accurate than the so-far available DEM of the area, enables us to systematically quantify the morphometry of volcanic cones and to constrain the volume of lava flow lobes. rom difference between two Tandem DEM's taken before and after the last eruption at Nyamuragira,the extension and volume of the lava flows have been estimated with a higher accuracy than preliminary field estimation. The new map and GIS database will serve as a basis for modelling the spatial distribution of volcanic hazard in the VVP. This research highlights the added value of newly available remote sensing data to study hazardous or inaccessible volcanic regions.

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Morpho-structural evolution of a volcanic island developed inside an active oceanic rift: São Miguel Island (Terceira Rift, Azores)

SIBRANT A.L.R.(1), HILDENBRAND A.(1), MARQUES F.O.(2), BOULESTEIX T.(1), COSTA A.C.G.(2)
(1) Univ. Paris Sud, laboratoire IDES, UMR8148, 91405 ORSAY, FRANCE ; (2) Universidade Lisboa, LISBOA, PORTUGAL

The evolution of volcanic islands is generally marked by fast construction phases alternating with destruction by a variety of mass-wasting processes, such as giant landslides, caldera collapse events, or graben development. More specifically, volcanic islands located in areas of intense regional deformation represent rapidly evolving and unstable reliefs, particularly prone to gravitational destabilization.

The island of São Miguel (Azores) has developed during the last 1 Myr inside the active Terceira Rift (TR), a major slow-spreading extensional structure materializing the present boundary between the Eurasian and Nubian lithospheric plates. The island is composed of a few main edifices affected by several volcano-tectonic structures. In this work, we depict the morpho-structural evolution of the island, based on high-resolution DEM data, fieldwork and structural investigations, and high-precision K/Ar dating on separated mineral phases.

The new results indicate that: (1) the primitive volcanic complex composing the eastern half of the island was active until ca. 800 ka, and experienced a major southward lateral flank collapse; (2) the resulting depression was extensively filled by basic volcanic activity; (3) tectonic deformation yielded the development of graben-like tectonic depressions oriented N150 and N110 close to the collapse rims, whereas a new volcano grew in the western part; (4) this volcano was affected by caldera collapse episodes, and associated ignimbrites filled the graben and erosional depressions; (5) recent volcanism and tectonics controlled the construction/destruction on the central and western parts of the island, including the development of N150 and N110 linear chains of strombolian cones and caldera forming eruptions.

Persistent magma focusing and faulting along the N110 and N150 main structural directions at different epochs suggest a great influence of regional tectonics, in close relationship with the evolution of the TR.

The volcanic morphology of the intra-caldera Kameni islands, Santorini, based on high resolution bathymetry and LiDAR data

NOMIKOU P.(1), CAREY S.(2), PAPANIKOLAOU D.(1), PYLE D.(3), PARKS M.(3), BELL K.(2), MATHER T.(3), LIVANOS I.(1), BEJELOU K.(1), PERROS I.(1)

(1) University of Athens, ZOGRAPHOU, GREECE ; (2) Graduate School of Oceanography, University of Rhode Island, NARRAGANSETT,, UNITED STATES ; (3) Department of Earth Sciences, University of Oxford, OXFORD, UNITED KINGDOM

The present day landscape of Santorini caldera is the product of a series of major caldera forming eruptions (including the Minoan eruption ~1600 B.C.) and post-Minoan dome-building eruptions, which have gradually built up the intra-caldera Kameni islands. These islands (Nea Kameni and Palea Kameni) represent emerged portions of extended submarine volcanic complexes that rise from 380m b.s.l. In contrast to the well-known geological, petrological and geomorphological evolution of the subaerial portions of the volcanic edifices, the submarine portions of them are surprisingly poorly identified. We present a new high-resolution, digital elevation model (DEM) for the volcanic edifices that form the Kameni Islands based on LiDAR data from the airborne survey carried out in April 2004 and multibeam data with 5m resolution.

The new DEM has enabled us to compile a revised geomorphological map of the Kameni islands, based on the identification and mapping of the main volcanic deposits (both onshore and offshore). This map allow us to: (1) characterize the morphology of submarine volcanic structures and deposits; (2) define the main submarine tectonic structures and relate them to those on land; (3) analyze the relationships between tectonics and volcanism in the Kameni Islands; (4) define the submarine continuation of the historic onshore lava flows.

The merged dataset reveal details of the total surface morphology (from -390m up to +127m) of young dacite lava flows, craters and domes, which in combination with historical accounts and information from previous studies, has enabled the compilation of a new geological map of Kameni islands. The revised map provides insight into the volcanological evolution of the islands, their tectonic features and new estimates for the volumes of extruded material during each of the historic dome buiding eruptions. Finally, the collected data allow us to put constraints on the evaluation of the volcanic hazard inside Santorini caldera.

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Multi scale patterns of aggradation and degradation on persistently active composite cones: the case study of Semeru, Indonesia, mapped and measured from satellite imagery, aerial photographs, and DEMs

THOURET J.C.(1), OEHLER J.F.(2), SOLIKHIN A.(3), GUPTA A.(4), LIEW S.C.(5)

(1) University Blaise Pascal, Laboratoire Magmas et Volcans, CLERMONT-FERRAND, FRANCE ; (2) ALTRAN OUEST Atlantide, BREST, FRANCE ; (3) Center of Volcanology and Geologic Hazard Mitigation, BANDUNG, INDONESIA ; (4) University of Wallongong and CRISP, WALLONGONG, AUSTRALIA ; (5) CRISP National University of Singapore, SINGAPORE, SINGAPORE

Very high sediment yields in the world are derived from erosion on persistently active volcanoes in humid climate. Sediment yields have been evaluated after large eruptions, but not long-term geomorphic response of rivers to disturbances on such volcanoes. We have used high-spatial resolution satellite imagery and DEMs, combined with field-based mapping, to determine sediment budgets for one catchment on the active volcano of Semeru, Indonesia. The measured annual (2007-2011) sediment yield from the Kobokan catchment (109 km^2) is 10^4-$10^5 m^3/km^2$, and that from one of its sub-catchment (Lengkong: 8.25 km^2) is 10^4-10^2 m^3/km^2.Patterns of aggradation and degradation on the Semeru differ from examples for other active volcanoes due to three factors. 1. Pyroclastic flows generate episodic pulses of sediment along with the continuous supply of tephra. 2. Rain-triggered lahars remove huge volumes of material during intense rainfall events and at much higher rates than by fluvial transport. 3. Storage and transfer of sediment develop a cycle of aggradation and degradation that lasts >15 years in river channels after each pyroclastic-flow eruption. Rivers respond to such cycles by creating two different channel forms. Large catchments show voluminous sediment choking long, multi-thread and meandering channels as a long-term characteristic (>10 years). Single-thread, shorter and narrower channels of sub-catchments show faster (<10 years) response with a set of terraces cut into infilling sediment. Sediment yields are two to three orders of magnitude less than those calculated for large eruptions and short-term periods at Pinatubo and Mt. St. Helens. However, persistently active volcanoes in a wet environment are characterized by average sediment yields that remain about ten times (10^3 $t/km^2/yr$) above the ambient values between eruptions. Over a long-term period (≥30 years), persistently active volcanoes supply more sediment than derived from large but infrequent eruptions.

Morpho-structural evolution of an active large-scale slump on the flank of an unstable volcanic island (Pico, Azores)

COSTA A.(1), HILDENBRAND A.(2), MARQUES F.(1), SIBRANT A.(2), CATALÃO J.(1), CATITA C.(1)
(1) University of Lisbon, LISBOA, PORTUGAL ; (2) Université Paris-Sud, ORSAY, FRANCE

The evolution of large-scale slumps on active volcanic islands is marked by a gradual development of normal faults and episodes of volcanism partly filling the resulting depression(s). Here we present the case of an active slump on the SE of Pico Island, Azores. This slump is located on the S flank of an active WNW-ESE volcanic ridge, and is characterized by, at least, three concentric arcuate faults concave towards the sea. These structures propagated progressively towards the SE, and were intercalated in time with several phases of volcanic filling, erupted from vents located in and along the borders of the depressed area.

In this work we investigate the interactions between slump development and volcanic activity, based on high resolution DEM, structural analyses, and high-precision K-Ar dating.

The new data suggest that: (1) the slump activity initiated with the largest fault, first displacing several km^3 of the volcano flank; (2) the slump structure was then filled by volcanic deposits, which fossilized a talus deposit at the base of the scarp; (3) concentric failure occurred along new faults inside the slump area, and towards the sea; (4) the new depression was again filled by lava flows that fossilized the new talus deposit at the base of the main scarp, and cascaded over the scarp newly created.

Four GPS campaigns were conducted between 1999 and 2006, and InSAR data were obtained between 2006 and 2009. The InSAR and GPS data show that the subsidence is faster in the central part of the slump (7-12mm/yr) relatively to the outer part (5-8mm/yr), suggesting the individualization of one of the slump structures, whose sudden collapse could be potentially tsunamigenic.

In order to monitor the activity along the structures of the slump, GPS and microsseismic networks were installed, as well as an inclinometer.

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Poster presentations:

Landslides in the Western Highlands of Cameroon: environmental impact.

NKOUATHIO D.G.(1), KAGOU DONGMO A.(1), ZANGMO TEFOGOUM G.(2), MEWOULOU NDI Y.(1), ABOUBAKAR B.(1), GUEDJO SUH C.(1)
(1) University of Dschang, DSCHANG, CAMEROON ; (2) University of Maroua, MAROUA, CAMEROON

The Western Highlands of Cameroon (WHC) formed a well individualized geographical entity. It lies between 4°5' and 6°5'N, and 9°25' and 11°40'E. This region is intensely fractured, cut in plateaus (1100-1600m), surmounted of volcanoes (Manengouba, 2411m; Bambouto, 2740m; Oku, 3011m) and pierced by collapsed basins (Mbo, 700m; Ndop, 900m). These structures predispose the WHC to mass movement's hazards.

The main characteristic of WHC is the compartments of the relief, often reorganised by erosion. The Mount Bambouto subdivides the highlands into two parts: the highlands of Bamenda-Nkambé and of Bamiléké-Bamoun consisting in plateaus separated by escarpments.

The WHC were a seat of an intense volcanic activity which generated lavic formations and pyroclastic rocks. These volcanic formations induce fertility that becomes an appeal for populations who moreover benefit of the cool and humid climate. The consequence is that the WHC are densely populated (< 200 habitants/km^2) and colonized by man for agricultural and pastoral practices.

This anarchical implantation associated to other factors (relief, hydrography, rainfall (> 1700mm) and anthropic factors) are creative of mass movements. A trigger factor is sufficient to provoke the avalanche. This factor can be an upsurge of rains, inadequate shearing of banks or flanks of hills or a light earthquake. The most recurrent mass movements in WHC are landslides. When it occurs the damages recorded are mainly:

- Losses of human lives and livestock,
- Destruction of plantations and communication way,
- Reduction of cultivated surface and destruction of pasture and vegetation.

Identification and analysis of the risk factors are of paramount importance to any planning project in these regions in order to reduce the effects of landslides. We propose zonation hazards maps in some exposed regions in order to circumscribe the dangerous areas. This study can stand as model for African highlands submitted to subequatorial monsoon climate.

Pyroclastic desnsity current and lahar deposits at Merapi, Indonesia, identified and measured with GeoEye and Pléïades imagery

THOURET J.(1), GUPTA A.(2), LIEW S.C.(3), KASSOUK Z.(1), OEHLER J.F.(4), SOLIKHIN A.(5)
(1) University Blaise Pascal, Laboratoire Magmas et Volcans, CLERMONT-FERRAND, FRANCE ; (2) University of Wallongong and CRISP, WALLONGONG, AUSTRALIA ; (3) CRISP National University of Singapore, SINGAPORE, SINGAPORE ; (4) ALTRAN OUEST Atlantide, BREST, FRANCE ; (5) Center of Volcanology and Geologic Hazard Mitigation, BANDUNG, INDONESIA

Very high-spatial resolution imagery enable us to identify pyroclastic and lahar deposits around erupting volcanoes. We have identified and mapped the extent and effects of the pyroclastic density current (PDC) and lahar deposits at the end of the 2010 eruption of Merapi volcano, its largest (VEI4) over the past 140 years, using two 50 cm GeoEye and Pléïades images. We determined remotely sensed textural indices and automatic classifications with DEMs, field-based D-GPS and thicknesses of the deposits, all embedded in a GIS.Detailed geologic map of the Gendol and Opak River catchment on the south flank of Merapi shows the effects of PDCs, including the longest (17 km) block-and-ash flow and widespread (20 x 4 km) pyroclastic-surge deposits and subsequent lahar activity The erupted deposits cover an area of about 50 $km^{2;}$ on the south flank. The volume of PDC deposits ranges between 40 and 50 million m^3, 35 to 40% of the volume of 2010 Merapi PDCs and tephra deposits. The GeoEye image enables us to identify: (1) several channel-confined and unconfined pyroclastic-flow deposits on the basis of textures and origins and large-scale surges that devastated the upper catchment, separated from ash-cloud surges that singed the forest along the valley edges; (2) Over-bank pyroclastic flows caused by anthropogenic structures and the sinuous, former valley channel, and lahars due to the mixture of pyroclastic material with water and paddy field sediment; (3) Lobes and tree logs on top of the pyroclastic flows and damaged houses in the over-bank lobes and in surge-hit edges of the valley. Geomorphic changes to the Merapi summit and vent area following the eruption were reviewed with a 2011 GeoEye image. The summit vent area was reduced by about 0.1 km^3 and stubby dome lava flows were isolated by a rectangular-shaped vent 400x300x75 m. A 1.2 km long and 200 m-wide scar was re-excavated and PDCs have scoured furrows on summit lava flows and gullies in thick tephra deposits.

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Mud volcanoes of Azerbaijan as the relief unite: natural phenomenon and hazard

RASHIDOV T.
Geology Institute of Azerbaijan National Academy of Sciences, BAKU, AZERBAIJAN

Mud volcanoes are the unique natural phenomenon representing more or less large elevations, often of plane-conical shape, rising for 400 m and more over the country. The base diameter is from 100 m to 3-4 km and more. Like the magmatic ones, the mud volcanoes are crowned with crater of convex-plane or deeply-seated shape. In comparison with magmatic volcanoes this type has restricted distribution in global scale; they basically locate within the Alpine-Himalayan, Pacific, Central Asian mobile belts.

Azerbaijan is the classic region of mud volcanoes development. From over 800 world mud volcanoes there are about 400 onshore and within the South-Caspian basin. There are all types of mud volcanic manifestations: active, extinct, buried, submarine, island, abundantly oil seeping. According to their morphology there are cone-shaped, dome-shaped, ridge-shaped, plateau-shaped. The crater shapes are also various: conical, convex-plane, shield-shaped, deeply-seated, caldera-like. The most complete morphological classification was given in “Atlas of mud volcanoes of Azerbaijan” (Yakubov et al., 1971). Recently (Aliyev Ad. et al., 2003) it was proposed a quite new morphological classification of mud volcanoes of Azerbaijan. For the first time the mud volcanic manifestations had been defined. Volcanoes are ranged according to morphological signs, crater shape and type of activity.

At the same time mud volcanoes represent a specific hazard. In Azerbaijan the majority locates far from the localities. But those locating close by the settlements bear the hazard during the eruption: gas burning, outburst of mud volcanic breccia, i.e. the hard fragments of rocks that can damage the nearby buildings, great volume of mud that cover the adjacent territory with thick mud layer. There are historical records when mud volcano eruption caused the human victims. At the same time the submarine volcanoes also represent hazard for drilling wells, rigs and other offshore infrastructure.

Long-runout volcaniclastic sediments from Asama volcano due to the catastrophic sector-collapse in the Pleistocene, Japan

YOSHIDA H.
Meiji University, TOKYO, JAPAN

This paper introduces the long-runout debris observed in the northwestern Kanto Plain from Asama volcano, Japan. The stratum observable there, with a thickness of 10-20 m, is named as the “Maebashi Mudflow deposits” conventionally. The most conspicuous characteristic of the mass transport is that their runout distance is ca. 100 km along the drainage system. Therefore, it is worth of attention from the viewpoint of catastrophic natural hazard. However, there is no consistent view about the transport mechanism of the “Maebashi Mudflow”, although the author has once investigated the deposits as a debris avalanche. Thick deposits with non-bedded and non-sorted facies are exposed. Additionally, the deposits consist of block boulders and gravels with muddy matrix. The deposit is divided into block facies (unmixed) and matrix facies (mixed). Such blocks consist of a single rock type of layers of airfall tephra, pyroclastic flows, lahars, and the others. Among these blocks, some seem to have formed part of the former volcanic cone. They are small, but were possibly transported gently in the debris avalanche mode and deposited relatively intact. Such facies and distribution show that the “Maebashi Mudflow” were partly debris avalanche even though its runout distance was surprisingly large. More detailed analysis of sedimentary facies will make out its true image.

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The Degradation Of Recent Volcanic Landscapes Associated To The passage Of People. The Example Of Canary Islands, Spain

ROMERO RUIZ C.(1), GUILLÉN-MARTÍN C.(2), DÓNIZ-PÁEZ J.(1), SÁNCHEZ-JIMÉNEZ N.(3), ROBERT A.(4)
(1) Universidad de La Laguna, LA LAGUNA - TENERIFE, SPAIN ; (2) Instituto Volcanológico de Canarias (INVOLCAN), PUERTO DE LA CRUZ - TENERIFE, SPAIN ; (3) Spanish Geological Survey (IGME), LAS PALMAS DE GRAN CANARIA, SPAIN ; (4) Département de Sciences Humaines et Sociales, Université de La Rochelle, LA ROCHELLE, FRANCE

The Canary Islands constitutes a natural space of great geological and geomorphological complexity due to several factors as the wide variety of eruptive processes associated to the basaltic volcanism and to the emitted products. The very recent volcanic areas without dense vegetation cover are extremely fragile territories.

This research has as a main goal the establishment and analysis of the landscape impact due to the uncontrolled ongoing massive influx of visitors to the recent volcanic landscapes. To do so, different degrees of fragility have been investigated taking into account the main characteristics of land elements at these spaces.

The assessment of the impact level of hikers activity has been established as a function of several factors: 1) fragility of the element exposed depending on the type of volcanic material affected (pyroclastics and lavas), specific features of these materials, morphology and age of formations, 2) degree of geodiversity, 3) slope, 4) frequency of use, 5) visual impact, 6) lost of outstanding geomorphological or geological elements, 7) irreversibility of alterations and 8) bioindicators of the degradation process (e.g. lichen coating).

Geomorphic Degrasdation of Volcanic Cinder Cones in Different Climatic Zones

INBAR M.
Department of Geography, University of Haifa, HAIFA, ISRAEL

The evolution of landscape over time is a central aspect of geological, paleogeographical and geomorphological studies. Cinder cones are the simplest and most common volcanic landforms in existence. It is probably the only landform on the globe with a distinct and defined initial date of formation, and lasting no more than a few million years. The progressive decrease of morphometric parameters with increasing of age is the basis for relative dating of cinder cones. Morphometric and morphological studies are efficient tools for determining ages of cinder cones and their morphological evolution.

There is no comprehensive inventory of the cones in the globe, but my estimation is about fifty thousand, around four thousand in Mexico, and five thousand in Kamchatka.The aim of this study is to analyze erosional processes affecting the degradation of the cinder cones under different climatic conditions.

Global examples: Degradation values for the Kamchatka peninsula are higher than for semiarid areas in the Southern Andes or the Golan Heights. Peaks of erosion occurred probably in the first stage of one or two years after the eruption, with the stripping of the fine ash material. The study on about 800 cones of the Payun Matru Volcanic Field in the Southern Andes (Mendoza, Argentina) showed a good correlation between the old cones with a low ratio of height/diameter of cone and the more recent of Holocene times with a high ratio. Morphometric values of the 1988 erupted Navidad cone, close to the Lonquimay volcano in Chile, are similar to those of recent erupted cones. Erosional processes on monogenetic volcanism determine their morphometric characteristics according to their climatic environment.

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Quaternary evolution of the waste mantle of the central volcanic Armenian highland

BALYAN H.
Yerevan State University, YEREVAN, ARMENIA

Post-Pliocene period is characterized by often changes of the geomorphologic and landscape climate conditions of the Armenian highland. Thus, because of that development, strong miopliocenic hypergenic waste mantle on effusive was denudated and formed into different types of plain formations. Space development and genetic ties of ancient waste mantle is highly revealed in different aged moraines of quaternary glaciations of the alpine and subalpine zones of the volcanic massive of Aragats, Gegham highland, etc. Along with the young orthoeluvium formed in the alpine climate conditions, there are also spots of clay metasomatists survived the exaration which consist of hydromicas, baidelite, koalinite and partially geolite. These are fragments of the Pliocene waste mantle on acid effusive, formed in conditions of mild and moisture climate. The main mass of ancient waste mantle is caught by moraine of mountain cover glaciations, occupying top plateaus. Moraines are complicated by weathering fragments of acid effusive, full of ferrum hydroxide. There are kaolin lenses in loam filling of moraine. Compared to above-mentioned, wurm moraines are to trough only which are cut into andesite-basalts. They have fresh look and have relatively monogenetic content. On thee slopes and pre-mountain of massive there are correlative ties of different aged moraines with lake-fluvial facies. This gives a chance for more careful palaeogeographical study of the issues of the post-pliocene history of the relief and landscape of volcanic highland.

Geomorphic impacts and socioeconomic consequences of rain-triggered lahars at Merapi volcano (Java, Indonesia) following the 2010 eruption

DE BELIZAL E.(1), LAVIGNE F.(2)
(1) Universite Paris Est Creteil - CNRS UMR 8591 Laboratoire de Geographie Physique, MEUDON, FRANCE ; (2) Paris 1 Panthéon-Sorbonne - CNRS UMR 8591 Laboratoire de Géographie Physique, PARIS, FRANCE

Lahars on Merapi volcano are a common phenomenon, as they remobilize the pyroclastic deposits of the frequent eruptions of the volcano. The 2010 VEI 4 eruption of Merapi volcano deposited about ten times the volume of pyroclastic materials of 1994 and 2006 dome-collapse eruptions. Although the eruptive phase is over, another threat endangers local communities: rain-triggered lahars. The aims of this communication are to study the post-eruptive lahar-related impacts at Merapi after a major eruption. The results were acquired through a methodology mixing field measures, remote sensing, laboratory analyses, and secondary data obtained from local administrations.

First, the high frequency of lahars and the broad distribution of affected drainages will be exposed: 240 events have been reported from October 2010 to May 2011 on 17 rivers, with runout distance exceeding 20 km. Second, the geomorphic impacts of the lahars (avulsions, river bank erosion, channel widening, riverbed downcutting, volume and sedimentological characteristics of the deposits) will be explained, with emphasis on the distal slope of the volcano which has been spared by large-scale lahars for about 40 years. Those geomorphic processes cause important damages which will be presented; the socioeconomic losses (more than 3000 affected people, 860 destroyed houses…) will also be detailed. Eventually, the risk management strategies developed by the NGOs, the local stakeholders and the communities living near the rivers on hazard-prone areas will be discussed.

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Construction and destruction rates of volcanoes constrained from a DEM-based geomorphological reconstruction

LAHITTE P.(1), GERMA CHARBONNIER A.(2), LAVIGNE F.(3)
(1) Univ. Paris-Sud, Laboratoire IDES, UMR 8148, ORSAY, FRANCE ; (2) Univ. Of South Florida, Department of Geology, TAMPA, FLORIDA, UNITED STATES ; (3) Univ. Paris 1 Sorbonne, Campus Bellevue, MEUDON, FRANCE

Determining growth and dismantling rates of a given volcano is critical to understand timing of its eruptive processes, to identify any possible periodicity of volcanic episodes, and, to a broader extent, define global impact of some major eruptions. Our DEM-based numerical reconstructions intend to model quantitative paleo-topography of landforms showing the geomorphological evolution of volcanoes. Based on the analysis of DEM cells dataset, each key-stage reconstruction allows us to define either a volcanic constructional event or a destructive one by caldera and/or flank collapses and long-term erosion and the correlated geochronological map. Primary volcanic landforms are modelled from the current DEM cells extracted as representative of the resultant remnant surfaces of each evolution stages. Because primary volcanic surfaces resulted from different settings and periods of construction and/or denudation, we define for each of them the optimal set of parameters that best model these surfaces by a specific least square method. We then correlate the modelled surfaces with the entire massif history by taking into account the evolution of the previous stages by erosion, caldera and flank collapse processes. Finally calculation of volumes involved in both volcanic construction stages and erosion/dismantling ones allows us to assess relief evolution rates. Such morphometric investigation is here applied to preserved enough edifices: Conil–Pelée volcano, the youngest volcanic complex (< 0.5 Ma) of Martinique Island, and to the Holocene Rinjani Volcanic Complex (Indonesia) that experienced a global climate impacting eruption with caldera collapse during historic period. The rather good preservation of remnant landforms and the high temporal resolution available allow us to discriminate from their volcanic history up to ten evolution stages though time, and to accurately quantify the volume variations involved by the main constructive or destructive events.

Lahar characteristics and erosion in the Gendol catchment after the centennial 2010 Merapi eruption

HADMOKO D.S.(1), THOURET J.C.(2), SOLIKHIN A.(2), WIBOWO S.B.(3), WACANO D.(1), KIKY P.(1)
*(1) Faculty of Geography, Universitas Gadjah Mada, YOGYAKARTA, INDONESIA ; (2) PRES Clermont, Université Blaise Pascal, Laboratoire Magmas et Volcans et ClerVolc, 5 rue Kessler, 63038 Clermont-Ferrand, France ** ANR Laharisk project, CLERMONT FERRAND, FRANCE ; (3) Institut de Géographie. Université Paris 1 Panthéon-Sorbonne, 191, rue Saint-Jacques 75005 Paris, France, PARIS, FRANCE*

Lahars are the most destructive volcanic phenomena with pyroclastic density currents but they can propagate much farther. Lahars are complex flows that can be triggered during and after, or without eruptions. Our experimental method aims to measure hydraulic and physical characteristics of lahars in river channels on active volcanoes. The method encompasses: (1) hydraulic and geophysical in situ measurements of flows with sensors located at the valley bottom and on the edges, (2) high-resolution DEMs of the valley channel before and after a lahar, aiming at measuring the processes of aggradation and degradation in a catchment and bulking/debulking in flows, (3) remote sensing analysis of erosion processes on aprons of pyroclastic deposits and remobilization by lahars and fluvial transport.
We use two experimental stations located on 2 check dams c.250 m apart for in situ measurements along the middle course of the Gendol River on the south flank of Merapi. This valley was heavily impacted by PDCs during the 2010 eruption. The stations include 2 seismometers, 2 geophones, 2 load cells, 2 pore pressure sensors, 1 radar gauge, 2 rain gauges, 1 barometer and 4 cameras. We measure discharge, sediment concentration, arrival and surface velocities, and dynamics features at the flow surface. The sediment concentration is measured using direct buckets in the lower station every 5 minutes during the flow. The data analysis helps to compute the volumes of transported sediment, understand the flow dynamics, the processes of entrainment, and the rheology of the lahar material. From the stations we measure the time-related propagation of the flows down valley and the process of erosion / sedimentation through the DEM of the channel before and after lahars. The final goal is to calibrate the input parameters of two numerical models (Titan2D, VolcFlow) used in volcanic hazard studies.
Keywords: lahar, hydraulic characteristics, experimental measurements, flow dynamics, bulking, DEM.

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Lahar flow caracteristics on Putih River during 2012-2013 rainy season after centennial eruption of Merapi

WIBOWO S.B.(1), MOUROT P.(2), LAVIGNE F.(3), HADMOKO D.S.(4)
(1) Université Paris 1 Panthéon-Sorbonne, PARIS, FRANCE ; (2) Myotis S.A.S, ECHIROLLES, FRANCE ; (3) Laboratoire de Géographie Physique, MEUDON, FRANCE ; (4) Research Center for Disaster, YOGYAKARTA, INDONESIA

Three years after centennial eruption of Merapi volcano, rainfall-induced lahars still flow on Putih River. The first lahar flow in 2012-2013 rainy season occurred on 25 December 2012. The objectives of this study are to (1) compare lahar characteristics (arrival times, magnitude, flow turbulence) on upstream and downstream; and (2) to analyse lahar composition and material size distribution. We installe two stations consisted of 2 seismometers and 2 videos. Each seismometer are connected to 2 geophones 70 m apart. The upstream station is installed beside the new constructed check dam PU-D5 in Jurang Jero area (888 m asl; 7,1 km as the crow flies from summit) and the downstream station is located nearby check dam in Plosogede village (248 m asl). River length between these two stations is 16.51 km. Daily fieldwork is also conducted to measure water content in upstream channel bottom before event, take direct bucket sampling during the lahars and fresh deposit samples after its occurrence. We use handy talky communication to update very recent lahar flow information from local communities including occurrence, approximate velocity, as well as stage and width fluctuation between these two stations. Until 2 January 2013, 4 rainfall-triggered lahars have been recorded with 3 m maximum height, 30 m maximum width, 1 hour duration and velocities of 3-4 m/s (upstream) and 2.5-3 m/s (downstream). There was only one lahar which could reach downstream station. Lahar behaviors were different within each occurrence due to its magnitude, infiltration rate and previous water content of river bed, morphology of the channel as well as lahar materials.
Keywords: lahars, putih river, seismometer, video, infiltration.

The morphology of the Chaîne des Puys and Limagne Fault: a Linked Volcanic and Tectonic landscape

VAN WYK DE VRIES B.(1), KERVYN M.(2), DELCAMP A.(2), MOSSOUX S.(2), LAGMAY M.(3), GROSSE P.(4)
(1) Laboratoire Magmas et Volcans, CLERMONT-FERRAND, FRANCE ; (2) Vrije Universiteit Brussel, BRUSSELS, BELGIUM ; (3) NIGS University of the Philippines, QUEZON CITY, PHILIPPINES ; (4) CONICET & Fundación Miguel Lillo, TUCUMAN, ARGENTINA

The Chaîne de Puys stands as an 80 monogenetic volcano-long alignment, parallel to the Limagne Fault in Central France. The volcanoes stand on the elevated footwall of the fault. While both the Fault and Volcanoes have a general North-South orientation, smaller segments of fault and volcano alignments have a distinct NNE-SSW trend. The Limagne Rift initiated in the Eocene, but the structure may be a reactivated Hercynian structure related to large-scale strike-slip movements at the end of that orogeny. Some of the older lavas originating from the Tertiary volcanoes that erupted from the Chaîne de Puys site, have clearly been cut by the Limagne faults, while the more recent ones show little, if any tectonic effect. In addition, erosion along the fault scarp during the Quaternary uplift has resulted in relief inversion, with older lavas forming the plateaux and younger ones the valley bases. The southern part of the Fault and Chaîne are the least eroded, and the fault is less clearly expressed in this area over a wide set of down faulted blocks. Further north, the fault escarpment narrows, erosion increases and the Rift margin becomes far more pronounced. In this area NNE-SSW deep valleys are associated with fractures and mylonite zones, and the streams show increased nickpoints that may indicated more recent structural movement. It is in this area, that the volcanoes are most clearly aligned with basement structures, and that structures are preserved in the volcanoes to suggest contemporaneous tectonic activity. Thus, it appears that tectonics and magmatic activity are strongly linked and that both are guided by a Hercynian tectonic inheritance. Any renewal of tectonic activity in the area may link to a resumption of magmatic activity, and lava flows, will probably be channelled down the deep fault-scarp valleys to the populated urban areas at the fault scarp foot.

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Volcanic features of the central part of the Chaîne des Puys (Massif Central, France) revealed from the morphoquantitative analysis of a high resolution LiDAR-derived Digital Terrain Model

LABAZUY P.(1), VAN WYK DE VRIES B.(1), BOIVIN P.(1), MIALLIER D.(2)
(1) Laboratoire Magmas et Volcans, Université Blaise Pascal-CNRS-IRD, CLERMONT-FERRAND, FRANCE ; (2) Laboratoire de Physique Corpusculaire, Université Blaise Pascal-CNRS-IN2P3, CLERMONT-FERRAND, FRANCE

High resolution LIDAR-derived digital terrain models (DTMs) of volcanic areas permit to highlight subtle topographic features that can significantly improve the understanding of the morphology, the structure and the behavior of volcanoes during and after their formation. Here, we present an application focused on the central part of the Chaîne des Puys (Massif Central, France), a classic volcanic alignment of monogenetic volcanoes. The volcanic chain is located on the uplifted footwall block of the Limagne fault, near Clermont-Ferrand.This study has been done in the framework of a UNESCO world heritage proposal and it aimed at revealing the main topographic features of the studied area to understand the link between volcanism, faulting and tectonics. The main topographic dataset used is a 0.5-m resolution DTM with an average altimetric and planimetric precision better than 10cm, obtained from airborne LiDAR survey made in March 2011.

The monogenetic volcanoes of the Chaîne des Puys form an overall NS trend, showing distinct NE-SW elongations, and local NNE-SSW alignments. Basement fractures are predominantly NE and NNE-SSW orientated with minor EW and NS components. Using the high-resolution topographic data set we investigated the complex relationships between the constructions processes of the volcanoes and the structure of the basement of the central part of the Chaîne des Puys. Therefore, the quantitative morphometric analysis of the LiDAR-derived DTM makes it possible constrain the evolution of the Puy de Dôme volcano, a large trachytic dome of kilometric size and its relationships with surrounding small scoria cones and domes and inferred hidden intrusive features.

The SEDIMER Project: Sediment-related Risks and Disasters following the 2010 eruption of Merapi Volcano, Indonesia

LAVIGNE F.
Panthéon-Sorbonne University, Laboratory of Physical Geography, MEUDON, FRANCE

The 2010 Merapi eruption has demonstrated that downstream areas can be impacted quickly and with economically devastating consequences by lahars and flooding in response to extreme sediment loading of watersheds by ashfall and pyroclastic flows. Funded by the AXA Research Fund, the SEDIMER Project (2012-2015) proposes a collaborative study gathering experienced international experts and young scientists from seven countries including Indonesia to determine what happened in 2010 and what is likely to happen in the next three years in the valleys downstream of Mt Merapi. We plan to complete a database on lahar occurrence and related disasters, to identify the sediment sources, to study the lahar dynamics and geomorphic impacts with implications for risk prevention. We will calculate the economic impacts caused by lahars and assess risk perception among local residents. This multi-disciplinary study will rely on a combination of innovative methods using high-tech instrumentation: optical and high-resolution radar remote sensing; hydrological monitoring based on various seismic and acoustic sensors, video footage of lahars in motion including nocturnal recording by infrared cameras; up-to-date modeling techniques; an innovative protocol for studying lahar depositional processes; and widespread surveys among risk managers and residents. In the shorter term, a better understanding of what is currently happening in the rivers downstream of the Merapi volcano can inform public policy with respect to rebuilding or relocating some villages and other facilities. In the longer term, the evidence gained can guide land-use and emergency-response planning in the vicinity of this volcano but also in other similar settings where sedimentation hazards during and following future eruptions are significant. The SEDIMER Interdisciplinary project will contribute to strengthening links between international networks working on lahars, regional networks of scientists from various institutions, field operatives, and populations at risk.

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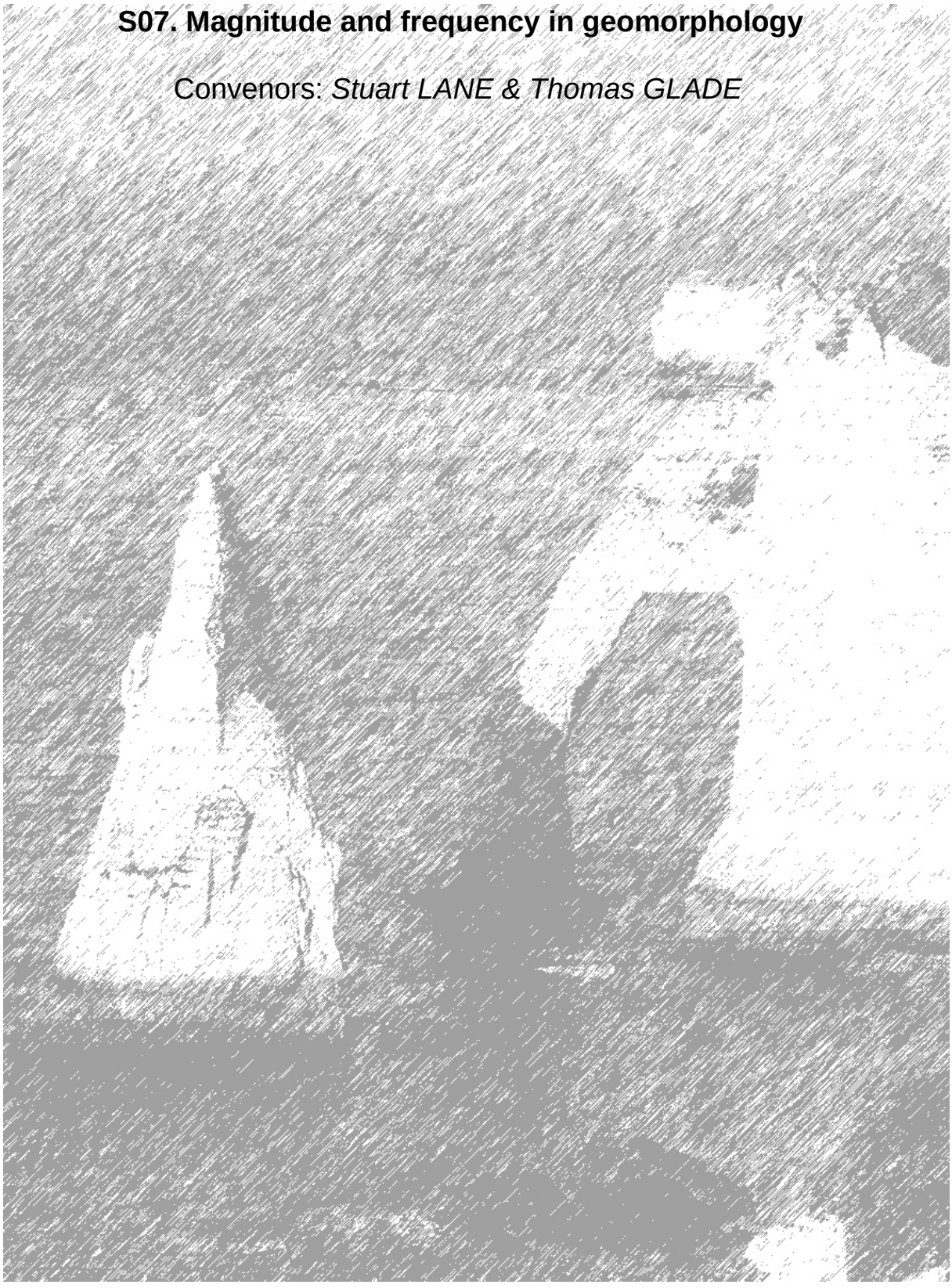
S07. Magnitude and frequency in geomorphology

Convenors: *Stuart LANE & Thomas GLADE*



Oral presentations:

Magnitude and frequency in geomorphology on changes and choices

KORUP O.
University of Potsdam, POTSDAM, GERMANY

The steadily growing number of field and remote sensing data continues to underscore systematic inverse relationships between the magnitude and frequency of Earth surface processes, based on metrics such as mass-wasting volume, flood discharge, wildfire size, turbidite thickness, or sediment yield. Such frequency-magnitude relationships have turned out to be a useful tool, if not paradigm, for assessing the geomorphic efficacy of a given process, while serving as a quantitative basis for assessing concomitant natural hazards.

In the light of contemporary global warming and environmental change, however, current research interest has shifted towards quantifying potential changes to frequency-magnitude relationships in order to predict future consequences and regime shifts in Earth surface processes. This research focus raises a number of issues that have been partly disregarded in previous work mostly for reasons of mathematical convenience. Here I encapsulate and discuss some of these issues and highlight potential avenues of future research.

The most pertinent issues include (1) statistical means to distinguish reliably different frequency-magnitude relationships with a view towards the question of their particularity vs. universality; (2) the pitfall of confusing frequency with abundance; and (3) adequate choice of model fit, which eventually dictates our capability of meaningfully detecting changes to frequency-magnitude curves brought about by external changes. I outline possible solution pathways to resolving these issues by presenting several current examples from natural hazards research.

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Human-induced changes in geomorphic process rates: Can we gain new insights when analysing magnitude-frequency distributions?

VANACKER V.(1), BELLIN N.(1), KUBIK P.W.(2)
(1) University of Louvain, LOUVAIN-LA-NEUVE, BELGIUM ; (2) Lab for Ion Beam Physics, ETH Zurich, ZURICH, SWITZERLAND

Very few, if any, geomorphic systems remain unaffected by human disturbances. An increasing number of quantitative studies are now available that show clear evidence of rapid acceleration of erosion as a response to human impact. While looking at overall changes in geomorphic process rates, most studies make abstraction of complex response and thresholds that may exist in geomorphic systems. Can we gain new insights on human-induced changes in geomorphic processes by analyzing magnitude-frequency distributions of geomorphic process rates ?

In this paper, we explore this idea by analyzing temporal changes in erosion rate-frequency distributions for two mountainous sites with very different human history: (1) the tropical Andes with a rapid conversion of native forests and grasslands to agriculture, and (2) the Spanish Betic Cordillera characterized by a long human occupation and recent abandonment of traditional mountain agriculture. Pre-disturbance erosion rates are derived from in-situ produced ^{10}Be concentrations in river sediment, and post-disturbance erosion rates are estimated from checkdam infillings. The erosion rate-frequency distribution then captures the spatial variation of erosion rates for a given location and disturbance level.

Our data show that overall shifts in erosion rates are largely controlled by the intensity of human disturbances. Furthermore, they also indicate that the local context matters as geomorphic response to human impact depends on the history and location of human disturbances. When including information on shifts in erosion rate-frequency distributions as a response to human disturbance, we can better grip the variety of potential response trajectories of geomorphic systems.

Event based magnitude/frequency analysis in geomorphology

GARES P.(1), SWANN C.(2), HILL S.(3)
(1) East Carolina University, GREENVILLE, NC, UNITED STATES ; (2) Texas A & M Univeristy, COLLEGE STATION TX, UNITED STATES ; (3) National Atmospheric and Oceanic Administration, NEW ORLEANS, UNITED STATES

Understanding landscape evolution has been a traditional goal of geomorphology. At the same time, process geomorphologists have focused on establishing a scientific approach to understanding landscape change that often relies on reductionist analyses of geomorphic dynamics. Although these efforts have produced significant advances in earth system dynamics, it has been difficult to establish connections between micro-scale process studies and meso/macro-scale landscape changes. Geomorphologists often return to a field site to discover major changes in an intervening time period. Explanations for the changes often focus on large events that can be identified in the scientific record. Recognizing that events differ in size and frequency, Wolman and Miller became proponents of magnitude/frequency analysis that is widely used in fluvial geomorphology where extreme discharges are used to determine flooding probabilities. Using the single measure of peak annual discharge may not accurately represent the amount of work that the river system does. Geomorphologists are interested in all events capable of producing landform changes. Time is an essential component of geomorphologic magnitude/frequency analysis because, for events of equal magnitude, longer lasting events should produce more change than shorter ones. Although Wolman and Miller consider the overall geomorphic work done by events of different magnitude, event duration is not included in their analysis. To examine the combined effects of magnitude and duration, we examine aeolian and coastal storm events. We provide details about the methodologies used to determine event energies and the magnitude/frequency analysis employed to classify the events. Whereas there are sufficient data to facilitate the analysis of event energy, data about landform response to the events are limited. We illustrate how the response could be related to the process data and discuss potential problems associated with this analysis.

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The concept of frequency-magnitude relationship versus system dynamics in mountain catchments

KEILER M.(1), FUCHS S.(2)
(1) Institute of Geography, University of Bern, BERN, SWITZERLAND ; (2) University of Natural Resources and Life Sciences, VIENNA, AUSTRIA

Torrent processes pose a threat to elements at risk exposed. In order to assess the hazardousness of such phenomena, firstly information on the probability of occurrence of the process is necessary, usually with respect to a defined design event. Secondly, this design event is characterised by a certain process magnitude. As a consequence, frequency-magnitude relationships are developed and used for hazard assessment and the subsequent management options considering natural hazard risk.

Traditional approaches are based on discrete hydrological events and a magnitude by measures of volume or mass of water and sediment associated with those events. They assume a direct relationship between the hydrological processes and the geomorphic response, such as the capacity of the water body to entrain and transport a certain amount of sediment in dependence of the shear stress and the grain size. However, such an assumption cannot be made considering torrent processes as once a major event has occurred in a catchment; time is required before sufficient material available for further events can accumulate. With respect to torrent events, internal system dynamics are responsible for a major limitation of frequency-magnitude relationships. Moreover, the relation between the trigger of torrent processes (e.g., precipitation intensity) and the system response of the catchment is nonlinear, therefore, even if empirical relationships propose a certain statistic relation they do not mirror the different system behaviour accordingly.

By analysing system loading and response scenarios, the challenge of system dynamics is treated in this paper and alternative concepts to express the frequency and magnitude of torrent processes are discussed. It is argued that such an approach can contribute to the discussion on an enhanced hazard assessment procedure which is targeted under the umbrella of the risk concept at a sustainable use of mountain environments for human settlement.

Magnitude and frequency scenarios for a changing alpine environment

MANI P.(1), LIENER S.(1), TOBLER D.(2), HAEHLEN N.(3)
(1) geo7 AG, geoscientists, BERN, SWITZERLAND ; (2) GEOTEST AG, ZOLLIKOFEN, SWITZERLAND ; (3) Civil Engineering Office Canton of Bern, THUN, SWITZERLAND

In recent decades, large natural disasters have become more frequent in the Swiss Alps. Landforms such as debris flow cones and alluvial fans indicate that comparable events occurred in the past, however, for many areas, there are no historical records of such events available. It is likely that the higher temperatures and more intense rainfall associated with climate change contribute to this amplification.

For predictive natural hazard assessment and protective measure planning, effects due to climate change must be taken into account. In this regard, we present a new periglacial hazard index map for the Bernese Oberland based on hydro-meteorological scenarios. The used scenarios are derived from the new climate change scenarios for Switzerland (CH2011 (2011)). To evaluate changes in magnitude and frequency of natural disasters, we analyse the influence of these scenarios on various process chains. Changes in process chains are mainly due to glacier retreat, permafrost degradation, rise in snowline altitude, and increased duration and intensity of rainfall. The scenarios cover both mean and extreme values, which is particularly important for precipitation. Our scenarios also cover expected changes in variability. In this paper, we present our methods to derive the scenarios as well as first results.

CH2011 (2011), Swiss Climate Change Scenarios CH2011. C2SM, MeteoSwiss, ETH, NCCR Climate and OcCC, Zurich

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Flood Reconstruction and Implications for Magnitude-Frequency

CROKE J.(1), THOMPSON C.(1), PIETSCH T.(1), SHARMA A.(2)
(1) Australian Rivers Institute, BRISBANE, AUSTRALIA ; (2) DISiTA, BRSIBANE, AUSTRALIA

Twenty-two lives were lost in the Lockyer Creek floods in southeast Queensland (SEQ), Australia in the summer of 2011. The predicted recurrence interval for this event in the upper catchment was 1 in 1000 yrs. Flood predictions in these systems are, however, based on relatively short river discharge records (median 38). Given Australia's hydrologically-variable climate, understanding the frequency and magnitude of extreme events is important for regional planning.Immediately following the Lockyer event in January 2011, detailed stratigraphic and sampling for optically stimulated luminescence (OSL) dating sampling was undertaken in order to investigate magnitude-frequency relationships for extreme events in the catchment. Lockyer Creek is a laterally stable, non-migrating channel with well developed floodplains and levees. Samples were taken from both bedrock and alluvial reaches and from within the main channel in within-channel benches. This talk explores the process of statistically representing over 100 OSL dates from the catchment. Two methods were trialled, including Bayesian modelling, to extrapolate the timing of flood events to infer some evidence of changing magnitude. The results highlight the complexity of the task and the importance of emerging concepts such as nonlinearity in fluvial systems.

Landslide frequency-area distribution in the region north of Lisbon (Portugal)

GARCIA R.A.C., OLIVEIRA S.C., ZEZERE J.L.
Centre for Geographical Studies, University of Lisbon (CEG-UL), LISBOA, PORTUGAL

This work is focused in the assessment of landslide magnitude and has two main objectives: (i) to compare and adjust the frequency-density distribution to a three parameters inverse gamma function; (ii) to establish a probability-magnitude curve for the north of Lisbon region to be used in landslide hazard analysis.

Field work and aerial photo interpretation allow identifying 2.104 landslides in an area of 319 square kilometers. The same methodological approach is applied to 3 different landslide data sets: (i) total landslides; (ii) shallow landslides (#1178); and deep landslides (#926).

Assuming that landslide area can be use as proxy of landslide magnitude, the probability-density function can be the support to achieve the probability of occurrence of landslides with a given magnitude. Additionally, it is possible to adjust this distribution to a three parameter inverse gamma distribution, as proposed for Malamud *et al.* (2004), as the best for characterize general landslide distributions.

Previous results reveal that frequency-density curves applied to total landslides in north of Lisbon region show a similar distribution to general curves obtained by Malamud *et al.* (2004). These distributions were marked by a power-law decay for medium and large landslides and an inflection of this tendency (rollover) on small landslides. The inflection location indicates the maximum probability distribution.

However, despite the similarity of the distribution pattern, the location of the inflection seems to be shifted to landslides with lower magnitude (area) when compared with the abovementioned general curves. Furthermore the exponential decay of smaller landslides is not as significant as the reference distributions. These differences are probably due to the importance of shallow landslides in the total inventory (67%) that is associated with the field work inventory, which allowed to identify small landslides that cannot be identified using aerial photo interpretation.

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Poster presentations:

Clusters of heavy rains at orographic barriers-geomorphic effects

STARKEL L.
Institute of Geography PAS, KRAKOW, POLAND

Edges of mountains form the barriers for invading air masses or only provoke the formation of convective clouds. From hydrogeomorphic point of view very important is not only total rainfall and its intensity but also clusterings in several months or years. The particular forms or their complexes may proceed total transformation, change a trend of evolution or opposite, restore its previous shape. As examples may serve barriers of various hight in different climatic zones. The southern edge of Meghalaya Plateau rising nearly to 2000 m is getting 10-15 000 mm rain yearly and notes every summer about 37 days with above 1000 mm and 6-7 days with 300-800 mm. There are clusters above 2000 mm in one week. Intensities reaching several mm/min are restricted to small areas. These flash floods are connected with convectional clouds and are responsible for washing upto bare rock. The highest global barrier of Himalaya is blocking air masses. Every year are registered downpours at the very edge of mountains 1500-2000 m high. Those downpours upto 400-500 mm cause flash floods in small catchments, debris flows and upbuilding of torrential fans. In 1990-ties were recorded several clusters of continuous rains of cyclonic origin (2-4 days long with total rain upto 1000 mm). The cyclones enter deeper in the mountains very rare. On the northern slope of Carpathians with prevailing western winds there are two scarps exposed to N-NW. Therefore the role of barriers is restricted. The higher one (300-800 mm) at the margin of higher ridges blocked air masses four times in summer 2010, causing heavy floods and clustering of rainfall (totally 600-800 mm) is leading to deep infiltration and formation of landslides. The scarp of Carpathian Foothills 100-200 m high can not be an important barrier for invading air masses. But it is sufficient to form convective clouds. Especially in some summers like 1995 or 2009 many downpours were recorded causing slope wash, earth flows and floods.

Frequency of rockfalls in the permafrost-affected rock walls of the Mont Blanc massif in relation with post-glacial warm periods

RAVANEL L.(1), EGLI M.(2), BRANDOVA D.(2), KUBIK P.(3), DELINE P.(1), GRUBER S.(2)
(1) EDYTEM, LE BOURGET DU LAC, FRANCE ; (2) Department of Geography - University of Zurich, ZURICH, SWITZERLAND ; (3) Ion Beam Physics - ETH Zürich, ZURICH, SWITZERLAND

The characterization of the evolution of rockfall (> 100 m^3) in high mountain areas is a prerequisite to any risk management. This study aimed to collect and analyse data on past rockfall in the Mont Blanc massif in order to investigate the possible correlation between periods of warming and rockfall and, beyond, between permafrost degradation and rockfall. This required to compile exhaustive inventories and to compare them with climatic data.

We first documented the occurrence of the 58 rockfalls at the Drus and the Aiguilles de Chamonix, documented by photo-comparison since the end of the Little Ice Age (LIA) and direct observation in the recent period. We then crossed these rockfall data with available climate data. In the West face of the Drus, air temperature seems to control the triggering of the 12 documented rockfalls, as suggests by their concomitance with the hottest periods. The main one (2005, 265 000 m^3) seems to have been promoted by the combination of heat and heavy rainfalls, resulting in high fluid pressure in the rock fractures. Surface runoff has been observed in the scar of this event and massive ice was also observed after the rockfall of October 2011. The role of climate is also demonstrated by the analysis of the 46 rockfalls documented on the North side of the Aiguilles de Chamonix after the LIA, with a very strong correlation between these and the hottest periods: 70 % of the rockfalls occurred during the past two decades, characterized by the increasing global warming. Heat waves are particularly prone to rockfall: the maximum rockfall frequency occurred during the 2003 Summer heat wave.

To investigate beyond the last century and a half, we carried out surface exposure dating on 20 samples of granite from 6 rockwalls of the massif by the determination of ^{10}Be-concentrations in their surface. The surface ages found vary from less than a few hundred years to tens of thousands years. These dates are generally corresponding to warm periods.

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Linking events to landscape evolution - comparing two models

BAARTMAN J.(1), TEMME A.(1), VELDKAMP T.(2), JETTEN V.(2), SCHOORL J.(1)
(1) Wageningen University, WAGENINGEN, NETHERLANDS ; (2) ITC Faculty of Geo-Information, Science and Earth Observation, University of Twente, ENSCHEDE, NETHERLANDS

An obvious timescale gap exists between a single storm event and long term landscape development. In this study the event- and physically based OpenLISEM soil erosion model was compared to the landscape evolution model LAPSUS, deliberately extending and shortening the timescales for which each model was developed. Calibration of OpenLISEM using average erosion rates derived from long-term simulations with LAPSUS and, vice versa, calibration of LAPSUS on event-scale did not give satisfactory results, suggesting that the gap between the different timescales of both models is too large to be bridged directly. However, calibration of LAPSUS on annual basis using the summed OpenLISEM erosion and deposition values for each year resulted in a good reproduction of these values by LAPSUS. Thus, when keeping to the timescale that the model was originally intended for, but calibrating the model using simulation results from the event-based model, short-term variability could successfully be introduced in longer-term modelling of landscape development. Subsequently, the erosion effects of rainfall variability, climate and land use change were explored on a centennial timescale. Results show non-linear behaviour between rainfall input and simulated net erosion. Simulated net erosion for increased rainfall erosivity was compared to rainfall variability, showing that mean annual net erosion of up to 15% increased erosivity is not significantly different from annual mean net erosion of the original simulations. Single events must be very high and/or frequent to leave a signal in the landscape that is beyond the scope of natural rainfall variability. Scenarios of human impact show that land use changes can have a potentially larger effect on erosion dynamics than climate variability and change. This is the first time that an event-based erosion model and a landscape evolution model were calibrated for the same area and compared in terms of erosion and deposition dynamics.

Green alder encroachment on alpine pastures: potential for changing type, magnitude and frequency of erosion processes

CAVIEZEL C., HUNZIKER M., KUHN N.J.
Department of Environmental Sciences University of Basel, BASEL, SWITZERLAND

In the European Alps economic and structural changes in agriculture lead both to a cessation of traditional pasture use causing reforestation of open landscape as well as use intensification of favourable areas. As one consequence, the Swiss national forest inventory noted an increase of shrub woodland in the period between 1983/85 and 1993/95 of 17.9%. Land use intensification often increases landscape susceptibility to erosion as shown in the greater frequency of shallow landslides under intensive pasture use in the main Ursern-valley in central Switzerland. On the other hand, the effect of land abandonment on erodibility is discussed controversially in literature.

Generally, vegetation improves the mechanical anchoring of the soil and the regulation of the soil water budget including the control over the generation of runoff. Green alder (*Alnus viridis*) for example, is used in bioengineering to mechanically stabilize slopes with its roots. Stabilizing effect of green alder stands on water budget has been reported. However, we found decreasing shear strength along a chronosequence stands of green alder encroaching on abandoned pasture areas in the Unteralptal, a sidevalley of the Ursern-valley in the central Swiss Alps. This apparent reduction in internal friction of the surface regolith layer infers that the encroachment of green alder on former pastures may shift the type, frequency and magnitude of erosion events from individual shallow landslides on pastures towards a continuous creep of the soil not fixed to bedrock by the deep roots of the shrubs. The results also indicate that the effects of shrub encroachment on slopes steeper than the angle of repose must consider the effects on all potential erosion processes and not limit the interpretation of the results to the process dominating erosion under pasture.

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Restoring the geomorphology to magnitude-frequency analyses

RICHARDS K.
University of Cambridge, CAMBRIDGE, UNITED KINGDOM

In some river basins the flood record clearly cannot be represented as a random sample from a single probability distribution; this may be more widespread. In many areas of risk assessment (chemical standards, volcanic hazards), a process-based methodology is preferred to the traditional reliance on arbitrary curve-fitting, which are inadequate when processes are non-stationary.

In flood hydrology, a (neglected) source of structured variability in probabilities is the basin geomorphology and network structure, especially in its interaction with the distribution and extent of runoff-generating processes. Kirkby (1976) showed, in convolution of the hillslope hydrograph with the network width distribution, that for large catchments the hydrograph shape mimics the width distribution. This assumed uniform runoff, when in reality, this is decreasingly likely as catchment area increases. There may be multiple process regimes of extreme events; in small drainage areas (< 10km^2) the hydrograph mimics the input hillslope hydrograph; in intermediate basin areas (<1000km^2) it may reflect the rainfall intensity coupled to a consistent flow routing pattern; and in large basin areas it reflects network structure, routing, and the specific locations where runoff is generated.

Because process controls vary between regimes, it is preferable to fit functions within regimes, but sparse data require simple parsimonious functions with few parameters (eg power functions). This paper uses examples to illustrate this regime behaviour. Peak flow magnitudes and frequencies reflect the probability of a rainfall-runoff event being routed from different contributing sub-catchments. This form of analysis lends itself to event-tree structures, involving chains of discrete probabilities (which can accommodate local non-stationarity), and is consistent with general approaches to risk management based on process-level understanding.

Has sediment transport regime been changed by climate change and human activities?-An analysis of a large semi-arid river basin

MA Y.(1), HUANG H.Q.(1), NANSON G.C.(2)
(1) Institute of Geographic Sciences and Natural Resources Research, Chinses Academy of Sciences, BEIJING, CHINA ; (2) School of Earth & Environmental Sciences, University of Wollongong, WOLLONGONG, AUSTRALIA

The annual runoff and suspended sediment load in the Wuding River basin has decreased significantly since 1970s due to climate change and human activities (check dams, reforestation and plantation). However, it has not been clear whether the flow-sediment regime has been changed in the wake of decrease in runoff and sediment load. Here, a total of 11 sites with more than 30 years (1956-1989) of measurements were chosen to be representative of all type of rivers in three different geomorphologic regions. We analyzed the magnitude and frequency of sediment transport discharge (effective discharge) between the two periods (before 1970 and after 1970), using the methods proposed by Ma *et al.* (2010). The results show that the effective discharge has not been changed significantly. For the whole river basin, the effective discharge is generally smaller than the flows with exceedance probabilities of less than 2%, and the flows with exceedance probabilities of less than 1% transport more than 50% of the total sediment load. In the loess gully region, the effective discharge is the largest floods with exceedance probabilities of less than 0.1% and the flows with exceedance probabilities of less than 1% transport more than 50% of the total sediment load. The large floods in this region have high transport ability despite of low frequency. In aeolian sand region, the effective discharge is the median flows with exceedance probabilities of 30%-50%, and the flows with exceedance probabilities of less than 30% transport more than 50% of the total sediment load. In aeolian sand region low and/or medina flows with high frequency are dominant. Consequently, we can draw a conclusion that climate change and human activities did not essentially alter the flow-sediment transport regime. The high variability of flow events and hyperconcentrated flows in the gully loess region, and the low variability of flow events and transport-limited flows are intrinsic and difficult to be altered.

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The Spatial Magnitude-frequency Analysis Applied to Holocene Mass Movements in an Humid Tropical Brazilian Plateau

COLANGELO A.
Sao Paulo University, SAO PAULO-SP, BRAZIL

The Ahnert's (1987) semi-logarithmic magnitude-frequency model was adapted and applied in Holocene slump units, that had their deposits and scars mapped with airphotos. In this case, the magnitude-frequency index refers to the "Spatial Frequency" (Events/Km²) and "Spatial Recurrence Interval" (Km²) of mapped deposits and scars (Colangelo & Cruz, 1997, 2000 and Crozier & Glade, 1997). The work was performed in three near sample areas, São Carlos, Borba and São José basins, with respectively, Mica-schist, Migmatite and Granite Pre-Cambrian parent materials. The highest frequency of landslides was found at São Carlos area, with 331.210 m^2/Km^2 of sliding area, represents 33,1% of total basin. For this area, the dominant event has 12.022 m^2 of extent, with spatial frequency of 5,2 events/Km^2, performing 62.931 m^2/Km^2. Here, the event with 31.922 m^2 has the $1Km^2$ spatial return interval. In the Borba area, with Migmatite, 191.766 m^2/Km^2 corresponds to the sliding area, or 19,2 %. In this case, the dominant event has 4.563 m^2 of extent, with spatial frequency of 3,5 events/Km^2, performing 16.092 m^2/Km^2, and the event with 10.314 m^2 has the $1Km^2$ spatial return interval. For São José sample area, with Granite basement, 127.964 m^2/Km^2 is the sliding area, or 12,8 %. Here, the dominant event has 7.467 m^2, with spatial frequency of 1,39 events/Km^2, that contributing with 10.382 m^2/ Km^2, and the event with 9,928 m^2 has the $1Km^2$ spatial return interval. These results show us that have a correspondence of the spatial magnitude-frequency distribution of landslides and basement, with its tectonic associated systems. The mass movements in the São Carlos area have the highest magnitude and frequency of all, contrasting with the lowest spatial magnitude-frequency distribution presented by São José area. This may be explained by elevated isotropy associated with granites, that confers a height porosity to the resulting gross material.

Extracting quantitative palaeoflood data from lake sediments: a case-study from Brotherswater

SCHILLEREFF D., CHIVERRELL R., MACDONALD N., HOOKE J.
University of Liverpool, LIVERPOOL, UNITED KINGDOM

Assessing the importance of low-frequency, high-magnitude catchment processes, such as flood events, over long time-scales is a key goal in geomorphological research. The geomorphic effects of extreme hydrological events are effectively recorded by upland lake basins as efficient sediment trapping renders flow-related proxy indicators (e.g., particle size) reflective of changes in river discharge. We demonstrate that, with suitable chronological control and spatial replication, lake sediment sequences from Brotherswater, English Lake District, offer a valuable natural archive for addressing magnitude-frequency relationships of hydrological extremes over extended time periods.

A series of sediment cores (3 – 5m length) contain numerous coarse-grained laminations, discerned by applying high-resolution (0.5 cm) laser granulometry, and interpreted to reflect a palaeoflood record extending to ~2000 yr. BP. The chronology is well-constrained through integrating radionuclide (^{210}Pb, ^{137}Cs and ^{14}C) dating with geochemical markers which reflect phases of local lead (Pb) mining. Geochemical and magnetic profiles have enabled precise core correlation and the repeatability of the flood stratigraphy to be verified.

Phases of increased catchment erosion are evident from down-core profiles of terrigenous elements (e.g., K, Ti, Zr), most likely due to changing land-use practices, resulting in fluctuating sediment supply through time. We also observe a threshold shift as progressively greater background Pb concentrations are recorded in the system in response to short-term pulses of mining pollutants. This non-stationary catchment conditioning may distinctly modify how magnitude and frequency of discrete flood events are reflected in their sedimentary signatures. We combine a multi-proxy palaeoenvironmental reconstruction with a grain-size standardization approach to assess the extent to which the lake sediment palaeoflood record can contribute to the magnitude-frequency debate.

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Late Quaternary extreme floods in the junction between the Alps and the Balkans

FERK M., KOMAC B., ZORN M., ERHARTIC B.
Research Centre of the Slovenian Academy of Sciences and Arts, Anton Melik Geographical Institute, LJUBLJANA, SLOVENIA

The Classical Karst region in southwestern Slovenia is the northern part of the Dinaric Karst. It has been studied from several aspects for centuries, but what is known and understood about this complex karst system is still lacking in chronological data from the Pleistocene. Modern investigations have focused on analysing various sediment sequences in order to acquire a more complete interpretation of palaeoenvironmental conditions in the area affected by both Alpine and Mediterranean glaciation types. Caves turned out to be the most valuable and as-yet underutilized source of information about hydrological and climatological processes here, and consequently about the palaeoenvironment. The origin of sediments and sedimentation conditions were obtained through X-ray and granulometric analyses. The results show that the water-flow directions have not changed much since then. On the other hand, their extent was greater and the elevation of floods was significantly higher than in present hydrological conditions (i.e. during floods on karst poljes in present conditions the water table rises by about 10 m; however, in the past the floods were up to five times higher). Therefore, the floods were extreme from today's perspective. To establish the timeframe of the palaeofloods, flowstone from caves has been dated using radiocarbon ^{14}C and U-Th dating methods. The dating results place the palaeofloods to the late Pleistocene and early Holocene. These extreme hydrological processes, confirmed by morphological and stratigraphic evidence as well as by dating, could be related to different climate conditions. In the future we intend to compare and combine these results with similar data in the region with the purpose of improving the understanding of palaeoclimatic signals in the junction between the southeastern Alps and the northwestern Balkans.

A slope evolution index to estimate adjustments of hillslope morphology in relation to landslide processes

DONNARUMMA A., REVELLINO P., GUERRIERO L., GRELLE G., GUADAGNO F.M.
University of Sannio, Department of Biological, Geological And Environmental Sciences, BENEVENTO, ITALY

The morphological configuration of large areas is continually modified by gravitative processes. Among these, landslide phenomena have, as a consequence, the reduction of slope angles on reliefs at values which give a long-term stability.

In particular, in mountain landscapes, high landsliding frequency has a significant control on their morphology and landform. Slope angle is therefore a key parameter in evaluating the likely future evolutive trend of slopes by landslide processes.

Based on the assumption that the frequency distribution of the slope angle can be modeled by the 3-parameter Weibull probability density function (PDF), this study develops a synthetic index for the physical estimation of the morpho-evolution stage of slopes.

The index (I_{SE}, Slope Evolution Index), using the distinctive parameters (β,η,γ) of the Weibull PDF, mathematically describes the shifting between the landslide area and stable area PDFs. Theoretically, I_{SE} may range from 0 to 1. I_{SE} = 0 means there is no match between the PDFs of the landslide area and the stable area, resulting in areas where slope evolution through landslide processes should still start. On the other hand, when I_{SE} = 1, this corresponds to areas where mass movements are already totally exhausted and the PDFs of the landslide area and the stable area are completely matching.

The resultant ISE may then be contextualized in a comprehensive model of slope evolution based on modifications in slopes geometry. The steepness is reduced by mass movements via the removal of unstable materials from the landslide source areas and adding them to the toe**.**

Several I_{SE} indices has been calculated for a geologically complex pilot area of the Samnite Apennines (Southern Italy), showing significant differences in relation to lithological shapes of some typical flyschoid formations.

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Modelling differences in catchment-scale sensitivity in neighbouring sub-catchments to the River South Tyne, UK

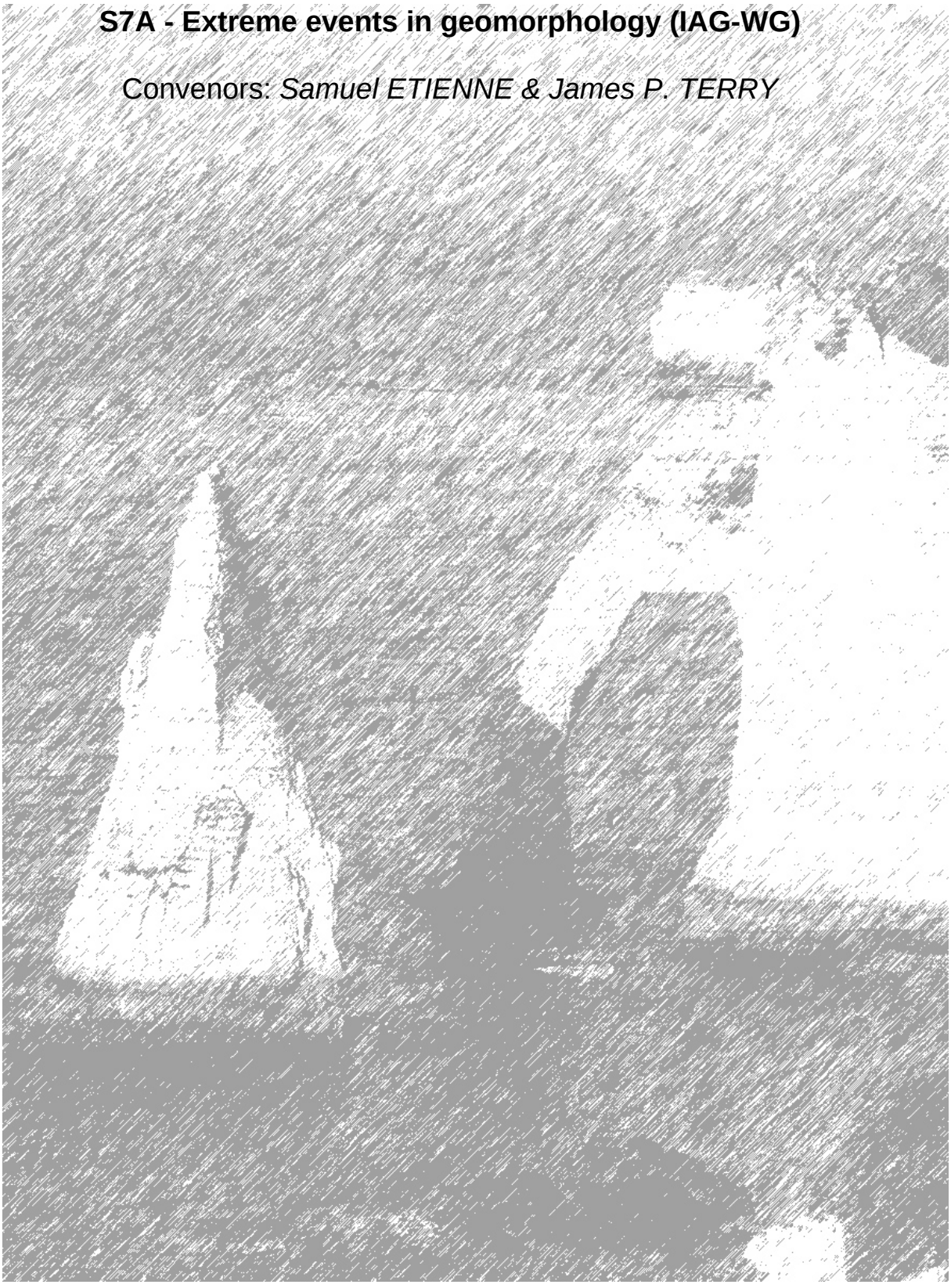
MILAN D.
University of Hull, HULL, UNITED KINGDOM

Localised intense rainfall fell on three neighbouring tributaries (Knar, Thinhope and Glendue Burns) to the River South Tyne catchment on 17th July 2007. Thinhope Burn appeared to show responsive behaviour to the event with 2125 m^3 and 5202 m^3 of erosion and deposition occurring respectively within a 500 m reach (Milan, 2012), and full activation of the sediment system, including slope failures and peat slides. In contrast, the neighbouring catchments of the Knar and Glendue Burns showed limited reworking of the valley floor (robust behavior), despite receiving similar rainfall intensities in their headwaters. This paper uses a cellular landscape evolution model (CAESAR) to simulate the geomorphic response to varying magnitude flood events for the three neighbouring sub-catchments. Morphometric factors such as catchment area and valley slope are thought to be key agents in conditioning geomorphic response to flood events. Specific discharges for the Knar and Glendue Burns (1.1 and 1.3 $m^3\ s^{-1}\ km^2$ respectively), were most likely too small for threshold exceedance, compared with the 5.5 $m^3\ s^{-1}\ km^2$ estimated for Thinhope.

Reference: Milan, D.J. 2012. Geomorphic impact and system recovery following an extreme flood in an upland stream: Thinhope Burn, northern England, UK. *Geomorphology*, 138(1), 319-328.

S7A - Extreme events in geomorphology (IAG-WG)

Convenors: *Samuel ETIENNE & James P. TERRY*



Oral presentations:

How does 'reshaping' Darwin's 'Subsidence Theory of Atoll Formation' broaden the scope of tsunami hazard assessment for the Pacific Islands?

TERRY J.
National University of Singapore, SINGAPORE, SINGAPORE

Charles Darwin's subsidence theory of atoll formation, conceived during the voyage of the *Beagle* through the Pacific in 1836, has endured the test of time and thus commands a remarkable longevity amongst geomorphic paradigms. Darwin's theory conceptualized a subsiding volcano and the corresponding upward growth of its surrounding coral reefs - an outstanding contribution in the mid-19thcentury considering that plate tectonics had yet to make an appearance in Earth Science.

Darwin's hypothesis emphasised the general circularity of atoll shape. Perhaps surprisingly, this simple premise has rarely been questioned. However, few atolls in the Pacific Ocean actually exhibit such morphology, with most atolls possessing single or multiple arcuate 'bight-like' structures (ABLSs) along their reef rims. These departures from the circular form complicate the simplistic model of atoll formation and signal geomorphological processes which require further examination. ABLSs are important since they are the surface expression of large-scale flank failures on the undersea volcanic foundations. Collapse features can occur during any stage of atoll formation and are a valuable addition to Darwin's theory because they indicate the instability of volcanic edifices. Crucially, the research community has recognized that sector collapses of island edifices are invariably tsunamigenic, although we have no clear understanding of how significant such events are on the broader canvas of tsunami sources.

Our inclusion of ABLSs into Darwin's iconic theory should reinvigorate assessment of tsunamigenesis across the vast expanse of the Pacific Islands. The presentation is illustrated with examples of ABLSs and associated tsunamis in atoll and atoll-like environments. Implications for our present understanding of tsunami hazards are profound, since in essence the significance of locally and regionally generated tsunamis throughout the entire Pacific Ocean is seriously underestimated.

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Large boulders accumulation along the NE Maltese coast: stormwaves or tsunami event?

BIOLCHI S.(1), FURLANI S.(1), ANTONIOLI F.(2), SCICCHITANO G.(3), CUCCHI F.(1), DRAP P.(4), GAMBIN T.(5), DEVOTO S.(1), SALIBA D.(6)
(1) University of Trieste, TRIESTE, ITALY ; (2) ENEA, ROMA, ITALY ; (3) Studio geologi associati T.S.T., CATANIA, ITALY ; (4) LSIS Laboratoire des Sciences de l'Information et des Systèmes UMR CNRS, MARSEILLE, FRANCE ; (5) University of Malta, VALLETTA, MALTA ; (6) Il-Majjistral Park, VALLETTA, MALTA

The accumulation of large boulders related to waves generated by tsunami and extreme storm events have been observed in different areas of the Mediterranean such as the Ionian coasts of NE Sicily, the Apulian coasts, the Algerian coasts and Cyprus. It is known through historical records that very few large earthquakes occurred close to the Maltese Islands. The local seismicity is mainly related to the Malta Escarpment, the Sicily Channel Rift Zone and the Hellenic Arc.

At Armier Bay (NE Malta), large limestone boulders were found at an altitude ranging between 0 and 5 m a.s.l. The deposit is about 100 wide and the blocks are scattered on a gently sloping coast. The boulders, metric in size, belong to the Upper Coralline Limestone Formation and are Miocene in age. They are very similar in lithology and age to those studied along the Ionian Sicilian coasts.

The occurrence of marine encrustations (Serpulids) and the lacking of a calcareous cliff behind the blocks as a feeding zone, attest their marine provenance.

^{14}C datings were made on three samples collected on different blocks in order to verify if their ages were comparable with historic tsunami events. A digital photogrammetric analysis was carried out in order to provide a precise measurements of the axes required by the Nott equation. This equation allowed to estimate the minimum wave height required for the detachment and the transport of the blocks: 15-16 m for storm waves and 3.80-4.10 m for tsunami waves. The first option seems too exaggerated compared to local wave heights, while the second one seems more realistic. Regarding ^{14}C datings, the first boulder is probably related to a storm wave event, both for its age (post 1950 AD) and small size. The second one could be related to the 1693 tsunami event (558-639 years BP), while the third to the 1169 tsunami event (1083-1205 years BP). In any case, tsunami events were originated by strong earthquakes occurred in correspondence to the Malta Escarpment.

Dating tsunami deposits triggered by the catastrophic flank collapse of Fogo Island, Cape Verde Islands: insights from ESR, U/Th and 36Cl ages

RIXHON G.(1), PARIS R.(2), MAY S.M.(1), ENGEL M.(1), BRÜCKNER H.(1)
(1) Institute of Geography, COLOGNE, GERMANY ; (2) Laboratoire Magmas et Volcans, CLERMONT-FERRAND, FRANCE

Unstable volcanic islands may undergo massive flank failures triggering giant tsunami waves. Given the scarcity of observations, however, such high magnitude but low-frequency phenomena are still poorly investigated. In the Cape Verde archipelago, the steep shield volcanic edifice of Fogo Island displays such kind of an evidence, expressed by a massive failure scar opened to the east. The resulting mega-tsunami stroke the western coastline of Santiago Island, located ~60 km to the east of Fogo. The age of this twofold event (collapse and tsunami), and whether it happened during a sea level highstand or a lowstand are as yet open questions.

A cliff-top tsunami deposit was identified at elevations between ~6.5 and ~12 m a.s.l. in Tarrafal Bay, NW Santiago. The deposit (i) mainly consists of volcanic rocks (basalt, phonolite), (ii) is rich in marine macrofauna (bivalves, gastropods), and (iii) is partly composed of CaCO3 cemented elements. It has a remarkable thickness of up to 5 m and contains rip-up clasts of a reddish palaeosol in its lower part. Given these morpho-sedimentary architecture, we adopted a multi-dating approach in order to yield a reliable age for the event and to crosscheck the results of the different dating techniques:

(1) ESR dating of bivalve mollusk shells (well-preserved Glycymerididae and Venusidae);

(2) U/Th dating of different kinds of marine fossils, such as (i) bivalve mollusks, (ii) branching forms of corals (Hydrozoan) and (iii) marine gastropods (Conidae, Strombidae);

(3) cosmogenic nuclide dating (36Cl) on basaltic elements of the deposit. Two sampling strategies were implemented: a surface exposure sampling on the largest boulders lying at the sediments surface, and a depth profile from the subsurface down to ~5 m, taking advantage of the unusual thickness for this tsunami deposit.

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Effects of the 1755 tsunami on the southern coast of the city of Cadiz (Spain)

GRACIA PRIETO F.(1), ALONSO VILLALOBOS C.(2), MENANTEAU L.(3), BENAVENTE J.(1), DEL RIO RODRÍGUEZ L.(1), MÁRQUEZ CARMONA L.(2)
(1) Universidad de Cádiz, Facultad de Ciencias del Mar y Ambientales, Departamento de Ciencias de la Tierra, PUERTO REAL, SPAIN ; (2) Instituto Andaluz del Patrimonio Histórico, Centro de Arqueología Subacuática, CADIZ, SPAIN ; (3) LETG-Nantes Géolittomer UMR 6554 CNRS et université de Nantes, NANTES, FRANCE

The historical tsunami generated by the Lisbon Earthquake (1st November 1755) had a considerable impact on the coasts of Portugal, southern Spain and Morocco. Geo-archaeological and geomorphological analysis of the shore of the Gulf of Cadiz shore provides insight into the erosive and depositional effects of the tsunami event, as well as the extent of flooding at various points along the coast. The data can be very useful for defining the areas that would be at risk in the event of a similar phenomenon in the future.

The city if Cadiz was hard-hit by the tsunami. Most of the southern part outside the walls was washed away by waves. This resulted in many casualties and the destruction of most of the infrastructures, including the only road linking Cadiz to the mainland across the tombolo and the Isla de León (San Fernando). Drillings and archaeological excavations have revealed gravel and sand deposits in different parts of the city, which help to define the extent of the affected area. These data together with those obtained from archives, eye witness accounts and early maps as well as geomorphologic analysis and mapping of the area allow us to determine the consequences of the tsunami and its influence on shoreline evolution in this sector of the Gulf of Cadiz over the last 250 years.

The application of Ground Penetrating Radar analysis to investigate the impact and recovery of a coastal dunes and the recurrence interval of palaeotsunami events on the coast of Phra Thong Island, Thailand

SWITZER A.(1), GOURAMANIS C.(1), LEE Y.S.(1), RUBIN C.M.(2), BRISTOW C.B.(3), JANKAEW K.(4), PILE J.(1), PHAM D.T.(1)
(1) Earth Observatory of Singapore, SINGAPORE, SINGAPORE ; (2) Division of Earth Sciences, Nanyang Technological University, SINGAPORE, SINGAPORE ; (3) Dept Of Earth Sciences, Birkbeck University College London, LONDOND, UNITED KINGDOM ; (4) Dept of Earth Sciences, Chulalongkorn University, BANGKOK, THAILAND

This presentation discusses the application of Ground Penetrating Radar (GPR) and complimentary techniques to reconstruct the tsunami history of Phra Thong Island. The common techniques for investigating the impact, recovery and recurrence interval (palaeoevent history) in coastal systems are point source augering or pitting and/or trenching. These techniques are time and cost intensive. GPR presents a rapid, non-invasive, spatially-continuous technique for identifying subsurface stratigraphy. Although GPR facies are not diagnostic of a particular sedimentary characteristic, when combined with satellite imagery they do provide an avenue for reconstructing a tsunamis impact and the post event recovery, or to help constrain the spatial extent of sandy deposits in the subsurface. Here we present results from two GPR survey campaigns at Phra Thong Island. The first aimed at investigating the large scale recovery of the coast using (100 MHz antennae) and the second a thin-bed approach aimed at imaging thin (<15 cm) sandy tsunami deposits and their associated structures using high-frequency (500 and 1000 MHz) GPR antennae complemented by auger cores. The tsunami impact and recovery was reconciled by two 100 MHz GPR profiles and quasi-yearly satellite imagery. The GPR revealed the depth and extent of tsunami scour along with the sedimentary history of post tsunami coastal aggradation (recovery). For the second program two swales with three distinct palaeotsunamis deposits recognised as discreet thin sand layers were examined. The bases of the swales are clearly evident as are the contacts between sandy and muddy layers, although these reflectors are less consistent across the profile, suggesting that the contacts between thin sand and mud units can be accurately imaged provided the units are thicker than ca. 10cm. Our investigations show that GPR can be used to rapidly and non-invasively assess tsunami post event recovery and to image sandy washover events in muddy swales.

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Constraining bedrock erosion rates and processes during extreme flood events: case study in Iceland

BAYNES E.R.C.(1), ATTAL M.(1), DUGMORE A.J.(1), KIRSTEIN L.A.(1), NIEDERMANN S.(2), CODILEAN A.T.(2)
(1) University of Edinburgh, EDINBURGH, UNITED KINGDOM ; (2) GeoForschungsZentrum, POTSDAM, GERMANY

Extreme flood events can be triggered by subglacial volcanic eruptions or dam failures and they are characterised by the release of vast quantities of water in a short period of time, with discharges potentially exceeding 10^6 m^3/s. During such events, the energy transferred to the Earth's surface can be considerable. Such energy transfer has the potential to significantly alter the landscape. This study examines the impact of extreme flood events (jökulhlaups) triggered by subglacial eruptions along the Jökulsá á Fjöllum River, North-East Iceland. In particular, the study analyses the bedrock erosion processes at work during the formation of both the Jökulsárgljúfur gorge system and Asbyrgi, a large canyon (3 km long, ~0.5 km wide, up to 90 m deep) that is now disconnected from the course of the current river. Terrestrial cosmogenic nuclide exposure ages (^{3}He, ^{21}Ne) of abandoned strath terraces combined with detailed geomorphological mapping of landforms and an assessment of bedrock jointing demonstrate the mechanisms and magnitude of waterfall retreat within the Jökulsárgljúfur gorge system during the jökulhlaups that have occurred over the last 8 ka. The exposure ages also provide constraints on the exact timing of the flood events, allowing a detailed reconstruction of the evolution of the landscape following the flow events. Ongoing research is being undertaken to develop a numerical model that accurately replicates bedrock erosion processes and rates during jökulhlaups.

Geomorphic implications of differential changes in the frequency of large rainstorms of varying return period: evidence from tropical and temperate environments, Borneo and South Wales 1906-2012

WALSH R.(1), ELLISON S.(1), JENKINS M.(1), BIDIN K.(2)
(1) Department of Geography, Swansea University, SWANSEA, UNITED KINGDOM ; (2) Scholl of Science and Technology, Universiti Malaysia Sabah, KOTA KINABALU, MALAYSIA

Different landforms and rates of action of different geomorphological processes are influenced by rainfall events of often very different return period. Although increases in the magnitude and frequency of extreme rainstorms are confidently predicted by IPCC 2007 with continuing global warming in the 21st Century, predictions are vague as to the scale of changes and the return periods involved. Also most studies of change to date have tended to use relatively short periods of record rarely extending back beyond 1960, thus raising questions as to the longer-term context and meaning of any increases found. Using daily rainfall series extending back over a hundred years for three stations (Sandakan, Kota Kinabalu and Tawau) in the humid tropical environment of Sabah (Malaysian Borneo) and upland (Treherbert) and coastal (Swansea) stations in the humid temperate environment of South Wales, this paper presents evidence in both locations of major recent changes in rainstorm magnitude-frequency that, however, vary with the return period of the rainstorms involved. In both regions significant increases in the frequencies of rainstorms > 50 mm per day (events that produce major runoff events and sediment transport) have occurred since 1980, with an intensification of this trend since 1999 in the case of Sabah. Extreme value analysis, however, demonstrates that the rises only apply to return periods of 5 years and less and that to date daily rainfalls of >10 years return period have actually reduced in size. Impacts of these findings for a range of geomorphological processes and features in the two areas are considered. In South Wales, analysis of river flow records for the Taff catchment since 1958 shows a parallel rise in magnitude of flows of < 5 years return period and fall in the size of events of higher return period. The effects of recent changes on monitored slopewash rates, pipe erosion, landslide activity and sediment transport are presented and discusse.

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Poster presentations:

3D modelling of boulder shape and volume using digital photogrammetric techniques. Applications in coastal geomorphology

GIENKO G.(1), TERRY J.(2)
(1) University of Alaska Anchorage, ANCHORAGE, UNITED STATES ; (2) National University of Singapore, SINGAPORE, SINGAPORE

Until now, the size and volume of large boulders transported or emplaced on coasts, for example by storm and tsunami waves, can be assessed only inaccurately using traditional measurement techniques. A new methodology is being developed for improving the accuracy of boulder measurement using 3D-image processing techniques. In favourable circumstances, such data will enable better calibration of the power of pre-historical and recent high-energy coastal inundation events.

The research concentrates on creating precise, measurable and textured 3D models of coastal boulders without physical contact with the object. Active measurement techniques such as terrestrial laser scanning are less feasible due to complexities associated with setting up equipment in tidal areas (rough sea floor surface), exposure to harsh tropical environments (direct sunlight, high temperature and humidity), and low mobility of equipment (multiple parts, heavy weight, large batteries, and bulky packaging). Furthermore, raw data acquired in the field require significant post-processing in office.

Our alternative solution is based on close-range photogrammetric techniques. Low-cost equipment (waterproof digital cameras) can be used in various environments to acquire quickly dozens of images of the object of interest. Immediate quality control of the images is possible in the field. The 3D models, built from multi-view digital photographs, allow for reconstruction of precise, quantifiable and realistic-looking textured models of complex-shape objects, such as coral reef or volcanic boulders. Resulting 3D models can be measured in any dimension, including calculation of surface area and volume. Viewing is possible in 2.5D on a regular screen, or in full 3D using stereoscopic monitors and glasses. Preliminary results of boulder measurements from a coastal field site on the Island of Viti Levu in Fiji are presented.

Identification of liquefied layers in a liquefaction induced by The 2011 Off the Pacific Coast of Tohoku earthquake in central Japan

SETO M.(1), ASAI T.(2), KITAZAWA T.(3), NAKAMURA Y.(4), OGUCHI T. C.(1), TAMURA T.(3)
(1) Saitama University, SAITAMA, JAPAN ; (2) Undergraduate student of Rissho University, KUMAGAYA, JAPAN ; (3) Rissho University, KUMAGAYA, JAPAN ; (4) Fukushima Universty, FUKUSHIMA, JAPAN

The 2011 Off the Pacific Coast of Tohoku earthquake of M_w9 induced liquefaction in various coastal and fluvial lowlands in northeastern and north-central Japan. At the playgrounds constructed in former back swamp of the Watarase floodplain, central Kanto, where seismic intensity of JMA scale seemed to be 6, several cracks were made around which water and sand gushed out. Although various liquefaction models have been presented based on a profile observation about the old liquefaction and laboratory experiment, few reports have identified liquefied layers on the site of liquefaction occurrence. We collected boiled sand and carried out boring investigations to loosely-deposited sand and mud alternation at four sites (sites A-D) to identify the layers which were liquefied after this mega earthquake. At site D, we had a 500cm deep core sample. We observed some layers; 0-30cm: artificial ground, 30-70cm: silt, 70-250cm: medium or fine sand, 250-400cm: clay, 400-500cm: medium sand. Ground water level was 200cm deep. Boring sites A, B and C were almost similar to site D. In comparison of granulometry and mineral composition of boiled sand with those of borehole-core samples below the watertable, we identified the liquefied layers, which were the medium and fine sand deposits around 200cm deep. All the liquefied sandy layers are correlated to the uppermost members of the Holocene deposits which were interpreted to have been formed during recent 2000years.

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Some geomorphological remarks on the 2011 mega-earthquake in Northeast Japan

TAMURA T.
Rissho University, KUMAGAYA, JAPAN

he mega-earthquake of M_w9 broke out on 11 March 2011 off the Pacific coast of Northeast Japan. The thrust movements amounting to 50m occurred on very gently (10 to 15 degrees) westward-dipping plane extending to 500km long and 200km wide. The big eastward slippage of the overriding block resulted in an extensive subsidence zone in its western part, where not reverse but normal faultings occurred afterward. The phenomena show notable plate behavior in the passive margin. Two types of tsunami occurred successively within several minutes. The first relatively low surges invaded deeply into the coastal lowlands and deposited sand and mud in similar extent to that the 869AD tsunami deposits indicated. The second higher ones eroded sandbars and sea cliffs and destroyed constructions. Umitsu et al. and Iwafune present geomorphological analyses of tsunami flow in this conference. On liquefaction, Seto et al. report in this conference the detection of source subsurface deposits by granulometric and mineralogic analyses. Many landslides were induced on natural hillslopes in the zone of 250km from the axis of the hypocentral region. Much more number of small landslides occurred on both filled ground and cut/fill boundary in residential areas transformed artificially from undulating hill-landforms. Characteristic features of the slides are reported by Doshida et al. in this conference. The main facilities of Fukushima Daiichi Nuclear Power Plant, which were located on the ground cut down artificially from the flat marine terrace of 35m above the sea-level, correlated to MIS 5e, to 10m high, were destroyed by tsunami 15m high. Radiological dosage spread from the plant provides a record of combined processes from simple aeolian diffusion to very local overland- and stream-flow, and limited percolation, as some hydrogeomorphologists have traced. Geomorphologists' works as above must contribute to rehabilitation and hazard mitigation too.

Extreme Environment and Geomorphological Crisis : the case of the Messinian Crisis

GARGANI J.
Univ. Paris-Sud, ORSAY, FRANCE

There are some times and places that are the centre of numerous catastrophic events. The Mediterranean area was certainly such a place during a brief period of time 6 million years ago. It was yet known that more than 2 km of evaporites were accumulated into the basin and deep canyons were incised when a sea-level drawdown of ~1.5km affected the Mediterranean Sea. This was the consequence of a complex influence of tectonic movement and global sea-level variation associated with climatic evolution. This dramatic event finished with the reflooding of the Mediterranean area. Here we show that during this catastrophic event, a landslide crisis also happened. We observe several landslides of Messinian age in various part of the Mediterranean Basin. These landslides could be due (i) to the relief created by the deep erosion and the bulge of the shoreline, (ii) to the reflooding that produced a pore pressure increase at the end of the Messinian Salinity Crisis. The Mediterranean was affected by a geomorphological crisis during the Messinian. This unique event triggered intense debates in the scientific community but also several reinterpretations outside of the scientific community.

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Extreme events and geomorphic crises: are they a kind of environmental crisis?

ETIENNE S.
Ecole Pratique des Hautes Etudes, DINARD, FRANCE

The concept of ‘environmental crises’ and the use of the expression ‘extreme event’ appear more and more popular in the geomorphology literature. Eventually, they are used as synonyms, but sometimes replaced by the term ‘geomorphic crises’. This talk will explore the history of these expressions and assess their semantic values. It appears that ‘environmental crisis’ is a concept with a triple dimension: scientific, ethical and political. The expression ‘geomorphic crises’ appeared in the 1960’s, especially in the French-speaking research community, and was strongly linked to the paradigms of climatic geomorphology, meanwhile extreme events have been removed from researchers’ considerations. The reason lies in that catastrophism has discredited for a long time any scientific acceptance of abnormal events (unpredictable and mostly unknown in historical times) so that they cannot enter any explanatory diagram of terrestrial landforms. Progress in the recognition of the importance of nonlinear dynamics and the application of the theory of deterministic chaos led the comeback of a reasoned catastrophism in Earth Sciences. The study of extreme events then appeared as a necessary branch of geomorphology more engaged with the concerns of modern societies (natural hazards).

Historical embayed coastal evolution under a high energetic hydrodynamic event

RAMOS-PEREIRA A.(1), TRINDADE J.(1), COSTA A.(2), MARTINS J.(3)
(1) Centre Geographical Studies, Inst. Geography and Spatial Planning, University of Lisbon, LISBON, PORTUGAL ; (2) Associação para o Desenvolvimento da Univ. Porto, BRAGA, PORTUGAL ; (3) Laboratório Radiocarbono, IST/ITN,Univ. Técnica Lisboa; Univ. Algarve, LISBOA, PORTUGAL

The Estremadura Portuguese coast (NW of Lisbon) is a present day cliff coast with narrow embayed beaches, most of them with estuaries of small catchment rivers. The case study covers 2100m of coastline and an indentation ca 200-300m.

The research deals with the evaluation of the balance between fluvial and marine influences on sedimentary record, as well as the impact of extreme events.

The methodological approach is based on the bay morphometry, detailed 1cm sedimentologic analysis of core samples and sediment statistical determination, geochemical methods and radiocarbon dating, complemented by historical documents.

The results show an open sheltered lagoon until 1710-1830calBP, followed by a period of progressive infilling and the settlement of the current conditions (beach-dune system), during XIX century. Documents from XII century mentioned a relative large lagoon enough to feed the monks of an ancient monastery that was abandoned during the 17th century.

A question arises: the lagoon infilling would be the result of natural resilience related to previous sea level stabilization or/and the result of an extreme coastal phenomenon?

Some layers of sediments of the infilling period show a high energetic hydrodynamic event after 250±30BP and are probably the result of the tsunami that followed the Lisbon earthquake (1755).

The infilling episode that started post 1830calBP is considered to be the combined result of the system natural resilience after sea level stabilization, the anthropogenic intervention and the extreme hydrodynamic event. A paleolandscape coastal evolution model is presented and discussed.

Acknowledgements

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Dating tsunami-induced transport of coral reef megaclasts on Bonaire (Leeward Antilles): a cosmogenic nuclide dating approach (36Cl)

RIXHON G.(1), BRÜCKNER H.(1), ENGEL M.(1), MAY S.M.(1), BINNIE S.(2), DUNAI T.(2)
(1) Institute of Geography, COLOGNE, GERMANY ; (2) Institute of Geology, COLOGNE, GERMANY

Onshore sedimentary records represent a valuable geo-archive to investigate Holocene high-energy wave events (tsunamis, storms). In contrast to fine sediments which have been subject of detailed sedimentological studies in the recent past, megaclasts in supralittoral position are less investigated. In particular, dating the time of their dislocation is still a major challenge in the research on extreme wave events. On Bonaire (Leeward Antilles), the transport of the largest coral reef boulders is attributed to Holocene tsunami event(s). Despite a large dataset of ^{14}C and ESR ages, it remains unclear whether these age estimates reflect the time of the initial dislocation.

We applied terrestrial cosmogenic nuclides (TCN, in particular ^{36}Cl) in order to date the transport event(s), *i.e.* the inferred tsunami(s). This dating method was hitherto disregarded in the coastal environment, particularly in the context of supralittoral megaclasts. Along the eastern coast of Bonaire, megaclast deposits were torn from the cliff edge of the MIS 5.5 coral reef platform and transported further inland by high-energy waves. The following characteristics of the megaclasts are fundamental for the success of the presented dating approach:

(1) due to the lithology (aragonite, calcite), concentration measurements of 36Cl were performed;

(2) only large and thick megaboulders (>50 t, >2 m thickness) for which tsunami transport was inferred were sampled (five samples);

(3) since the boulders stem from the edge of the coral reef platform, they had been exposed to cosmic radiation prior to the transport event(s) and had already accumulated a certain amount of TCN. To avoid this problem of inheritance, we only sampled (i) the thickest boulders, and (ii) boulders that had experienced a 180° overturn during transport; thus having exposed a “blank” side to cosmic ray only since the event. The complete overturn is attested by former rock pools and bioerosive notches in upside-down position.

Response of different land covers to an extreme event in the Spanish Pyrenees

LANA-RENAULT N.(1), NADAL-ROMERO E.(2), SERRANO-MUELA M.P.(3), GONZÁLEZ HIDALGO J.C.(2), ALVERA B.(3), SANJUAN Y.(3), GARCÍA-RUIZ J.M.(3)

(1) La Rioja University, LOGRONO, SPAIN ; (2) Zaragoza Univeristy, ZARAGOZA, SPAIN ; (3) Instituto Pirenaico de Ecología (CSIC), ZARAGOZA, SPAIN

An extreme rainfall event occurred on 19-21 October 2012 in the central Spanish Pyrenees, as a consequence of the development of a large cutoff low system. Total rainfall values of approximately 200-300mm in two consecutive rain-showers of different intensity, triggered an extreme hydrological event in the Aragón River basin, with a flood of more than 1300 m3 s-1 at the tail of the Yesa reservoir, corresponding to a 100-200 years return period. The flood caused the occurrence of landslides and changes in the fluvial channel morphology, which affected roads and buildings. Since 1996 the Pyrenean Institute of Ecology (CSIC) monitors five experimental catchments in the area most affected by the rainstorm, allowing the record of discharges and suspended sediment concentration during the flood under different plant covers. This paper studies the response of such land covers to the extreme event, including the following scenarios: (i) a densely forest-covered catchment, (ii) a farmland abandoned catchment, actually covered with dense shrubs and small forest patches, (iii) an intensively eroded catchment, with the presence of active badlands, (iv) a catchment afforested with pines in the 1960s, and (v) a sub-Alpine catchment, dominated by grasslands with some eroded areas in the headwater. The authors discuss the role of forests and shrubs in controlling extreme hydrological events.

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Use of repeat aerial LiDAR to assess geomorphic impacts of the January 2012 Cyclone Dando floods on the Sabie River, South Africa

MILAN D.(1), HERITAGE G.(2), TOOTH S.(3)

(1) University of Hull, HULL, UNITED KINGDOM ; (2) JBA Consulting, WARRINGTON, UNITED KINGDOM ; (3) Aberystwyth University, ABERYSTWYTH, UNITED KINGDOM

High quality topographic data enabling geomorphic change detection in dryland river systems is difficult to collect and is therefore rare. Aerial LiDAR now permits large complex river systems to be surveyed with great detail. This paper presents some initial findings of the geomorphic response along a 50 km reach of the Sabie River, Kruger National Park, South Africa, to a major flood (~3000 m^3s^{-1}) during January 2012. Geomorphic changes resulting from this event were quantified through the use of repeat aerial LiDAR survey, specifically by comparing 2005 data with a new survey flown in May 2012. Change detection was assessed through DEM subtraction, whereby spatially distributed error within each surface is assessed through an assessment of the relation between local surface roughness and vertical error. The results reveal widespread sediment redistribution, with net sediment loss from the system, and with both alluvial and bedrock dominated channel types affected. Channel response by channel type was inconsistent, and was thought to be related to remnant fragments of cohesive anastomosed channel that survived a larger (~7500 m^3s^{-1}) event in 2000. Isolated sediment accumulation was also found to be associated with less active tributary junctions. The overall system response appears to one of partial stripping to both the 2000 and 2012 events, with the removal of large bar units in the alluvial sections of the river, but with no evidence of total stripping. The findings of this investigation allow for the development of a revised model of dryland river system response to large flood events that will be applicable both regionally and possibly to similar mixed bedrock-alluvial, vegetation-influenced, dryland rivers.

Reconstruct the spatio-temporal distribution of Xiakou landslide using Dendrogeomorphological method

HONG T., BAI S., WANG J.
Nanjing Normal University, NANJING, CHINA

The research of landslide magnitude–frequency is necessary for landslide hazard assessment. Dendrogeomorphological techniques allow us to determine the frequency of events, also it is available to use the distribution of disturbed trees to reconstruct the magnitude and spatial distribution of landslide. The main goal of this research is to reconstruct the magnitude and frequency of the landslide using tree-ring analysis.

The study area is located in the middle of Sichuan Province in China. This landslide is a thrust load caused soil landslide located in the left side of Longxi River. The large landslide has a length of 650 m and a width of 470 m. The landslide area is about 0.31km^2, the average depth is 28.7m, the mean slope angle is 32°. In the field, a standard borer was used to drill fir trees on the landslide body and to extract samples. In total, 75 fir trees were sampled in the landslide area, while 16 fir trees were taken in a stable slope as reference trees. The stable slope is about 2 km east of the landslide. Four cores were taken each tree at the breast height (about 130cm). 222 core samples were taken to the laboratory in total and tree-rings were measured by microscope analysis.

We found ten re-activities (1987,1988,1989,1992,1993,1995,1997,2004,2006,2007) using dendrogeomorphological method, three times of them (1987,1995,2006) consistent with the local archive records, and calculated the return period and frequency of the landslide. The highest probability of reactivition is in the south part of the landslide.

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Geomorphological effects of extreme precipitation in 2010 in selected parts of the Polish Carpathians

BOCHENEK W.(1), GIL E.(1), KIJOWSKA-STRUGAŁA M.(1), KISZKA K.(1), WIEJACZKA Ł.(2), RĄCZKOWSKA Z.(2)
(1) Institute of Geography and Spatial Organisation, PAS, Research Station in Szymbark, SZYMBARK, POLAND ; (2) Institute of Geography and Spatial Organisation, Polish Academy of Sciences, Department of Geoenvironmental Research, KRAKOW, POLAND

Extreme rainfall occurred in the Polish Carpathians in May and June 2010. At the Research Station in Szymbark total rainfall in May constituted 224% of long-term average total monthly rainfall for May, and 25% of average total annual rainfall. Rainfall total for period 1 of May – 4 June was 375.5 m, with daily maximum total 107.0 mm, and maximum intensity = 28 mm/h and 7.2 mm/10 min.

Differentiated spatially, geomorphological changes was observed both on slopes and in river channel. On slopes there was intense runoff, measured on experimental plots in Szymbark. Overland flow and throughflow showed, however, important differences, particularly in relation to drainage outflow, which affect dynamics of geomorphological processes. During heavy rainfall water flowing on surface of the plot was a 123% of drain flow, but during continous rainfall this share was about 11%. Many landslides were triggered or rejuvenated. Besides shalow landslides, especially in the Beskids, have started deep, rotational landslides. At the Carpathian Foothills, on the area with dust rill erosion produced, at area of 0.25 ha, 53 shallow fills, which carried out 103 tons of soil and two deep gullies, reaching of 270 cm depth, which caried out 640 tons of material.

In the Ropa river channel, above the Klimkówka reservoir, accumulation and channel widening up to 7-8m dominated, while below it erosion and deepening of river bed up to 40cm. Effects in small stream channel belongs of valley bottom character. In the Bystrzanka channel numerous erosive cuts of banks, up to 2 m hight, bank retreat up to 10 m, point and central bars of various size and shape were observed along whole length of channel.The Bielanka channel also experienced transformation by erosion. It was estimated that up to 500m^3 of material in cross section, in its mouth part was eroded.

Extreme or ordinary processes? Facts and thoughts on geomorphic scales in the Himalayan Mountains

FORT M.
Université Paris Diderot, Sorbonne-Paris-Cité, CNRS-UMR 8586 PRODIG , PARIS, FRANCE

The Himalayas are the highest mountains in the world. The erosion work, as expressed by several km deep fluvial valleys and giant (more than $1km^3$) landslides, relies on tectonic and climate forcing. It supplies the largest sediment fluxes on earth, trapped in piedmont megafans (such as Kosi) or in submarine Bengal and Indus fans. The contrasted monsoon climate exerts a strong control on environmental characteristics (river discharge, pore pressure in soil, vegetal cover) hence in geomorphic processes acting seasonally at all spatial scales. We document a few geomorphic features (landslides, debris flow, floods) that may be considered as “extreme” according to alpine standard yet that are “ordinary” features, fairly common in the Himalayan Mountains. Whatever the time and spatial scales considered, it appears that despite regional differences, most of Himalayan landforms are shaped by, processes that are persistent in time. Yet, nowadays their impacts represent a major threat for Himalayan populations, whose increasing density make them more vulnerable to geomorphic hazards, as exemplified by the Higher Himalaya in Central Nepal, characterized by the highest gradients (elevation, slope, rainfall) and rates (uplift, fluvial incision, denudation) ever recorded along this mountain range.

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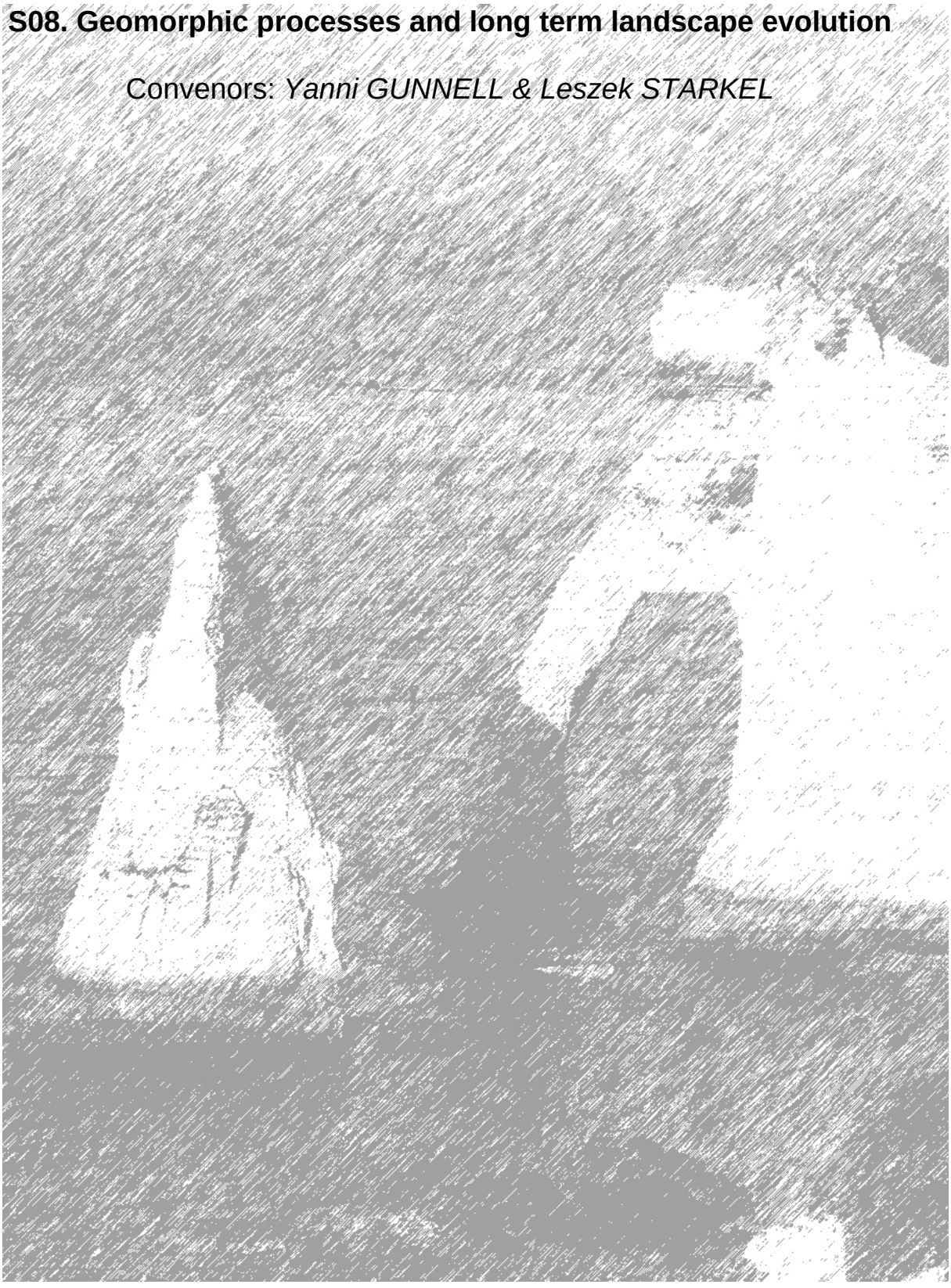
S08. Geomorphic processes and long term landscape evolution

Convenors: *Yanni GUNNELL & Leszek STARKEL*



Oral presentations:

The Quaternary transformation of inherited older mountain landscapes

STARKEL L.
Institute of Geography PAS, KRAKOW, POLAND

The transformation of inherited relief during Quaternary is controlled in the mountains by three factors: climatic changes, resistance of substratum and neo-tectonic uplift. The climatic cyclic fluctuations in the lower elevations of Eurasian mountains are reflected in the alternation of interglacial stages with forests, subsurface runoff, chemical weathering and of cold stages with treeless vegetation, permafrost, prevailing overland flow, solifluction, wind activity and at higher elevations in advances of glaciers. In this progressing degradation an important role play the transitional phases of rebuilding of water circulation, which transfer the regolith and deposition from a previous phase. It is related both to early glacial removal of interglacial soils and to lateglacial replacement of periglacial deposits. The rate of degradation of inherited Tertiary planation surfaces and slopes depend on resistance of bedrocks. In case of flysch deposits the degradation during one (last) cold stage fluctuate from centimeters to 10 meters. Therefore the higher planated levels are better preserved on the beds of higher resistance reflecting structure – controlled features. Frequently the lowest piedmont along rivers on less resistant beds was lowered to 50 m and more. In the young mountains the Quaternary uplift may play an additional role. The incision is progressing upstream. Therefore especially in headwaters older surfaces are much better preserved and former pediments under permafrost regime may be transformed into cryopediments. In case of higher rate of Quaternary uplift reaching 2 km in the Himalaya or Pamir the whole fluvial forms were shifted to cryonival or even nival (glacial) vertical zone. The former V- shape valleys undergo extension to wide and deep troughs and on narrow ridges appear cryoplanation terraces. The glacial overdeepenings and thresholds may be iniciated on the pre-Quaternary steps limiting younger incision from hanging headwaters.

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Impact of late-Cainozoic climate change on orogenic relief development

VAN DER BEEK P.
Institut des Sciences de la Terre, Universit_ Joseph Fourier, GRENOBLE, FRANCE

Over the last two decades, multiple feedbacks between tectonics, climate and erosion have been identified. In particular, late-Cainozoic climate change, characterized by overall cooling and increased climatic variability, has been suggested to be responsible for increased erosion rates as well as uplift of mountain peaks through the isostatic response to erosion. Pliocene-Pleistocene increases in sediment flux have been reported from many major mountain belts. It has been suggested this is a global signal in response to increased climatic instability, although recent work suggests that at least part of the signal may be intrinsic to the nature of the sedimentary record. An initial analysis of thermochronology data from the European Alps appeared to support the Pliocene increase in erosion rates. However, recent more detailed work, based on numerical inverse modelling and the use of new high-resolution thermochronometers, suggests locally decreasing erosion rates during that time. In contrast, the new data imply a significant increase in relief through focussed valley incision since mid-Pleistocene times (~1 Ma), which can be related to efficient but highly localised glacial erosion due to extensive glaciation of the Alps triggered by the mid-Pleistocene climate transition. The isostatic response to glacial valley carving may explain part of the surprisingly high measured geodetic uplift rates in the western Alps and may also contribute to the current extensional deformation observed within the core of the mountain belt. Thus, it appears that this recent climatic change had a significant impact on the mountain belt by enabling more focussed and efficient glacial erosion of topography. Confirmation of this hypothesis awaits more detailed analyses of the recent erosional, relief and tectonic history of glaciated mountain belts worldwide.

Factors determining the impact of glacial erosion on shield surfaces

EBERT K.(1), HALL A.(2), KLEMAN J.(1)
(1) Stockholm university, STOCKHOLM, SWEDEN ; (2) University of StAndrews, STANDREWS, SCOTLAND, UNITED KINGDOM

The erosional effect of ice sheets on shield bedrock surfaces has been debated for many decades. Whilst there seems to be agreement that ice sheet erosion of the bedrock landforms was generally modest, and that many preglacial landscape elements remain, we need to know which factors influence ice sheet dynamics and erosional impact on the shield. Using GIS-analysis and field observations, combined with cosmogenic exposure ages, we investigate areas with a similar ice cover history but with greatly different degrees of glacial erosional impact. On two transects with an area of ~35 000km^2 each across the shield, we examine why glacially eroded areas exist adjacent to areas of negligible glacial erosion. Firstly, a E-W transect, identifies two areas of exceptional glacial preservation, the Parkajoki area in Sweden and the so-called ice shed zone in Finland, each with large tors and deep saprolite covers. Secondly a NW-SE transect, overlapping in the northern part with the first transect, includes areas of intense glacial streamlining, with bedrock areas stripped of loose material and barely any weathering remnants. For areas of negligible and advanced glacial erosion, we investigate geology, elevation, topography, hydrology and duration of ice cover in an attempt to identify factors leading to ice sheet erosion/preservation of the underlying shield landscape. We estimate the duration of ice cover from the known ice cover history. We use a single flow path and thereby use steady glaciological parameters. Our results point to glacial bedrock erosion of flat shield surfaces in the range of tens of meters. Erosion only happens in areas where the ice is forced to flow around obstacles or into basins. These preglacial landscape properties are in turn determined by bedrock geology and long-term geomorphic and tectonic evolution. Consequently, a combination of bedrock type and topography determines ice sheet properties and thereby effects of ice erosion on shield surfaces.

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Duricrusts in the Borborema highlands, northeastern Brazil: a climatic and structural approach

TAVARES B.A.C., BARROS A.C.M., CORRÊA A.C.B.
Universidade Federal de Pernambuco, RECIFE, BRAZIL

The genesis of the duricrusts is closely related to the landscape evolution in tropical environments. The highly evolved lateritic crust has a strong influence in the local features placemen, although the most important is the vital connection between the surface materials and the total landscape building. In order to support these premises, the origin of the laterites and its relation to the summit surfaces evolution in the Borborema Highland turns out to be significant, once these highlands sectors is interpreted as residual massifs from the classical models of landscape evolution, without add a structural component to the morphogenesis analysis. Therefore, this research was conducted in the summit surfaces of the Borborema Highlands, northeastern of Brazil. The study area is characterized as one of the highest surfaces of Borborema, with summits reaching 1.200 meters and three defined intramontane plains. There are lateritic crusts widespread along the flat summits and occur as pisolits in colluvium and soils found in the steepest slopes of the massif. From the evidences of laterites along the summits surfaces, it was produced a structural mapping with the crusts location, presenting the relation of the duricrusts position and its possible connection to the highland genesis. The data, enable inferred that the evolution of the highest levels of the massif is consistent with the intramontane plain evolution models, where these sectors evolve through tectonics controls and development of lowered areas followed by a tectonic inactivated sequence enabling lateritic crusts build in the summit surfaces. The formation of these duricrusts is linked to the tectonic stability of an area, however tectonics controls in the studied place is keeping those elevated areas with high altimetry differences between the summits surfaces and the lowered areas being this scenario only possible with the reactivation of old shear zones in the Borborema Highlands.

Geomorphological evolution of the Armorican massif (Western France): a base Upper Cretaceous wave-cut platform degraded in a tropical setting until Late Miocene

BESSIN P.(1), GUILLOCHEAU F.(1), ROBIN C.(1), BAUER H.(2), SCHROËTTER J.M.(3)
(1) Géosciences Rennes, RENNES, FRANCE ; (2) BRGM, ORLÉANS, FRANCE ; (3) BRGM, SGR Bretagne, RENNES, FRANCE

The Armorican massif is one of the four main variscan basements outcropping in France. Its geomorphological study has been performed since at least one century with the classical works of E. de Martonne, R. Musset, A. Guilcher, A. Meynier among the other ones.

This relief is characterized by numerous planation surfaces, sometimes associated with different types of wethering as laterites, silcretes, calcretes or clays with flints. Surimposed on these surfaces, thin sediments deposits of four different ranges of ages are preserved: Ypresian to Lutetian marine deposits, Bartonian to Rupelian marine to continental sediments preserved in several grabens, Langhian to Serravalian marine deposits and Tortonian to Gelasian marine to continental sediments. These last ones are contemporaneous of a major change of climate, from tropical to temperate, during Late Miocene to Early Pliocene period.

We performed a geomorphological study of those surfaces and associated pediments, weatherings and sedimentary deposits.

DEM (SRTM, 3 arc-seconds resolution) analysis and field controls were used to produce a macro-geomorphological features map.

At least, three types of planation surfaces were defined prior the Late Miocene climate change. They record an overall base level change, which could be due to both tectonic uplift in response to Africa-Iberia-Eurasia convergence and eustasy, and are thereafter listed from high to low levels:

i) The Cenomanian high surface, a wave-cut platform surimposed on Lower Cretaceous alterites;

ii) The Paleogene pediplains, composed of pediments with some preserved laterites, silcretes and calcretes, which is sealed by Bartonian deposits;

iii) The Neogene pediplains and pediments, less weathered and sealed by Langhian to Serravalian deposits.

Theses planation surfaces and pediments are later incised, first by the "Red sands" system of Tortonian to Gelasian age, and second by the present-day river system since its incision at the end of the Early Pleistocene.

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Paradoxical topographies: the example of Betic chains

FARINES B., CALVET M.
Laboratoire Medi-Terra EA 4605 Université de Perpignan Via Domitia, PERPIGNAN, FRANCE

The chains crowned by post-orogenic planation surfaces are a singular but usual case. They raise the problem of the genesis and the lifetime of transient landscape in total disequilibrium with the internal and external forcing. We present here the example of the Betic Chains, where these planation forms were ignored by the geodynamic works of the last decades. Two generations of forms, in two spatio-temporal scales, recover from geomorphologic singularity. Extended culminating (1200 – 1900 m) surfaces exist on the eastern internal ranges (Sierra de los Filabres, Sierra Nevada, Sierra de Gádor and Sierra Alhamilla) but also on the whole chain. The mapping on DTM confirm their extension; the chronology and the facies of neogene sediments basins, crossed with available thermochronologic datas, demonstrate a very late completion of these forms, in pre-evaporitic Messinian. The gravitational collapse and the post-orogenic neogene extension, now revealed in the Betic chains, provide the favorable structural context to theit realization. The second generation of forms is inscribed in the first half of the Quaternary: it's about partial erosional plans, pediments, rocky fans, very flared paleo-valley, karstic poljés. These evolved landscapes, actually very perched at 400 to 900 meters of height, precede a major phase of dissection, particularly intense and extended until the current, the tectonic driving of which seems obviously attributable to the lithosperic detachment of slab. The image that results from it, when these peculiarities are taken that are local and regional planation forms, is thus the one of recent, fast and jerky surrection of Betic chains and not of a continuous movement of emersion since the seas of the Miocene, such as up to here postulated from these only sedimentary markers.

Numerical simulations of Plio-Quaternary landscape evolution of the Iberian Chain (Spain)

GIACHETTA E., SCOTTI V.N., FACCENNA C., MOLIN P.
Roma TRE University, ROME, ITALY

The Iberian Chain is an intraplate range located in the central-eastern Iberian Peninsula, showing a dome-shaped topography characterized by a low relief landscape located at a mean elevation of 1300 m. The mountain range results from the late Cretaceous-middle Miocene compression. During the Upper Neogene, compressive structures experienced planation processes presently recorded by wide erosion surfaces. Since about 2.5 Myr (?), a regional tectonic uplift occurred guiding the organization of the present fluvial network. We performed numerical experiments to simulate landscape evolution characterized by the same tectonic and erosion inputs of the Iberian Chain area, using a range of physical parameters calibrated on field, radiometric and morphometric data. To test the evolution of different initial topographies, we used SIGNUM, a Matlab, TIN-based landscape numerical model. The results show that the initial topography that better matches the geomorphological features encountered in the present-day landscape consists of a wide plain with a slightly higher relief to the NE. This plain was surrounded by endorehic areas. After running the SIGNUM, this initial synthetic landscape evolves into a topography that reaches a mean elevation quite similar to the Iberian Chain high-standing plain, preserves small internally drained areas in its interior and is poorly incised by hydrography. Our results, coupled with geological and gemorphological data, allowed us to conclude that:

1) in Miocene-Middle Pliocene a relief of few hundred meters was located in the NE sector of the Iberian Chain; lakes occupied the rest of the present range;

2) in Late Pliocene-Quaternary a regional uplift occurred, causing the progressive capture of endorheic lakes;

3) the time span necessary to obtain a synthetic topography morphologically similar to the Iberian Chain is almost 3 My. This indicates that the uplift onset could be Late Pliocene-Early Pleistocene in age.

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Geochronological constraints on the weathering, exposure, and erosional histories of the Second Paraná Plateau, Southern Brazil

RIFFEL S.B.(1), VASCONCELOS P.M.(1), CARMO I.O.(2), FARLEY K.A.(3)
(1) The University of Queensland, BRISBANE, AUSTRALIA ; (2) PETROBRAS/CENPES/PDGEO/GEOTEC, RIO DE JANEIRO, BRAZIL ; (3) California Institute of Technology, PASADENA, UNITED STATES

The Second Paraná Plateau (2PP), southern Brazil, is a high elevation (ca. 800 m) landsurface characterized by widely distributed deep saprolites and scattered lateritic profiles. These lateritic profiles are possible remnants of a more extensive weathering cover now poorly represented in southern Brazil. We dated homogeneous, well-crystallized, and dense grains of Mn and Fe oxyhydroxides to constrain the ages of weathering profiles at two sites: *in situ* ferricretes and mottled zones at Serra das Almas; and a leached and ferruginized sandstone associated with the ruiniform landscape at Vila Velha. Twenty-two grains of Mn oxyhydroxides were dated by $^{40}Ar/^{39}Ar$ geochronology using the incremental heating method, and 28 grains of goethite were analysed by the (U-Th)/He method. Both methods, at both sites, yielded compatible ages ranging from 36.4 ± 3.6 to 1.0 ± 0.1 Ma. The oldest results, ca. 35 Ma, were recorded by (U-Th)/He ages on goethites from Serra das Almas and Vila Velha, and they represent a minimum age for the stratified lateritic weathering profiles preserved in the 2PP. They also record a minimum exposure age for the 2PP. Our results, when combined to other regional geological and geochronological constraints, suggest that the 2PP was carved by erosion of a minimum of ca. 700 m to a maximum of ca. 2100 m of overlying lithologies. Erosion of this cover between ~135 (constrained by the Paraná basalt age) and 35 Ma implies denudation rates ranging from 7 to 21 $m.Ma^{-1}$. Since ca. 35 Ma, the 2PP surface has been continuously exposed to weathering and localized erosion driven by localized river incision, where incision rates range from ca. 1 to 9 $m.Ma^{-1}$.

Basin inversion, scarp retreat and soil distribution in the Araripe basin (northeast Brazil): implications for denudation history

PEULVAST J.(1), BETARD F.(2)
(1) Université Paris-Sorbonne, PARIS, FRANCE ; (2) Université Denis-Diderot, PARIS, FRANCE

At the border between the Ceará, Piauí, and Pernambuco states (northeast Brazil), the high sandstone table called Chapada do Araripe overlooks lower and drier plateaus and depressions shaped into underlying post-rift and rift layers, in the east, or in the basement, to the west and south. The modes and rates of relief inversion that lead the upper layers of the Araripe basin to their culminating position are examined in relation with geological structure and regional uplift, through the presentation and discussion of morphostructural patterns and types of escarpments, differential erosion landforms, soil sequences, modalities of scarp retreat, and possible differential vertical movements (tectonic inversion). The geomorphic and pedological contrast between the plateau (a near-structural surface covered by Ferralsols) and its lower surroundings (either an exhumed Pre-Cenomanian paleosurface covered by Plinthosols, or lower surfaces with relatively immature soils of Luvisol type, often associated with Leptosols) is explained through a study of the evolution of the cuesta-like scarps or glints and outliers that fringe the chapada above sedimentary depressions and basement surfaces. A reconstruction of the conditions and chronology of relief inversion and corresponding area reduction is proposed, according to principles and methods of morphostratigraphy and morphopedology. It brings elements for discussing recently published models of episodic burial and exhumation history, based upon interpretations of thermochronological data obtained in nearby regions. This discussion also bears strong implications about long-term landform evolution in northeast Brazil and other passive margin areas. From a more general point of view, the present work is considered as a case study for analysing processes and rates of vertical erosion and scarp retreat in tropical tabular structures and sandstone plateaus.

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Structural and Lithologic Control on Topography in a Post-Orogenic Landscape: East-central Appalachians, Pennsylvania

GERMANOSKI D.
Lafayette College, EASTON, UNITED STATES

During orogenesis and the early history of a mountain system, topography is determined primarily by tectonic processes and processes operating to sculpt the landscape (mass-wasting, glacial, periglacial, and fluvial erosion). Active uplift influences climate and dictates process dominance by generating orographic precipitation and thermal regimes that promote glaciation and periglacial activity. Although lithology and structure affect erosive effectiveness, the landscape is dominated by tectonic, glacial, periglacial, fluvial, and mass wasting processes. Post-orogenic landscapes experience a diminishing influence on climate, and a decrease in potential energy differential that reduces the vigor of fluvial incision, and mass wasting, and eventually eliminates altitude-driven periglacial and glacial activity.

We used DEMs and GIS to quantify the average elevation of segments of a post-orogenic landscape underlain by different lithotypes in two areas of the Ridge and Valley of the central Appalachians in Pennsylvania. The results show that the topography in this region reflects the influence of lithology on the relative effectiveness of chemical and physical weathering to erode the landscape regionally.

Regional scale erosion surfaces correlate with lithology in both regions. The highest topography consists of elongate ridges underlain by resistant sandstones, followed in descending elevation by high-grade metamorphic gneiss and intrusive igneous rocks, slate, shale, and soluble carbonates. Variability in elevation among fault-bounded basement blocks of crystalline rock relates to the size of the areal outcrop of each terrane.

These observations suggest that the relative rates of chemical and physical weathering of different lithotypes exert the primary control on landscape morphology in post-orogenic mountain systems. Therefore, landscape form transitions from a tectonic, mass wasting, and glacial/fluvial dominance to a weathering dominated landscape.

Cosmogenic evidence for profound landscape disequilibrium and pre-Pleistocene landscapes in South Africa

BIERMAN P.(1), ROOD D.(2)
(1) University of Vermont, BURLINGTON, UNITED STATES ; (2) Scottish Universities Environmental Research Centre, EAST KILBRIDE, UNITED KINGDOM

Southernmost Africa is characterized extensive, gently-sloping uplands dissected by drainage systems flowing through deeply incised valleys. These uplands have been interpreted as ancient land surfaces and used in establishing denudation chronologies even though there are few geochronologic constraints on their age or the rate at which they are modified by surface processes.
Measurements of *in situ*-produced, cosmogenic ^{10}Be and ^{26}Al place quantitative, geochronologic constraints on the minimum surface exposure age and maximum erosion rate of land surfaces in south-central South Africa. Upland surfaces are little changed since the Pliocene; cobbles and outcrop samples collected from 5 silcrete-mantled surfaces have minimum limiting surface exposure ages of 0.2 to 2.7 My (median = 0.93 My) and maximum limiting erosion rates of 0.11 to 3.2 m/My (median = 0.54 m/My). Considering ^{26}Al analyses suggests that most samples have experienced only short periods of burial since initial exposure; two-isotope exposure/burial solutions extend minimum total histories of samples back to between 1.0 and 3.7 My and suggest that some of these surfaces have been stable near Earth's surface since at least the Pliocene.
The ^{10}Be content of 8 sand samples collected from rivers draining to the Southern Ocean indicates that the landscape as a whole is eroding much more quickly (about 5.4 m/My, area-weighted average) than the upland surfaces; thus, relief is increasing over time. Basin-scale erosion rates increase from west to east across southern Africa, suggesting the influence of the East African Rift and/or the African super swell on rates of surface processes.
Together, these data indicate a landscape of profound disequilibrium where ancient, gently-sloping land surfaces, their form inherited from millions of years ago, stand above incised channel networks which are eroding the overall landscape 10 to 25 times more quickly than erosion proceeds on the uplands.

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Robust lithologies preserve ancient alpine-like topography in southern Africa

SCHARF T.(1), CODILEAN A.(2), DE WIT M.(1), JANSEN J.(3), KUBIK P.(4)
(1) AFRICA EARTH OBSERVATORY NETWORK, NELSON MANDELA METROPOLITAN UNIVERSITY, PORT ELIZABETH, SOUTH AFRICA ; (2) EARTH SURFACE GEOCHEMISTRY, GFZ GERMAN RESEARCH CENTRE FOR GEOSCIENCES, POTSDAM, GERMANY ; (3) DEPARTMENT OF PHYSICAL GEOGRAPHY AND QUATERNARY GEOLOGY, STOCKHOLM UNIVERSITY, STOCKHOLM, SWEDEN ; (4) LABORATORY OF ION BEAM PHYSICS, ETH ZURICH, ZURICH, SWITZERLAND

The Cape Mountains of southern Africa present an exception to the much-cited coupling of topography and tectonics. This relict postorogenic terrain is comparable to present-day active orogens in terms of hillslope and relief, yet returns some of the lowest ^{10}Be-based denudation rates in the world. Consequently, the Cape Mountains provide an outstanding demonstration that rugged topography alone is not sufficient to incite high denudation rates, and active tectonics need not be responsible for the maintenance of alpine-like topography. We attribute the suppression of denudation rates and maintenance of rugged topography within these mountains to the physically robust and chemically inert quartzites and metasediments that comprise the backbone of these mountains. The Cape Mountains thus provide a striking example of the strong role that lithology may play in long-term landscape evolution.

Are flat-topped orogens robust indicators of non-equilibium mountain topography?

CALVET M.(1), GUNNELL Y.(2), FARINES B.(1)
(1) Université de Perpignan-Via Domitia, EA 4605 Médi-Terra, PERPIGNAN, FRANCE ; (2) Université Lumière-Lyon 2, UMR 5600 CNRS Environnement, ville, société, LYON, FRANCE

The skyline of non-equilibrium mountain topography commonly exhibits elevated erosion surfaces, here termed Paleic surfaces, thus forming flat-topped rather than peak-topped mountain ranges. Such enigmatic features go against the common perception of alpine scenery, are still rarely accounted for in geodynamic models, and raise the questions of how and when these landforms were generated and why they have been preserved. Here we review a collection of examples around the complex plate convergence zone of the Mediterranean, some of them underpinned by new morphotectonic field evidence or low temperature thermochronological data (Betics, Bulgaria, Carpathians). We subsequently examine existing answers to this ancient geomorphological problem of transience in landscape development. We show that alternatives to recent vertical uplift, such as 'altiplanation', are difficult to generalise even though the inventory of plausible lithospheric mechanisms responsible for recent and rapid uplift needs further investigation. A key issue also concerns the palaeoelevation at which the Paleic surfaces formed before uplift, and the methods by which to establish it.

Key words: erosion surface, mountain, Cenozoic, denudation, altiplanation, palaeoaltimetry.

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Using landscape evolution models to interpret climatic drivers of cyclic aggradation and incision along the fringes of a decaying mountain range

LANGSTON A.(1), TUCKER G.(1), ANDERSON R.(2)
(1) University of Colorado, BOULDER, UNITED STATES; (2) Institue of Arctic and Alpine Research, BOULDER, UNITED STATES

Flights of terraces that flank range fronts throughout the Rocky Mountains record episodic stream incision over at least the past 1.5 Ma. Recent work dating terraces in the Denver Basin along the Colorado Front Range suggests that these high surfaces were formed during glacial intervals and rapidly incised during interglacials. Climate change related to glacial-interglacial cycles has been suggested as a possible driver for the repeated aggradation and incision of these high surfaces. Potential mechanisms for increasing sediment supply and transport in rivers include variations over time in (1) periglacial weathering and hillslope transport, (2) the magnitude and timing of runoff and stream flow, and (3) sediment flux from intermittently glaciated major valleys. These three mechanisms raise the question which of them (if any) is primarily responsible for the cycles of aggradation and incision that appear to have created the staircase-like terrace surfaces along the range front. In this study, we use a landscape evolution model to determine whether the first of these mechanisms, in isolation, is sufficient to explain the observed rates and patterns of terrace formation and abandonment along the Colorado piedmont. We study an idealized catchment in which the upper half lies on resistant rock that detaches into cobble-sized regolith (representing the crystalline mountain range) and the lower half lies on soft rock that detaches into sand-sized regolith (representing the adjacent sedimentary basin). By increasing hillslope diffusivity by a factor of 4, we observe sediment aggradation in valleys within both the mountains and the basin. These results suggest that temporal changes in hillslope diffusivity alone play an important role in sedimentation and incision in mountain-bounded basins.

The post-orogenic Rocky Mountain Surface on the front ranges of Colorado, USA - its character and possible causes of its deformation

LEONARD E.(1), MCMILLAN M.(2), OUIMET W.(3)
(1) COLORADO COLLEGE, COLORADO SPRINGS, CO, UNITED STATES ; (2) UNIVERSITY OF ARKANSAS AT LITTLE ROCK, LITTLE ROCK, AR, UNITED STATES ; (3) UNIVERSITY OF CONNECTICUT, STORRS, CT, UNITED STATES

The low-relief Rocky Mountain Surface, which formed on the Colorado Front Range and adjacent ranges during and following the Cretaceous-to-Eocene Laramide Orogeny, has long been used as a marker of Cenozoic deformation. This study employs geomorphic and stratigraphic analysis to investigate original character of the surface, its subsequent erosion, and the location, character, and magnitude of its Neogene/Quaternary deformation. Much of the surface has experienced less than 50 m of erosion since its formation, although local incision along drainages approaches 1 km. This focused incision is greater in the south than in the north, consistent with erosion patterns on the piedmont to the east.

In the north the Rocky Mountain Surface has a consistent eastward dip, presumably reflecting its formational slope. To the south, its geometry is more complex. The southern portion of the surface generally dips eastward or southeastward, but its eastern edge is elevated several hundred meters above its central portions. Deformation of the southern portion of the surface has long been attributed to Rio Grande Rift-related stresses. Additionally, some of the complexity of this part of the surface may reflect its original geometry. Another possibility is that relative uplift of the eastern portion of the surface occurred as an isostatic response to differential Neogene/Quaternary erosion. Long-wavelength, km-scale erosion of the piedmont to the east of the mountain front contrasts with areally much more limited, short-wavelength erosion by mountain streams to the west. Initial modeling suggests that flexural isostatic response to this differential erosion would produce a westward tilt of the eastern portion of the Rocky Mountain Surface consistent with the observed *pattern* of relative uplift. However, the observed *magnitude* of relative uplift is several times that predicted as a flexural response to differential erosion.

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The Colorado Plateau of the American Southwest where patterns of river incision are decoupled from topography and proposed mantle sources of uplift

PEDERSON J.
Utah State University, LOGAN, UTAH, UNITED STATES

The active orogenic plateaus of the world have revealed the linkages between erosion, steep topography, uplift, and climate feedbacks in landscape evolution. Yet none of these linkages is apparent in the Colorado Plateau. Here I present calculations of river energy and steepness as well as new incision-rate data and then relate these patterns to proposed mantle sources of uplift.

Calculations of unit stream power and discharge-adjusted steepness index (k_{qsn}) in the upper Colorado drainage highlight four canyon knickzones. The strong coincidence of knickzones with changes in bedrock and mass-movement inputs suggests they are mostly pinned, equilibrium adjustments to greater bed resistance. Similarly, new late-Pleistocene incision rate data exist for locations spanning the trunk drainage, constrained by multiple OSL, CRN, and U-series ages. These results reveal a distinct central-Colorado Plateau bulls-eye of faster river incision. This contrasts sharply with expectations based upon the patterns of energy expenditure and topography, but it matches modeled isostatic rebound from the broad late Cenozoic exhumation of the central plateau. Finally, neither patterns of steepness nor incision rate match recently proposed uplift patterns from mantle sources. For example, the highly incised and steep Grand Canyon region has proposed dynamic-mantle sources of uplift yet contrastingly low rates of incision, while the broadly exhumed central plateau Canyonlands features much more rapid incision yet no mantle sources of uplift.

The latest information from this famous region reveals that, rather than the expected situation of active uplift inspiring steep topography and fast incision rates, the Colorado Plateau is a decaying and transient landscape ruled by bedrock controls and passive isostatic rebound.

Late Cenozoic River Incision in the Rocky Mountain region and implications for Neogene uplift in the western U.S.

ASLAN A.(1), KARLSTROM K.(2), KIRBY E.(3), HEIZLER M.(4), LAZEAR G.(5), ROSENBERG R.(3)
(1) Dept of Physical and Environmental Sciences, Colorado Mesa University, GRAND JUNCTION, COLORADO, UNITED STATES ; (2) Dept. of Earth and Planetary Sciences, University of New Mexico, ALBUQUERQUE, NEW MEXICO, UNITED STATES ; (3) Dept. of Geosciences, Penn State University, UNIVERSITY PARK, PA, UNITED STATES ; (4) New Mexico Bureay of Geology and Mineral Resources, SOCORRO, NEW MEXICO, UNITED STATES ; (5) Consulting Geologist, CEDAREDGE, COLORADO, UNITED STATES

The Rocky Mountain province experienced multiple phases of uplift since retreat of the Cretaceous Seaway ca. 80 Ma. To evaluate late phases of uplift, we present data on the incision histories of the Colorado, Green and Yampa Rivers over the past 10 Ma. We also draw connections between patterns of river incision and mantle processes to explain landscape changes during the Neogene.

Provenance of river gravels and ages of Miocene basalt flows show that upper Colorado integration occurred ca. 16-11 Ma, prior to integration through Grand Canyon ca. 6-5 Ma. Colorado River incision began 9.5-7.8 Ma and resulted in 750 to 1500 m of incision at rates of 96 to 155 m/Ma since 10 Ma. Largest magnitudes of incision and fastest incision rates are associated with areas of Miocene basaltic magmatism. In the Yampa River, incision began later than 6.1 Ma, and the river has incised 800 to 850 m at rates of 90 to 115 m/Ma. Integration of the upper Green River is poorly constrained between 8 and 2 Ma, and probably post-dates the advent of the ancestral Yampa River ca. 6 Ma. Using Oligocene river gravels as a datum, the Green River has incised <400 m at rates of <20 m/Ma over the past ca. 30 Ma. In the Colorado River basin where more than one datum is available to calculate long-term rates, incision has remained semi-steady over the past ca. 10 Ma.

Comparison of river incision patterns with P-wave tomography suggests possible connections between mantle processes and landscape evolution. Upper Colorado regions have the fastest incision rates and slowest P-wave velocities. In contrast, the upper Green River basin has the slowest incision rates and fastest P-wave velocities. Post-10 Ma differential bedrock incision could be explained by differences in mantle flow or buoyancy between the upper Colorado and Green River basins.

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Role of climate and tectonics in the geomorphologic evolution of the Semiarid Chilean Andes between 27-32°S

AGUILAR G.(1), RIQUELME R.(2), MARTINOD J.(3), CARRETIER S.(3), DARROZES J.(3), REGARD V.(3)
(1) Departamento de Geologia, Universidad de Atacama, COPIAPÓ, CHILE ; (2) Departamento de Ciencias Geologicas, Universidad Catolica del Norte, ANTOFAGASTA, CHILE ; (3) Geoscience Environnement Toulouse, CNRS, IRD, Université de Toulouse,, TOULOUSE, FRANCE

A morphometric analysis that considers hypsometry and topographic slope reveals longitudinal and latitudinal differences in the degree of maturity of the relief of the Andes between 27-32 ° S. Whereas landscape rejuvenation of the Coastal Cordillera takes place to the south of 29.5°S, in the Main Cordillera it happens south of 28.5°S. The combination of a wetter climate towards the south and the presence of segments with different tectonic features explain these variations. Longitudinally, the geomorphological features indicate the presence of a mountain front that separates the Coastal Cordillera from the Main Cordillera. Between 28.5 and 30.5°S this front can be attributed to the activity of the Vicuña-San Félix Fault System, which during the Oligocene - Early Miocene accommodated the relative uplift of the Main Cordillera. In response to this tectonic activity, successive levels of cut-and-*fill* pediments formed. During the Middle Miocene, there was a new episode of uplift affecting the entire fore-arc. In response to this uplift, the valleys that cross this region were excavated. Calculated velocities of knickpoints retreat for each period are 7 km/Ma for the early and 10 km/Ma for the later. Knickpoints reached the high Main Cordillera at 17 Ma and 8 Ma respectively. Long-term erosion rates show also these two different periods in the high Main Cordillera. Cut-and-*fill* pediments from 17 to 8 My show erosion rates between 5 and 30 m/My and valley incision during the last 8 My yields larger erosion rates, between 45 and 75 m/My. This geomorphologic approach shows that the uplift of the Semiarid Chilean Andes occurred in two different episodes with different geomorphological signals. We correlate these episodes with changes in the geodynamics of subduction during Oligocene-Neogene.

Erosion rates and their controlling factors along the eastern Qilian Shan Mountian, China

PAN B., HU X., GENG H., LI Q., GAO H.
Key Laboratory of Western China?s Environmental Systems (Ministry of Education), Lanzhou University, LANZHOU, CHINA

The interaction among earth-surface erosion, tectonic uplift and the climate is a key issue to understand the earth surface evolution. In recent two decades, a number of studies are carried out in orogens, especially in the Himalaya area, trying to solve the erosion problem, and also arouse big controversy on which factor is in controlling the erosion rate. One of the uplifting mountain belts along the northeastern Tibetan Plateau, the Qilian Shan Mountain, has been experiencing intense deformation in late Cenozoic. Varied erosion rates in different mountain zones supply an ideally natural lab of the Qilian Shan to study the surface erosion and its controlling factors. With different methods, we obtained erosion rates in different time scales along the eastern Qilian Shan. Apatite fission track and apatite (U-Th)/He studies in the Xiying River basin give cooling ages of 56~80 Ma and of 22-45 Ma, respectively. Thermo-history modeling results show that: From ~ 70 to 10-8 Ma, the rock was cooling in a relatively low rate; from 10-8 Ma to present, the rock was cooling in a relatively high rate of 7.5±1.8 ℃/Ma. Estimated average rate of rock erosion since 10-8 Ma is ~ 0.23 mm/a, and the results illustrate a higher erosion rate in the south (hanging wall) of the Huangchen-Taerzhuang thrust fault (the H-T fault). In the late Quaternary, river terraces are mainly formed in five periods: 10 ka, 20-25 ka, 30-37 ka, 51-56 ka and 67-71 ka. Based on the terrace heights and ages, calculated river incision rates are between 0.3 and 2.5 mm/a. Spatial pattern of river incision rates shows the higher rates are also located in the south of the H-T fault. Cs^{137} contents give modern erosion rates of 0.1~0.4 mm/a, and show a good correlation with slope gradient. After we correlate the different erosion rates of different time scales with the tectonic uplift and precipitation, we find out that the erosion rate is mainly controlled by tectonic uplift.

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Rain, water, and ice: driving forces behind rapid erosion in western Bhutan

PORTENGA E.(1), BIERMAN P.(2), DUNCAN C.(3)
(1) University of Glasgow & Macquarie University, GLASGOW, UNITED KINGDOM ; (2) University of Vermont, BURLINGTON, VT, UNITED STATES ; (3) GISmatters, AMHERST, MA, UNITED STATES

We employ the cosmogenic nuclide, ^{10}Be, to quantify basin-averaged erosion rates on millennial timescales and analyze spatial patterns of erosion in western Bhutan where knickpoint retreat, tectonic uplift, monsoonal precipitation, and glacial erosion actively shape the landscape. Measurements of ^{10}Be in quartz purified from modern stream sediment in 47 drainage basins (4-8,000 km^2) span almost three orders of magnitude, from 560±290 atoms/g to $3.8x10^5±7x10^3$ atoms/g, yielding erosion rates ranging from ~98-21,000 m/My; the median erosion rate is 880 m/My. Erosion rates are not correlated with topographic metrics such as elevation, relief, mean annual precipitation, or ice cover. Erosion rates, however, reach a maximum in basins where the average basin slope exceeds 25°. These steep basins are geographically grouped into two regions: one region is south of an uplifted and preserved low-relief step associated with the Greater Himalayan Sequence (27.0-27.4°N) and the other is north of this same preserved land surface (27.6-28.4°N). Monsoonal rains drive erosion along the range front where average basin slope angles are steepest. Headwater streams are likely oversteepened, adjusting to the passing of a knickpoint which is propagating through the Greater Himalayan Sequence, exposing the underlying Lesser Himalayan Sequence. A declining precipitation gradient with increasing latitude (R^2 = 0.74) suggests that other factors dominate erosion north of the preserved low-relief step. The percentage of basins covered with ice and glaciers increases abruptly north of the raised step and includes the majority of basins exhibiting high erosion rates. Rates from these northernmost basins are likely the combined result of intense glacial erosion and steepened valleys nearing threshold slope angles. The calculated erosion rates are similar to fission track exhumation rates for western Bhutan but are twice as fast as basin-average erosion rates from eastern Bhutan.

Spatial distribution and residence time of large valley-fills along the Himalayan arc

BLÖTHE J., MUNACK H., KORUP O.
University of Potsdam, POTSDAM, GERMANY

Our understanding of sediment routing through mountain belts and their forelands, and their final deposition in large submarine fans remains incomplete with lacking estimates of intermediate storage, which is the crucial link between erosion rates and sediment yields. Sediment storage can have a profound influence on material fluxes through attenuating water and sediment flows; decoupling hillslope from river-channel processes; sequestering biogeochemical constituents; and providing intermontane sedimentary archives of environmental change. Besides this, sediment storage frequently offersflat ground for settlements and land use, but also acts as a source for sediment related hazards. Here we quantify the sediment stored in >38,000 Himalayan mainly postglacial valley fills, based on unsupervised extraction and geometric scaling of digital topographic data. We find large differences between the Western, Eastern, and Central Himalayas. While most of the total volume of ~650 +/- 200 km^3 focuses around the Himalayan syntaxes, where erosion rates are high, and glacially conditioned valley trains provide sufficient accommodation space, the Central Himalaya only hosts very few large valley fills (> 1 km^3). We compare the spatial distribution of valley fills along the Himalayan arc to different influencing factors, i.e. precipitation pattern, distribution of glaciers, mean local relief, tectonic structures, and long-wavelength topographic gradient. We speculate that the step-like long-wave topography in the central Himalaya limits glacier extent, and thus any significant sediment storage. Our morphometrically based estimates of volume and residence time are in good agreement with published data. The estimated volume stored in Himalayan valley fills could potentially feed contemporary denudation rates for $>10^3$ yrs, and signifies the elevated residence times of eroded material of up to 10^5 yrs at the mountain-belt scale.

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Poster presentations:

Significance and age of "megakarrens" in Sardinia (Italy)

GINESU S.(1), DUNCAN R.(2)
(1) University, SASSARI, ITALY ; (2) College of Earth, Oceanic and Atmospheric Science, CORNVALLIS OREGON, UNITED STATES

In the central part of Sardinia, a series of parallel cavities along an erosional surface ouctropped in the limestones and marbles of the Miocene that characterize the study area. The survey of the area around the micenic rocks allowed to assign these open cavities to the fractures of the Miocene rocks undergo a slow process of karstification. The fractures show distances between the walls from 0:50 to 2:00 ms, while it was not possible to observe the closure in the bottom. All fractures were filled with residual clay sandly (like "Terra Rossa") with missing components. The distance between the individual fractures is varied but the direction is always parallel, while in the area the fractures sequence has directions concordant with the recent tectonic and different. However, fractures outside the studied area rarely show the fill clay; fact due to the remarkable quantità of water moved into and out for a long time in these morphologies exposed to surface water circulation. The spread of the phenomenon and the morphology of the territory is rather difficult to define, it is a series of "megakarren" whose size suggests a landscape like "forest stones" whose forming time could have been very long. Recently, in a cave not far from the studied site, the explotation activity revealed a contact between an outcrop of these fractures with an overlying volcanic episode. The sampling has identified a basalt rock of the Plio-Pleistocenic volcanic cycle that affected the whole island through numerous episodes effusive. The dating of this basalt by Ar/Ar method gave an age of 2.2 M.y.b.p. placing it at the end of the Pliocene. This information provides an important element to dating this phenomenon in a sub-tropical environment, under hot and humid climate. The age of this rock let to date the long period of leaching and the important rule of areal erosion consequent to cold phases after the Pliocene.

Valley slope evolution in a southern thyrrenian coastal area (Calabria, Southern Italy) as a coupled effect of quaternary sea-level changes and river erosion

BOZZANO F., CIPRIANI I., DELLA SETA M., MARTINO S.
Dipartimento di Scienze della Terra - Sapienza Universita' di Roma, ROME, ITALY

The Thyrrenian coastal area between the villages of Scilla and Bagnara Calabra (Calabria, Southern Italy) is the result of polyciclic geomorphological processes influenced by the coupling of high-rate Quaternary regional uplift, eustatic oscillations and intense river erosion. Within this area, the Favazzina and Sfalassà creek valleys represent the main geomorphological evidences of the river erosion, since they consist on deep cuts involving the geological bedrock of Ercinic metamorphic rocks as well as the Pliocene to Holocene terrigenous deposits. Geomorphological evidences, such as remnants of marine terraces and river strath terraces, testify for the polycyclic morphoevolution. Numerous landslides affecting the valley slopes generally do not reach the valley floor as an effect of the aforementioned evolution.

A detailed geological survey, supported by terrain analysis on a high resolution DTM, made it possible to recognize several river deepening phases along the Favazzina and Sfalassà creek valleys, and to associate the observed distribution of the largest landslides to the two main stationary phases, which correspond to an equal number of relict strath terrace surfaces.

A sequential evolutionary model of the Favazzina and Sfalassà creek valleys is here proposed, alternating different steps of river deepening and valley widening. Based on this model, a slope stability analysis was also approached by a finite difference modeling; to this aim, an engineering geological model of the valley slopes was reconstructed along representative geological sections and the geomechanical properties were attributed to the rock masses according to an equivalent continuum rheological behavior.

The numerical modeling was performed under a time dependent creep configuration and it was calibrated by taking into account the available geomorphological constraints. The modelling output the significance of the step-like valley evolution in the triggering of the main existing landslides.

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Mechanism and structure of denudation in Island Steppes of Siberia

BAZHENOVA O.
V.B. Sochava Institute of Geography SB RAS, IRKUTSK, RUSSIAN FEDERATION

A special regional trigger mechanism of denudation, realizing an intensive transport of matter is established for the sub-arid foothills of the northern periphery of the South Siberian mountain belt. Its essence lies in the progressive removal of the weathering products from the mountain country alternately by wind and water currents. Switch rearrangement process is realized by are the climatic variations. The mechanism is stable; as it is set not only in the course of the modern long-term supervision, but it is found in the structure of the reference sections of Quaternary sediments.

A climate-caused cycle manifests itself in the functioning of denudation systems of various levels. It is expressed in an active interchange of periods of matter drifting, when the relief is being rebuilt, and periods of relative stability. The parts of the cycle are the dynamic phase of denudation, which follow each other in a certain order. The structure of the dynamic phase gives an idea of time invariant of denudation systems, characteristic for a particular morphoclimatic area, as it is stored in the rings of different hierarchical levels (ranging from 11-year-olds and 30-35 thousand years old). The leading role in the reconstruction of the relief does not belong to a long zonal phase of denudation with slow and moderate speed processes, but to occasional extreme impulsive phase with rapid demolition of large volume of material. Summing up in the geological time scale, such a "salvo" matter drifting creates a corresponding geomorphological effect. While in some cases the relief is broken (the middle Siberian denudation type), in other it is aligned (the Minusinsk type), and in others the denudation is accompanied by preservation of the morphological appearance of the relief (the Central Asian type of denudation).

Differential weathering in the Turvo River Basin

RICCIONI DE MELOS A., FERREIRA BESERRA S., MENDES J.C., COELHO NETTO A.L.
Universidade Federal do Rio de Janeiro, RIO DE JANEIRO, BRAZIL

Denudation is caused by a combination of weathering and erosion processes which model the earth's surface, resulting in changes in the landscape. Basins following different evolutionary and functional models can be found in the middle of the Paraiba do Sul River Valley. The Bananal, São José do Barreiro and Sesmarias river basins show erosion features, indicating the great effectiveness of mechanical processes. In addition to operational variations observed between the Bananal and Turvo river basins, the Turvo basin has internal variations in magnitude of the mechanical and chemical denudation processes. This paper attempts to understand the spatial distribution of different weathering degrees in the Turvo River Basin, and to comprehend and explain the geomorphological differences between them. In areas representative of these two denudation types, chemical and textural analyses were performed on weathering profiles with the same lithology and on those with different lithologies. Surface water chemical analyses were made. The results indicated highly weathered profiles across the basin. However, the silt / clay ratio indicated more weathered profiles in the Turvo sub-basin. WIP and CIA chemical indices pointed towards totally weathered profiles in the Turvo sub-basin, with little variation across the depth evaluated. However, in the Pedras sub-basin, a great decrease in weathering occurs from third meters in depth. In this sub-basin, surface water chemical results showed higher concentrations in all elements, indicating that mobile elements are available in weathering profiles, which are thinner, and that water can percolate up to the weathering front. Given the overall data, it is reasonable to conclude that mechanical denudation processes are more active in the Pedras sub-basin, whereas chemical processes dominate the Turvo sub-basin evolution.

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Chemical dynamics, weathering rate and atmospheric/soil CO2 uptake of basalts at São Paulo State, Brazil

CONCEICAO F., DIEGO S., MATHIAS C., LETÍCIA G.
UNESP, RIO CLARO, BRAZIL

The balance between the processes of weathering contributes to the geomorphologic modeling the Earth's surface. Weathering rates are therefore an important role in the rate of consumption of $CO_2$and moderation of the climate. The chemical dynamics, weathering rate and atmospheric/soil CO_2uptake of basalts from Serra Geral Formation (917,000 $km^2$of area) in the Preto Stream basin, São Paulo State, Brazil, were evaluated using major elements as natural tracers. This basin has serious environmental problems in terms of quality of surface and rainwater, which affect the determination of weathering rate and atmospheric/soil CO_2 uptake. The Preto Stream, downstream from Ribeirão Preto city, receives several elements/compounds through anthropogenic activities, with only sulfate yielding negative flux values. The negative flux of SO_4^{2-}can be attributed to atmospheric loading mainly related to anthropogenic inputs. After corrections for anthropogenic and atmospheric inputs in the Preto Stream basin, the transport of dissolved material derived and weathering rate were 30 ton/km^2/yr and ~7 m/Ma.The weathering rate value is lower than the Amazon basin or other estimations made for equatorial environments. This is equivalent to 10.4 x 10^6kgof rock being removed each year by the Preto Stream. The instantaneous flux was found to be a function of discharge, with the majority of dry residue (dissolved load) being transported during the summer (wet) months. The Preto Stream basin is in a region where the climate causes moderate chemical weathering, with the predominance of monosiallitization, with partial hydrolysis of minerals from bedrock, with some of the Si remaining in the profile and Na, Ca, K and Mg being removed. The atmospheric/soil CO_2uptake related to basalts weathering processes corresponded to 375x10^3mol/km^2/yr, being this values higher than when compared to world continental averages (161x10^3mol/km^2/yr) or Amazon basin (331x10^3mol/km^2/yr).

The resilience of a badlands area to climate change

YAIR A.
Hebrew University of Jerusalem, Department of Geography, JERUSALEM, ISRAEL

Badlands represent an intensely dissected barren landscape; devoid of soil cover, with a sparse or absent vegetation cover. The very high drainage densities, V shaped valleys and steep slopes have often led to believe that badlands represent a landscape where the frequency and magnitude of runoff, and erosion processes are high; resulting in rapid landscape evolution. This is why badlands have been regarded as 'ideal field laboratories. Such a landscape may therefore be regarded as highly responsive to climate change. However, hydrological and erosional data collected in the Zin valley badlands (Northern Negev desert, Israel), carved in a uniform lithology of shales, do not support the views listed above. They point to a very low frequency and magnitude of runoff generation; and low hydrological connectivity within very small watersheds. Erosion rates are extremely low. Geomorphological features and prehistoric dated sites point to a very low sensitivity to of the Zin badlands to climate change during the upper Pleistocene. The Zin badlands offer a good opportunity to address the complex issue of geomorphic processes over short distances; while dealing with the question of their sensitivity to climate change.

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Characteristics of hypsometry and valley geometry of the Suoshui basin in Zhangjiajie and their implications in landform evolution

SHI C., SHAO W., QI D.
Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, BEIJING, CHINA

Using data of DEM, landform and geologic maps and surveys in fields, this study investigated the characteristics of valley geometry, the knickpoints along the main steam and first-order tributaries, hypsometry and the stage of landform evolution of the Suoshui River basin, in which most of the sandstone forests or pillars, the typical Zhangjiajie landform, are located. Results show that the Suoshui River has a concave longitudinal profile with a slope declining downstream and a concavity value of 0.70. Over ten knickpoints or knickpoint zones are identified on the trunk stream and first-order tributaries of the river. The total fall of the knickpoints from KP1 to KP10 is about 149 m, which seems to be the result of base level lowering in the past about 0.93 million years. Comparing the downcutting rate of the Suoshui River with the height of sandstone pillars, formation of the sandstone pillars or forests should start before Quaternary. The cross-sectional concavities of both the Suoshui valley and its first-order tributaries are higher than 0.5 on average, suggesting the formation of strips of floodplains along the valleys by lateral erosion, which are the characteristics of landforms in the middle and late mature stage. The lateral erosion and a higher value of cross sectional concavity of valleys should be a favorable condition for the formation of the isolated sandstone pillars in Zhangjiajie. The impacts of relief and rock property are not detectable on the hypsometric integral in the basin. The sandstone forests and pillars in Zhangjiajie concentrate in the areas with Devonian sandstone as the bedrock in the lower section of the upper reaches and upper section of the middle reaches, where the fluvial-erosional landforms are in their mature stage indicated by a mean hypsometric integral of 0.46.
Keywords: Zhangjiajie landform; Suoshui River; Valley geometry; Hypsometric integral; Landform evolution.

Are cirques exclusively cold-climate landforms? Allometric growth revisited in the Eastern Pyrenees

DELMAS M.(1), GUNNELL Y.(2), CALVET M.(1)
(1) Université de Perpignan-Via Domitia, EA 4605 Médi-Terra, PERPIGNAN, FRANCE ; (2) Université Lumière-Lyon 2, UMR 5600 CNRS Environnement, Ville, Société, LYON, FRANCE

Cirques have long been the focus of morphometric analysis. Allometric relations underpinned by the ergodic hypothesis have been used as proxies to speculate about the dominant processes responsible for cirque growth patterns, typically making these a combination of floor lowering by subglacial processes (abrasion, quarrying) and headwall recession by periglacial processes. Faith in this direct link between form and process is based on the widely accepted view that cirques are exclusively ascribable to cold-climate processes (they are hence prescribed as 'glacial'), thus dismissing the possibility that cirque volume may include a proportion of pre- and/or interglacial inheritance. A quantified sediment budget of Würmian cirque erosion in the Carlit massif, Eastern Pyrenees, has yielded a maximum bedrock denudation depth of 18.4 m. This result is used here as a benchmark to assess which among a population of 1071 first-order cirques in the Eastern Pyrenees could be of a composite nature, i.e. not exclusively produced in cold-climate conditions. Morphometric results do show that cirque location and size are strongly constrained by solar radiation, the morning–afternoon effect and wind-blown snow accumulation in the lee of ridgetops. However, allometric indices also reveal stronger correlation with bedrock lithology and with characteristics of the pre-glacial topography than with climatic parameters, suggesting that cirque allometry is an imperfect predictor of process and hence a spurious metric. Extrapolation to the entire Pleistocene of Würmian denudation depths in the lightly glaciated Carlit massif show that ~40 % of the cirque basins cannot exclusively be cold-climate landforms, implying that they were partly formed by other processes during pre- and/or interglacial intervals. Likewise, the proportion of composite cirques in massifs on the more intensely glaciated north side of the East-Pyrenean range is ~20%.

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GIS-based morphometric analysis of the Blue Nile and Tekeze watersheds (Ethiopia)

SEMBRONI A., GIACHETTA E., MOLIN P., FACCENNA C.
Roma Tre University, ROME, ITALY

The Ethiopian plateau is a wide high-plain (mean elev. 2500 m) underlain by ~1000 m of flood basalts (30-29 My) generated by the Afar plume. The basalts overlie Pre-Cambrian basement and Mesozoic sediments. During late Oligocene-Pliocene shield volcanoes formed rising hundreds of meters above the plateau. We examined the topography of the NW Ethiopian plateau focusing on the metrics of the Blue Nile and Tekeze rivers basins. Our main data source is the SRTM DEM coupled with geological maps. We extracted 173 longitudinal river profiles, identified knickpoints and computed concavity and steepness indices. We analyzed the hypsometric curve and integral (HI) of basins to discern the relative dominance of fluvial incision or hillslope processes. Reconstructing the plateau surface, we calculated the minimum and maximum eroded volumes in the two main basins. Our results show the Tekeze R. basin is characterized by wide valley-bottoms and gentle slopes; its smooth concave longitudinal profile indicates this river is close to equilibrium; most of knickpoints of its tributaries are related to rock-types changes; the hypsometric curve shape (HI=0.31) indicates a strongly incised landscape, where the high plain is poorly preserved. The Blue Nile R. basin presents gorges and tectonic-controlled valleys; the longitudinal profiles of the Nile and its tributaries are disturbed by knickpoints: downstream they correspond with tectonic lineaments; upstream they probably record base level changes; the hypsometric curve (HI=0.41) indicates a poorly incised landscape (apart of the valley of the Blue Nile R.) that still preserves the plateau. We conclude that, although both main basins experienced a regional uplift, their evolution was affected by local volcanism and tectonics. The Tekeze R. basin hydrography is more close to steady-state, whereas the Blue Nile R. basin was affected upstream by the formation of large shield volcanoes and downstream by tectonics.

Processes and rates of bedrock erosion in Welsh rivers, and the implications for long term landscape development

RICHARDSON J., TOOTH S., GRIFFITHS H.
Aberystwyth University, ABERYSTWYTH, UNITED KINGDOM

Many studies of Welsh rivers have examined contemporary processes and late Quaternary histories in alluvial reaches but the development of shorter, steeper bedrock reaches remains poorly understood. It is unclear whether the characteristic gorges, rapids and waterfalls have developed since the last glacial or are older, inherited features that have been exhumed from beneath glaciofluvial outwash and little modified since. On the River Rheidol, west Wales, we investigated four bedrock reaches up to 524 m long (8% of total river length). The reaches have developed in interbedded, moderately resistant, shales and sandstones with varying degrees of jointing, folding and small-scale faulting. Bedrock erosion during floods is by plucking and abrasion. Seeding experiments in well-developed potholes indicate active gravel exchange during floods, although gravel volumes vary with pothole size, location relative to bedrock outcrop, and inundation frequency. Pothole morphometries suggest that they deepen faster than they widen but deviations from idealised growth trajectories result from preferential widening along bedding planes or from block plucking around pothole rims. Contemporary erosion rates are poorly constrained but some rock engravings near water level have survived for decades and minimal bedrock erosion occurred during extensive flooding (Q >100 m^3/s) in June 2012. Coupled with estimations of reach antiquity derived using a published equation for waterfall retreat rate, the Rheidol bedrock reaches have probably developed intermittently during part of the Quaternary, having been buried by sediment and/or ice during glacial advances and exhumed by river activity during glacial retreat. By influencing upvalley transmission of baselevel changes, the relative stability of bedrock reaches in the Rheidol and possibly other Welsh rivers has implications for wider landscape dynamics, including patterns and rates of alluvial terrace, river profile and hillslope development.

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Mudflow morpholitogenesis((MMLG) on the Greater Caucasus

YURY E.
Kuban State University, KRASNODAR, RUSSIAN FEDERATION

Studying of mudflows was spent by a of geology and geomorphology of the Kuban State University within last ten years with use a conceptual model of mudflow morpholitogenesis (Efremov,2010). To dateexperience material makes it possible to imagine the development MMLG ,as follows: conditions - factors - processes - mechanisms of mudflows - a genetic type of mudflow. Developed MMLG theory opens the basic stages, their further change, accumulation of mineral and organic substance within their baths, and also allows revealing various types MMLG.

Mudflow morpholitogenesis is total combination of processes and the phenomena with the assistance of which mudflows are formed. Their formation occurs with direct participation of friable deposits in the conditions of the dynamic environment and high energy of endogenenetic and exogenous processes. It is supposed that formation of mudflow occurs under the influence of other factors in rather stable environment of the considered territory.

Morfolitological, climatic and morfolitodinamical objective laws of formation of mudflows processes are considered. Morfolitological conditions reflect interrelation of a geological structure of the territory with formation of a friable substratum – a material for origin of the mudflows which are forming at strong heavy rain or thawing of snow cover.

Morfolitodinamical conditions are total combination of natural processes to unit tectonic movements, the seismic phenomena, a volcanism and forces of gravitation. Neotectonic and modern movements together with climatic conditions created basis for development of exogenous processes.

Climatic factors created basis for development of exogenous processes. Most significant factors for of mudflow process are air temperature and an atmospheric precipitation.

The very long wavelength (x1000 km) relief of the Congo Cuvette: a local base level controlled by upstream (EAR) and downstream (Atlantic bulge) uplifts during Miocene times

GUILLOCHEAU F.
Geosciences Rennes, RENNES, FRANCE

The Congo Cuvette is one of the most famous very long wavelength (multiple of one thousand kilometres) relief in the world. Because of its size, it can be related to mantle dynamic and convection and sit is a case example for several models of dynamic topography. Those models imply contradictory recent vertical movements, from a subsiding to an uplifting domain. In order to better constrain its recent evolution we performed a geomorphological study of the Cuvette and surrounding highs (from the Cameroon Volcanic line to Central Africa and Uganda in the north, from the western branch of the East African rift to the Kalahari Plateau eastward and southward), in the frame of the ANR project TopoAfrica.

This study is based on the mapping and relative chronology of three types of forms: the planation surfaces (weathered, pediplains..), the pediments and the incised valleys. Those forms are dated by intersection with sedimentary deposits and magmatism. A synthesis of the magmatism of both the Cameroon Volcanic Line and the Virunga-Kivu domains was compiled and the relationships with the weathering surfaces and pediplains/pediments was studied.

1. No relief, even in the Cameroon Volcanic Line, is older than Eocene (middle?). The oldest one is a weathering surface bearing in some places bauxites.
2. A first regional uplift occurred at the Eocene – Oligocene boundary.
3. Late Oligocene is a period of fluvial sand deposition (“Sables ocres”), followed by a second period of weathering.
4. An Early Miocene uplift occurred along the Atlantic bulge from Cameroon to Gabon, Congo and northern Angola and at the southern edge of the present-day Cuvette (Kalahari Plateau uplift).
5. The East African Rift dome (and its western limit along the western branch) has been uplifted since at least Late Miocene.

The Congo Cuvette is mainly a by-pass to low incision domain bounded by uplifted bulge, dome and plateau during Late and Early Miocene and may be Early Pliocene.

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Evolution of catchment basins in the Himalayas: New observations

GHOSH P., MISRA A., SINHA S., SENGUPTA I., HATUI K.
Indian Statistical Institute, Geological Studies Unit, KOLKATA, INDIA

Evolution of drainage basins on a linear mountain belt initiates as small regularly spaced gullies at the contact between the orogen and the base level. With time, due to upstream growth, widening and coalescence, these gullies develop into catchment basins. It has been noted that the outlets of the basins are spaced regularly irrespective of scale, slope, lithology, climate and tectonic setting. However, the spacing (s) is related to the width of the orogen (w). For many orogens the spacing ratio (w/s) takes a value between 1.91 and 2.23. However, in the Himalayas, due to drainage reorganization, the outlet spacing is increased and that leads to a lower spacing ratio of 1.7.

We observe that the cross-sections of these Himalayan catchments does not show a valley-like profile due to the occurrences of orogen transverse ridges that are in many cases higher that the drainage divide. It confirms that these catchments are composite features made-up of lateral juxtaposition of a number of smaller valleys. The transverse streams draining smaller valleys abruptly turn and become orogen parallel in a narrow zone close to the mountain front and immediately north of the Siwalik range. They meet other streams and form a higher order outlet stream.

This work studies the shape and disposition of watersheds of the streams that are one order lower than the outlet stream. The results show a series elongated transverse valleys (some deformed) of similar size. We propose that the disposition of these lower order watersheds provide a crude approximation of the drainage configuration prior to their re-organization. Each of the catchments of Girwa, Gandak, Kosi and Manas comprises three sub-valleys indicating that the original spacing ratio was much higher. These sub-valleys terminate north of the Siwalik range suggesting that they existed prior to the deformation of the Siwalik strata. Thus, they could have served as the conduits for the sediment supplied to the Siwalik foreland basin.

The Yangben inselberg and planation surface

MBEUGANG TCHEUBONSOU E.M., TCHINDJANG M.
University of Yaoundé I, YAOUNDE, CAMEROON

Palaeo landforms remain a concern, which, through morphogenic process that is constantly changing, drive to the understanding of the evolution of the world landforms. The palaeo geomorphological studies in Cameroon remain insufficient. There is the need to move beyond general studies to perform detailed studies at any scale to identify inherited forms. Given the original landscape of Yangben, the present study is seeking to specifically understand the main shapes and explore their implementation.

Yangben relief appears to be a very flat and amazing landscape marked by layering glazes (Northwest, Southeast) and dominated south East and North west by Hills surrounding residual massive (inselberg). Adding to this, one can observe that soil formations varied from gravel, sandy silt and ferralitic facies. All of these are indicators of a changing landscape contrasting with the reconstruction problem due to the characteristics of current erosion. This observation leads us to study the Yangben inselberg and it planation surface.

In fact, located in the savanna of the Mbam pediplain region, this paper proceed by collecting Yangben soil sample data, observing soil horizons and collected some for morphoscopic analysis. Also, two main types of inselbergs have being identified: the inselberg of lithological resistance and the inselberg of position. We succeed in describing the genesis process leading to their implementation in this subdry and dissected environment developed on basement structures. Finally the Yangben the pediplain is bristling with massive inselbergs and convex hills arranged in the Precambrian lineaments. This landscape originates from differential erosion during the geological history of Cameroon and shapes in a tropical climate contrasts.

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Long-term evolution of Southwest Indian landscapes by 40Ar-39Ar dating of K-Mn oxides in supergene Mn-ore deposits

BONNET N.
CEREGE, AIX-EN-PROVENCE CDX 04, FRANCE

The high-elevation passive margin of Southwest India is marked by the Western Ghats escarpment, which separates the coastal domain from the low-relief East-dipping Mysore plateau. The escarpment has evolved from the Seychelles rifting at ~ 63 Ma which followed the Deccan traps volcanic event at ~ 65-63 Ma.

We investigate and quantify the post-rift evolution of the South Indian passive margin through the characterisation of stepped relicts of lateritic paleosurfaces across the escarpment, and notably by ^{40}Ar-^{39}Ardating of in-situ formed K-Mn oxides in supergene Mn-ore deposits carried by these paleosurfaces. Elevation differences between lateritic paleosurfaces of different ages provide denudation rates for the considered time spans. On the basis of previous work (e.g., [1]) and our own investigations, three main lateritic paleosurfaces were identified on the plateau at altitude ranges of 1000-900 m (S2), 900-800 m (S3) and 800-700 m (S3d), and a last one in the coastal domain at 150-50 m (S4). These lateritic paleosurfaces can bear bauxite (e.g., S2) and/or ferricretes (e.g., S3). Bauxitic weathering also developed under glacis/pediment of paleosurface S4in the coastal domain.

K-Mn oxides (cryptomelane) were sampled from Mn ore deposits underlying each paleosurfaces. The first ^{40}Ar-^{39}Ar ages (28.6 ± 0.5 to 36.25 ± 0.95 Ma) obtained from carefully characterised assemblages from the Sandur Mn-ore deposit indicate intense lateritic weathering processes at the transition Eocene-Oligocene underneath the paleosurface S2.

Assuming that the genesis and maturation of Mn-ore deposits are linked to progressive weathering of the paleosurfaces that carry them, further dating K-Mn oxides formed in these Mn-ore deposits will thus provide important time constraints on the setting and evolution of successive paleosurfaces and the correlative post-rift denudation chronology of the Southwest India passive margin.

[1]Gunnell, Y. (1998). *Basin Research10*, 281-310.

Long-term landscape evolution of the southeast Brazilian highlands: analysis of Poços de Caldas Alkaline Massif region

DORANTI-TIRITAN C.(1), HACKSPACHER P.C.(1), GLASMACHER U.A.(2), POCAY M.A.H.(1)
(1) UNESP, RIO CLARO, BRAZIL ; (2) Ruprecht-Karls-Universität Heidelberg, HEIDELBERG, GERMANY

The aim of this paper is to study the configuration of the long-term landscape evolution of a specific region of southeast Brazilian highland. Poços de Caldas Alkaline Massif (PCAM) was formed during alkaline volcanism event from the Late Cretaceous. It islocated on the west side of the Mantiqueira Mountain Range, characterized by alkaline rocks and topography reaches over 1700m high. The topography of the crystalline basement, so called North Crystalline Zone (NCZ), is a dissected plateau with irregular topographic ridges reaching 1200m in elevation. The PCAM and NCZ areas together form the Poços de Caldas Plateau that is characterized as a remnant of the South American Planation Surface resulted from erosional events from Late Cretaceous–Paleogene transition. The present-day relief has resembled over many millions of years, a major feature of denudation is the development of the "circular drainage", a particular feature of some caldera and other circular or concentric structural features. Recent tectonic movements may critically affect regional geomorphology by influencing river patterns and orientations. Apatite Fission-Track (AFT) thermochronology and morphometric analysis on drainage basins and river morphologywere used on the tentative of understanding the landscape evolution of this region. AFT ages range from and 333.3±27.6 to to 48.7±10.7 Ma and the age-elevation relationship shows that the ages decrease systematically with increasing elevation with a break-in-slope near the 150Ma and another in 80Ma. The morphometric analysis shows some rivers are controlled by reactivated faults, and in the other hand the correlation between the techniques shows that some of the faults that control the river morphology were not reactivated with events displayed by the AFT thermochronology.

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Toward a quantification of long-term evolution of coastal landscapes? Drainage developed on marine terraces sequences on the North Cotentin peninsula (France)

NEXER M.(1), AUTHEMAYOU C.(2), PEDOJA K.(1), DELCAILLAU B.(1)
(1) Laboratoire M2C - UMR CNRS 6143, CAEN, FRANCE ; (2) Laboratoire CNRS Domaines océaniques, UMR 6538-IUEM, BREST, FRANCE

Sequences of Plio-Quaternary shorelines generated by sea-level fluctuation and tectonics massively shape the coasts worldwide. Except in arid zones, they are covered by aerial drainage pattern. Surprisingly, few studies deal with both geomorphic features, although such cross-study could lead to the quantification of the coastal drainage evolution.

North Cotentin peninsula is a key site for such studies of coastal landscape evolution. This peninsula was shaped during the Plio-Pleistocene by the alternation of glacial and interglacial stages. The latters, associated with highstand of the sea, result in the carving of marine terraces on Paleozoic and Precambrien rocks. During glacial stages, periglacial climate lead to the deposition of head (solifluction cast) and loess sequences, overlapping marine terraces. Furthermore, glacial periods are marked by important incision due to the base-level retreat.

Our methods include field-work (geophysics, dGPS), analyses of satellite images and DEM (10m, 30m), and morphometry: drainage area, length profile, the stream length-gradient index (SLi), Ks, drainage basin asymmetry, hypsometric integral and curves, sinuosity and incision rate.

We significantly bettered the knowledge on the sequence in this area. As previous authors, we recognized a “low” sequence of four marine terraces (correlated to the MIS 5e, 7, 9 & 11). But we found that this low coastal sequence is overlooked by an upper sequence of three rasas. The paleo-shorelines of the rasa delimit a paleo-island with islets. Longitudinal profiles of 10 rivers developed on coastal terrace (marine terrace and rasas) exhibit numerous knickpoints. We tentatively interpret them as related to the base level migration.

At this stage, our work is still exploratory but such this cross studies could be applied to any coast where Plio-Quaternary sequences and aerial drainage are both present.

Piedmonts of the Transdanubian Range, Hungary: Limited slope retreat of the pediments?

CSILLAG G.(1), SEBE K.(2), FODOR L.I.(3)
(1) Geological and Geophysical Institute of Hungary, BUDAPEST, HUNGARY ; (2) University of Pécs, PÉCS, HUNGARY ; (3) Geological, Geophysical and Space Sciences Research Group of Hungarian Academy of Sciences at Eötvös University, BUDAPEST, HUNGARY

The SE side of the Transdanubian Range in the middle of the western Pannonian Basin is accompanied by an approx. 150 km long and max. 10-15 km wide piedmont zone with numerous planation surfaces. Their study indicates that landscape evolution around mountain ranges emerging from soft basin sediments may differ both from the classic pedimentation process and from the accumulation of alluvial (depositional) piedmonts.

The Palaeozoic–Palaeogene rocks of the Transdanubian Range are surrounded by Upper Miocene molasse sediments from the Alp-Carpathian ranges. These deposits used to cover most of the Transdanubian Range; its exhumation started in the Late Miocene, when the beginning of uplift overlapped with the final period of sediment accumulation. The denudation of 200-300 m of Upper Miocene sediments uncovered the mountain front fault scarps. Flights of up to 8, Pliocene–Pleistocene planation surfaces in the piedmont zone lap onto this scarp. These flat surfaces were carved into the weakly consolidated molasse sediments and have slopes $<1^{o}$; in front of valleys 5-10 m thick alluvial fans accumulated.

The described landforms are

– no pediments *s. str.*, because slope retreat is restricted, the ultimate knickpoint is at the scarp, even though they were formed by pedimentation;

– no depositional piedmonts (’bajadas’) in front of an active mountain front, because no modern tectonic activity can be detected along the frontal fault, and alluvial fans originating from the mountains cover only a minor portion of the dominantly erosion- or transport-dominated slopes.

Retreat of the piedmont zone is limited by selective denudation at the mountain front scarp undergoing exhumation, since pedimentation can only occur on the soft foreland sediments. Consequently, landscape evolution cannot proceed to produce a pediplain (*sensu* King).

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The spatial distribution of knickpoints in south-central Africa: implications for longterm landscape evolution

FLUGEL T.J.(1), ECKARDT F.D.(2), COTTERILL F.P.D.(3)
(1) Department of Military Geography, Faculty of Military Science, Stellenbosch University, SALDANHA, SOUTH AFRICA ; (2) Department of Environmental & Geographical Science, University of Cape Town, CAPE TOWN, SOUTH AFRICA ; (3) AEON Geoecodynamics Research Hub, c/o Dept Botany and Zoology, University of Stellenbosch, STELLENBOSCH, SOUTH AFRICA

The spatial distribution of knickpoints (the break in river slope gradient) may provide insights into the evolution of a river. As rivers may be seen as the summation of process occurring across its basin, river evolution reflects the broader landscape processes. As knickpoints may have several origins, it is important for these knickpoints to be characterised. This poster illustrates the distribution of 15 such points that share the Congo-Zambezi watershed. A geospatial information system was created recording the characteristics of these knickpoints as determined from a variey of spatial data sources.

The lithology of each knickpoint has been categorised and is shown in context of the simplified geology. This combined with the knickpoint heights, as determined from Shuttle Radar Topography Mission data, allowed several conclusion may be drawn. The development and evolution of knickpoints are likely to be strongly influenced by underlying geology, where the occur on stable cratonic regions of the regions; whereas those found on shield margins and within the Neoproterozoic mobile belts are predominantly influenced by both localised and regional tectonics.

Constraining Cenozoic uplift of the central Appalachians using river profiles and relict surfaces

HARBOR D.(1), MEYER R.(2), CONNORS C.(1)
(1) Washington & Lee University, LEXINGTON, VA, UNITED STATES ; (2) University of Bergen, BERGEN, NORWAY

Much recent research points to Cenozoic uplift of the Appalachians. Profiles of streams in the James River reveal incision by knickpoint retreat into a relict upland of western Virginia. This inherited landscape occurs at the remote ends of some Blue Ridge or Valley and Ridge tributaries. The landform geometry, regolith weathering, and Eocene extrusive rocks of these pre-Quaternary landscapes describe a low erosion rate currently beyond the reach of more rapid erosion by larger streams. James River basin channel profiles are modeled to estimate deviation from a graded or expected profile for the rock type and regional geomorphic setting. The greatest deviation and profile relief results from progressive landward regression of the drainage divide, and ensuing capture of the James River headwaters. However, the capture-generated deviation decreases from east to west in the basin, implying that capture alone is insufficient explanation for the total relief of the basin and shape of the profile. Restoring the relict landscape as a low-relief surface with a graded profile yields at least 500 m of Cenozoic uplift west of the Blue Ridge and increasing channel slope. In the neighboring Potomac River Basin, tributaries sharing western headwaters with the James River have more than 400 m profile deviation. Capture and uplift produce rates of incision rising to 150 m/m.y. in modern channel of the James River, an order of magnitude higher than extremely low upland denudation rates observed by others throughout the central and southern Appalachians. In the steep modern profile, erosion by knickpoint retreat seems to dominate the response of the James River from mouth to headwaters, similar to the response in other Southern Appalachian basins. Both channel and upland relief in the central Appalachians is growing in response to the difference between headwater and mainstream erosion rates.

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Correlations between geology and erosion surfaces in the central eastern sector of Paracatu river catchment, State of Minas Gerais, Brazil

BRAGANÇA M.T.R., OLIVEIRA D.D.
University of Sao Paulo, SAO PAULO/SP, BRAZIL

The regularity of the relief of Paracatu river catchment inserted into Atlantic Shield is preserved in weathering and erosion resistant rocky layers. The landscape is organized over a stratigraphic column which keeps its original conditions of deposition with record of small crustal movements, allowing the ideal theoretical conditions for the study of erosion surfaces. The Pediplanation Theory (King, 1953) and the geomorphological method of Ab'Saber (1969) are the theoretical research basics. The work aims is to correlate the Paracatu river catchment geomorphology to material and structure, looking for explanations to the preservation of erosion surfaces in the arrangement of sedimentary successions, unconformities and erosive plateaus. A broad fieldwork through a general and regional approach, followed by an intense bibliographic review and manipulation of topographic and geologic maps, at scale 1:100,000, and its manipulation in GIS, through a development of a Digital Terrain Model and many topographic profiles, allowed to describe the relief in suggesting the reconstitution of the geomorphological history of the study area, resulting in an erosion surfaces map. There were the conditions to identify and describe four surfaces which record the regional morphological evolution: Tabular Plateau Surface, Tabular Plateau Surface with Dissected Valleys, Low Tableland with Ravined Pedments and Dissected Valleys Surface, and Paracatu River Fluvial Plain Depression Surface. The erosion surfaces can be correlated to four tectonic cycles that elevated the Brazilian Platform since Cretaceous until Pleistocene, and drainage incision and dissection of the landscape as a consequence of wet climates installed after Atlantic rift open.

Relief evolution of the eastern part of the Bierzo Basin (NW Spain): Response of erosion surfaces and fluvial network to Cenozoic Tectonic Activity

RODRIGUEZ GARCIA A.(1), GARCIA-MELENDEZ E.(1), MARTIN-SERRANO A.(2), SUAREZ RODRIGUEZ A.(3), MINGUEZ A.(3)
(1) Universidad de León, LEÓN, SPAIN ; (2) Instituto Geológico y Minero de España, TRES CANTOS, MADRID, SPAIN ; (3) Instituto Geológico y Minero de España, Oficina de Proyectos de León, LEÓN, SPAIN

The eastern part of the Bierzo basin (NW Spain) and its boundary with the Duero basin shows Cenozoic tectonic structures that control the present-day topography. In this work, Homogeneous Geomophological Units (HGUs) have been used in order to study the relief of this area. The interpretation of aerospace imagery (ASTER and aerial photographs), Digital Elevation Models (DEMs) and derived information (fluvial network, drainage basins, slope, curvature and aspect maps) and fieldwork allowed to delimit a HGUs map to scale 1:100.000. This map compiles geomorphological units (structural, fluvial, glacial and planation units) with homogeneous substrate geology, morphometry and origin. As a result, the morphometry and the spatial relationships among the HGUs show some characteristics of the relief evolution. The planations (erosion surfaces) are characterized by abrupt changes in slope at their limits related to the presence of Cenozoic thrusts (mainly E-W direction) present in the area. In addition, these surfaces show differences in height among them associated with vertical displacements and the two main vergences (S and N) of the mentioned thrusts. The fluvial network has three main patterns grouped in two time slices: a) the older one (Pre-Cenozoic) is determined by the strength of the Pre-Cenozoic substrate units (mainly E-W direction); b) later, the activity of Cenozoic thrusts (mainly E-W direction) forced some fluvial channels (Cenozoic) to follow two main paths, being the first one perpendicular (mainly N-S direction) and the second one parallel (mainly E-W direction) to the main thrusts. Some N-S fluvial channels connect upstream with E-W less steep channels, being interpreted as fluvial captures as a consequence of the Cenozoic fluvial network reorganisation.

Keywords: landscape evolution, landform units, paleoreliefs, drainage patterns

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Applying hack index in drainages to define slope levels: a case study of the Eastern Borborema plateau Rivers

MONTEIRO K.(1), CORREA A.C.B.(2)
(1) Universidade Federal de Pernambuco, PAULISTA, BRAZIL ; (2) Universidade Federal de Pernambuco, RECIFE, BRAZIL

How the landscape evolved and how the landforms evolution define it is one of the most important themes in geomorphology. With understanding of the drainages it is possible to think about the evolution of landforms, and comprehending the structures that control the drainages it is plausible to relate the drainage, the structure and the landform dynamic. Hack elaborated an index to define anomalous sections on drainages relating the slope and the length of the drainages. The index consist in the relation between the Δh (difference of altitude of the section) and the Δl (difference of length of the section) multiplied for the distance of the section until the begin of the drainage (L). So, the index is showed as Δh/Δl*L. Previous research applied in drainages which drain the east side of the Borborema Plateau, Northeast of Brazil, showed that this index is satisfactory to identify anomalous sections in the drainages and it could be used to define slope levels if used in a set of neighbor rivers. The rivers studied were the Paraiba river, Goiana river, Capibaribe river, Sirinhaem river, Una River and Mundau river. However, Paraiba river, Goiana river and Capibaribe river are in a different structure of the other rivers, more resistant called “median shear corridor”, and they present less levels compared with the region that Sirinhaem river, Una river and Mundau river. It is known that rivers are, in many cases, controlled for the structure, so we can deduce that anomalous sections are related with resistant structures or tectonic levels. So, once defined the levels, from the use of the Slope-Length Index, the next step is understand what is making these levels, erosion cycle, tectonic movements, or both actions.

Denudation rates of the Southern Espinhaço Range, Minas Gerais, Brazil, determined by in situ-produced cosmogenic beryllium-10

N. BARRETO H.(1), A. C. VARAJÃO C.(2), BRAUCHER R.(3), BOURLÈS D.L.(3), A.R. SALGADO A.(4), F.D.C. VARAJÃO A.(2)

(1) Universidade Federal do Maranhao, SAO LUIS, BRAZIL ; (2) Universidade Federal de Ouro Preto, OURO PRETO, BRAZIL ; (3) Université Aix-Marseille, AIX-EN-PROVENCE, FRANCE ; (4) Universidade Federal de Minas Gerais, BELO HORIZONTE, BRAZIL

To investigate denudation rates in the southern part of the Espinhaço Range (central-eastern Brazil) and to understand how this important resistant and residual relief has evolved in the past 1.38 My, cosmogenic ^{10}Be concentrations produced in situ were measured in alluvial sediments from the three main regional basins, whose substratum is composed primarily of quartzites. The long-term denudation rates estimated from these measurements were compared with those that affect the western (São Francisco River) and eastern (Doce and Jequitinhonha Rivers) basins, which face the West San Francisco craton and the Atlantic, respectively. Denudation rates were measured in twenty-seven samples collected in catchments of different sizes (6–970 km^2) and were compared with geomorphic parameters. The mean denudation rates determined in the northern part are low and similar to those determined in the southern part, despite slightly different geomorphic parameters (catchment relief and mean slope). For the southern catchments, the values are 4.91±1.01 m My^{-1} and 3.65±1.26 m My^{-1} for the Doce and São Francisco River basins, respectively; for the northern catchments, they are 4.40±1.06 m My^{-1} and 3.96±0.91 m My^{-1} for the Jequitinhonha and São Francisco River basins, respectively. These low values of denudation rates suggest no direct correlation if plotted against geomorphic parameters such as the catchment area, maximum elevation, catchment relief, average relief and mean slope gradients. These values show that the regional landscape evolves slowly and is strongly controlled by resistant lithology, with similar erosional rates in the three studied basins.

Keywords: The Southern Espinhaço Range; ^{10}Be; Cosmogenic Nuclide; Denudation Rates; Brazil

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Reconstruction of long-term (last 35 Ma) pediment evolution in the Atacama Desert using a multidisciplinary approach

SANCHEZ C.(1), TAPIA M.(2), RIQUELME R.(2), CARRETIER S.(3), BRICHAU S.(3), MARQUARDT C.(4)

(1) Universidad Catolica del Norte / Géosciences Environnement Toulouse, ANTOFAGASTA, CHILE ; (2) Universidad Catolica del Norte, ANTOFAGASTA, CHILE ; (3) Géosciences Environnement Toulouse-IRD, TOULOUSE, FRANCE ; (4) Antofagasta Minerals., ANTOFAGASTA, CHILE

Pediment evolution processes have been discussed for over a century by geomorphologists worldwide. Understanding these processes is tackled using both numerical modeling and field observations. However there is generally little agreement between the two, mainly due to lack of observable geomorphological features and the difficulties to date them over such a long term period. Nevertheless, the Atacama Desert represents a promising field study area to understand pediment evolution:

(1) A first estimation of pediment backscarp positions in each stage of landscape evolution can be inferred by contrasting stratigraphic gravel lithofacies distributions and upslope pediment bedrock distribution. In fact, the composition of clasts and exotic mineralization (from nearby porphyry copper deposits) in the gravel exposed due to erosion can reveal the amount of vertical incision related to backscarp pediment retreat.

(2) Ages of gravel deposition can be determined by Ar-Ar dating of inter-bedded ignimbrite layers or syn-sedimentary Mn-oxides, and U-Pb detritical zircon dating.

(3) Although the timing of late Cenozoic (5-30 Ma) climate change in the Atacama Desert is debated, most authors agree that this period is characterized by progressive climate desiccation. Field data indicate that pediplenation began after the Incaic orogen (~38 Ma) with the exhumation of intrusive rocks emplaced at ~2-km-depth before the Oligocene. Subsequent backscarp retreat occurred extremely slowly (<20 km for ~30 Ma) as climate conditions changed from arid to hyper-arid. Since middle Miocene the pediment has not been modified related to the hyperaridity. Ongoing research are refining and quantifying our models by reconstructing the denudation history using high to low temperature thermochronology data, and integrate them into Landscape Evolution Modelling (CIDRE software) under different scenarios.

The main elevation levels of the northeastern quadrilatero ferrifero region, Minas Gerais, Brazil and their relation with the different parent materials

LADEIRA F.S.B., LEONARDI F.
Unicamp, CAMPINAS, BRAZIL

Works associating elevation levels with the different parent materials have been gaining strength in the world geomorphology for the interpretation of paleosurfaces. Then, this work has had the objective of associating the terrain morphology and elevation with the Iron Laterite Surface present in the northeastern Quadrilátero Ferrífero. Iron Laterite Surfaces are regionally called *Chapadas de Canga* and they result from residual accumulation of iron in humid tropical regions. Iron Laterite Profiles are present in a great part of this area, making it have much interest by the mineral extraction industries. In this work two main procedures have been performed, the production of the Elevation Digital Model through topographic radar image SRTM and field mapping of the lithology and laterite materials. Associating elevation, terrain morphology and iron laterite profiles, there are three well demarcated levels: 1 – above 1500m of altitude, where it is located Serra do Caraça, sustained by quartzite; 2 – from 1000m to 1200m of altitude there are iron mines of Alegria Complex, which exploit Itabirito (corresponding to BIFs); 3 – from 600m to 1000m Ferricrete Continuous Surface appears, that exceeds 8km in extension, exposing a profile with more than 40 meters of thickness. This exposed laterite profile is an old alluvial fan, associated with the Serra do Caraça threshold. In this point the laterite profile evolved over fan deposits, very poorly sorted, composed only by itabirite clasts cemented by iron and not quartzite clasts, though quartzite outcrops be in higher levels, very near this area. Thus, the Laterite Continuous Surface covers a great area between the levels 850-950m of altitude and it functions as a stratigraphic mark, representing the end of the South American erosion cycle.

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Self-organisation of geomorphological evolution in the brazilian Central Plateau

DE SOUZA MARTINS E.(1), VASCONCELOS V.(1), CARVALHO JÚNIOR O.A.(2), REATTO A.(1), COUTO JÚNIOR A.F.(2)
(1) Embrapa, BRASILIA, BRAZIL ; (2) Universidade de Brasília, BRASÍLIA, BRAZIL

In the Brazilian Central Plateau are recognized South American (Paleogene) and Velhas (Neogene) geomorphologic cycles. These geomorphologic cycles are preserved in the form of planed surfaces with varying degrees of dissection. The interfaces between these surfaces generally occur through scarps. These interfaces are strongly controlled by litho-structural factors. The processes of laminar erosion and chemical weathering are very slow and tend to preserve the soil and geomorphological characteristics of the formation processes of planning surfaces. Moreover, the iron has a seasonal pattern, especially between the ferruginous horizon and saprolite. In this transition, the iron tends to be dissolved at the season of water saturation for the formation of water-soluble iron in oxidation state II. In dry season ground water tends to be lowering and the iron goes to the oxidation state III, the very low solubility form and precipitates as oxi-hydroxides. Inside the residual surfaces of the Central Plateau ferruginous horizon tends to be very thin or even non-existent by dissolution generated by the continuous reduction and dissolution process of iron oxi-hydroxides. Moreover, the edges of these surfaces occurs a progressive thickening of the ferruginous horizon formed by the process of oxidation of iron from the solutions of the innermost portions sources. At the edges of the planing surfaces occurs iron oxi-hydroxides hardening and the formation of ferruginous lateritic cuirasses. The hardening is caused by the irreversible drying of iron oxi-hydroxides on the edges of planing surfaces, which occurs cyclically in the dry season. This continuous geochemical process generates planing surfaces edges more resistant to chemical and physical weathering, increasing the resilience of their own planing surfaces. This process of self-organized evolution is responsible for preserving of planning surfaces of the Brazilian Central Plateau in the scale of millions of years.

Correlation between iron and laterite layers paleosurfaces Minas Gerais, Brazil

RODRIGUES DE MORAES G., SÉRGIO BERNARDES LADEIRA F.
UNICAMP, CAMPINAS, BRAZIL

The Brazilian relief presents salient features of development in tropical environment for a long duration. Some forms produced during Paleogene remain on the landscape in the form of residual deposits, especially iron and aluminum, the former associated with these surfaces.

In Brazil the Cretaceous was marked by intense mechanical erosion, reflecting the hot and dry weather, a semi-arid climate to arid. Vast planning surfaces were formed. Already in the Paleogene occurred moments of intense chemical alteration, generating thick lateritic profiles, which focused, in southeastern Brazil, especially iron.

The objective of this work is the analysis of lateritic profiles, which present ferricrete, which allowed preservation of old planing surface in the western state of Minas Gerais, Brazil.

The profile has approximately analyzed twenty-nine meters thick, with a ferricrete on top of about 8 meters and the remainder correspond to speckles and kaolinitic horizons. This change affects profile at the base of the Cretaceous deposits Marília Formation, consisting primarily of calcretes. At the base of the profiles occurring silica concentration levels constituting silcretes.

These profiles claim slopes pronounced that enable easy identification of the surface, which has slopes of less than 2%. Under these conditions the surface Oxisols develop thick and high in iron and aluminum.

ACKNOWLEDGEMENTS: to FAPESP for funding the project Geomorphic Paleosurfaces Correlation of Summit in Brazil, Uruguay and Argentina - dating, morphology, cartography, deposits and associated alteration profiles (2011/23325-7), and the scholarship for first author. To CNPq for the second author's productivity scholarship (312583/2009-5).

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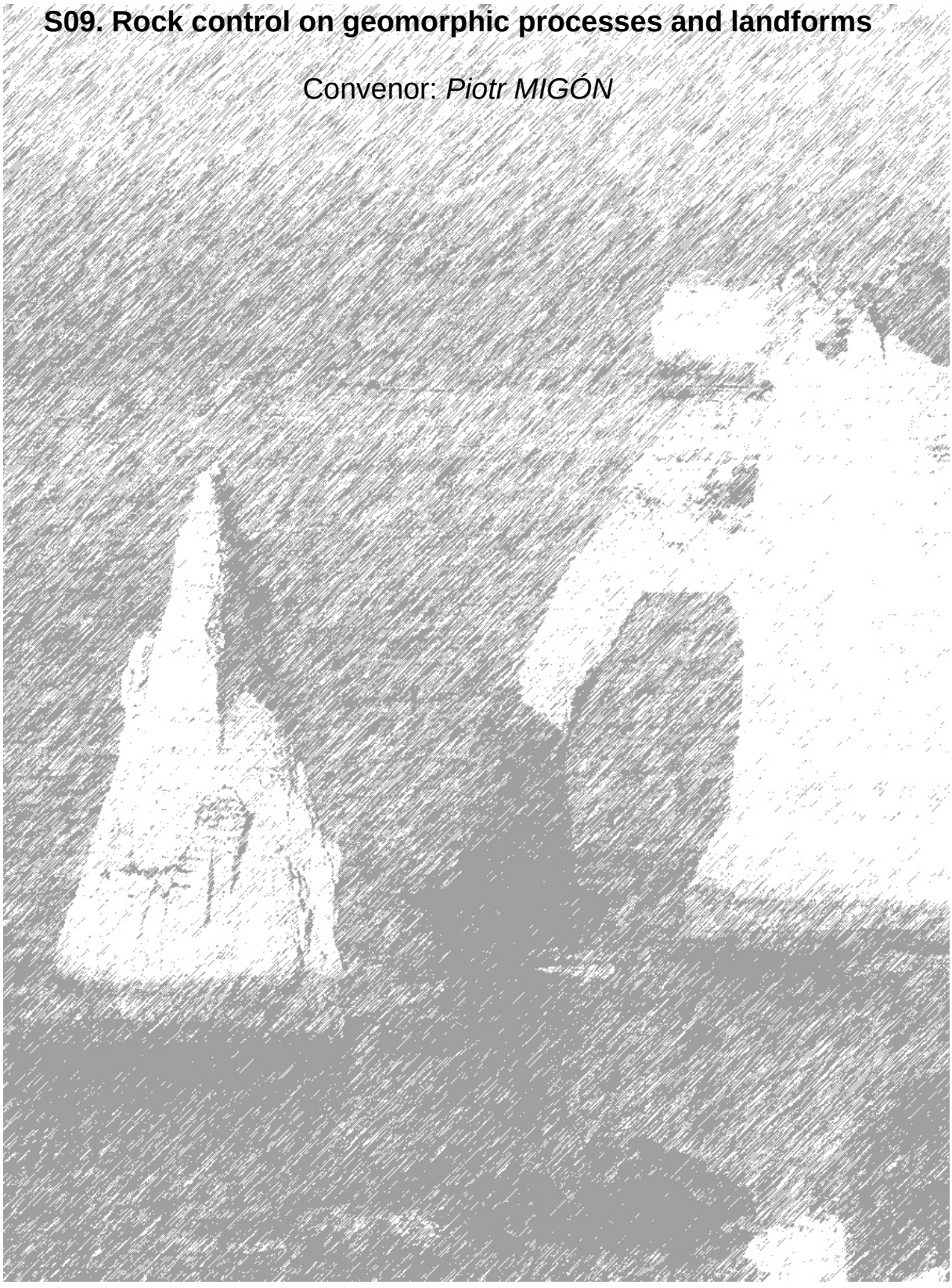
Use of detrital cosmogenic 10Be and LIDAR DEM to evidence and quantify the propagation an erosion wave in steep tropical watersheds, Luquillo Critical Zone Observatory, Puerto Rico

BROCARD G., WILLENBRING J.K., SCATENA F.
Department of Earth and Environmental Sciences, University of Pennsylvania, PHILADELPHIA, UNITED STATES

The modern island of Puerto Rico emerged from the sea some 5 Ma ago. Pervasive planation surfaces in its mountainous highlands have been interpreted as ancient wave-cut platforms. The El Yunque National Forest at the eastern tip of the island is an unscathed primary forest that clads very steep mountains. These mountains receive up 5 000 mm of annual precipitations. The rivers draining these mountains exhibit dramatic knickpoints. Because these knickpoint lips lie at the elevation of an uplifted regional wave-cut platform (~600m), we interpret these knickpoints as headward migrating erosion waves that nucleated at the coast when tectonic uplift of the mountain resumed. The knickpoints separate a slowly-eroding relict upland region, from faster eroding lower slopes. We use ^{10}Be concentration of river-borne quartz to compare erosion rates above and below the knickpoints. We find a threefold increase in catchment-scale soil erosion rates below the knickpoints, over timescales of 10^4-10^5 years. The change in erosion rate is associated with a change in the dominant erosional processes, as reflected by the grain-size dependency of ^{10}Be concentration in quartz sediments and the hillslope morphology revealed by a newly acquired LIDAR DEM. The uplands exhibit a strong variation in the ^{10}Be concentration as a function of sediment grain size, interpreted as the effect of a strong decoupling between the erosion of slopes and ridge tops. This decoupling is evidenced in the DEM by the presence of deep seepage coves propagating into a deep saprolite, dissecting pre-existing broad ridges. Downstream of the knickpoint lips, such coves are absent, hillslopes are straight, ridge crests are narrow and the ^{10}Be dependency with grain size is less pronounced, indicating a shift from chemical weathering dominated erosion upstream of the knickpoints to mechanical weathering dominated landscape below the knickpoints.

S09. Rock control on geomorphic processes and landforms

Convenor: *Piotr MIGÓN*



Oral presentations:

Lithological controls on patterns of landsliding in northwest Malta

DYKES A.(1), DEVOTO S.(2), SOLDATI M.(2)
(1) Kingston University, KINGSTON UPON THAMES, UNITED KINGDOM ; (2) Università di Modena e Reggio Emilia, MODENA, ITALY

The geomorphology of Malta is strongly determined by a relatively simple pattern of underlying geological structures. Northwest of the Victoria Lines Fault, the altitudes of the stratigraphic layers are lower, bringing a thick calcareous marl known as the Blue Clay Formation down to around sea level. The coastal landforms around the northern 25% of the island, dominated by mass movements, appear to be primarily controlled by the juxtapositions of the Blue Clay and its adjacent lithologies with respect to sea level. Initial field inspections of the entire northwestern coast highlighted an apparently controlling influence of the Upper Corraline limestone that overlies the Blue Clay. The contrasting properties and thicknesses of the two members of the limestone formation appear to be directly associated with both the types and characteristics of the mass movements. Furthermore, the thickness of the upper member of the limestone determines the degree of natural protection from marine erosion, with a very thin limestone cap generally being associated with relatively debris-free clay slopes at the inland sides of bays such as Ghajn Tuffieha Bay. There is thus an apparently counter-intuitive geomorphological situation with the most unstable coastal slopes, having the highest cliffs and exerting the greatest loads on the underlying clay, being the most protected from ongoing marine erosion and generally forming the local-scale headlands. This paper will use these geological and morphological observations, with some geotechnical stability modelling, to derive the most likely explanations for the different types of landslides.

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Factors that Affect the Formation and Development of Gölcük Uvala in Western Turkey

CUREBAL I., EFE R., SOYKAN A., SONMEZ S.
Balikesir University, BALIKESIR, TURKEY

Although Karst topography and terrain is common in Turkey, it is observed in more limited locations in Western Turkey. The development of karst terrain depends on the interplay of several factors in varying degrees. Gölcük Uvala is situated in the south of Balıkesir province and is close to Sındırgı. Uvala was formed on limestone bedrock of Upper Miocene-Lower Pliocene periods.

The current study investigates the karstification conditions of Gölcük Uvala in the past and at present and the factors that have affected its formation.

Lithostratigraphic properties of the rocks in the study area and other geological and geographical elements that control karstification were studied with this purpose. Also, morphological properties, formations and development of the karstic forms in the area were examined by associating them with regional karst elements.

Uvala, developed on the surface of the plateau whose altitude changes between 430-440 m. In terms of shape, the uvala resembles a crescent that faces the southeast. The uvala has a length of 1250 m in the north-south direction and 1000 m in the east-west direction.

The uvala was developed under karst topography formation conditions. However, tectonic activities played a role in its development as well. Faults and lineamentin the study area show that the field is tectonically active. Kazan Creek is situated in the west of Gölcük uvala on a tectonic line with north-south direction. There is 100 m difference of altitude between Kazan Creek valley floor and uvala floor. The altitude difference between Kocaova and Gölcük Uvala is 200 m. This difference in altitude was caused by the vertical movements of the active faults in the area. This fact shows that uvala was formed by tectono-karstic processes. A karstification process that can be identified as simple is dominant in the study area and formation and development are still ongoing.

Keywords: Gölcük uvala, karst topography, karstification, tectonics

A new paradigm in geomorphology and geology of reservoirs: The deep alteration of rocks by « ghost-rock » process

MAIRE R.(1), BINI A.(2), BRUXELLES L.(3), CAMUS H.(4), DANDURAND G.(5), DEVES G.(6), DUBOIS C.(7), LANS B.(5), ORTEGA R.(6), ROUDEAU S.(6), QUINIF Y.(7)

(1) CNRS, PESSAC, FRANCE ; (2) University of Milano, MILANO, ITALY ; (3) INRAP, MONTPELLIER, FRANCE ; (4) CENOTE, MONTPELLIER, FRANCE ; (5) CNRS-University Bordeaux 3, PESSAC, FRANCE ; (6) CNRS-CENBG, BORDEAUX-GRADIGNAN, FRANCE ; (7) University of Mons, MONS, BELGIUM

The alteration of rocks was described since a long time in pedology, geomorphology and geology. However, recent discoveries in quarries of Belgium allow to revisit this problematic. A first stage is constituted by an isovolumic weathering of the bed-rock. In conditions of low hydraulic potential, the phreatic water carries the soluble part outside the system. The insoluble or minus soluble part of the rock remains in place and forms the residual alterite. Due to the lowering of the piezometric level, the water flows out of the limestones, forming caves in 1-2 years by evacuating the alterite according to the headward process. This experimental verification revolutionize the classical theory of karst voids genesis. A period of deep alteration need peculiar paleogeographic conditions: long time (10^6-10^8 years), biostasy and tectonic quiescence with a low relief and a close water level allowing the genesis of long alteration roots. This process create a strong porosity (10-50 %), keeps the original rocky volume and prefigures areas of weakness for a future differential erosion. It has been verified in many carbonated areas (Europe, Siberia, South Africa), in the sandstones and quartzites (Venezuela, Australia), in granites (Sidobre). In New Caledonia, the nickel ore is trapped in the alterated peridotite showing a typical karst morphology. In the different examples, the petrographic analyses and the chemical imaging by X-Ray Fluorescence shows the pores organization and the distribution of chemical elements. This alteration in a very low oxygen context mobilizes probably a considerable microbial mass and a slow energy dissipation with convection loops to evacuate the dissolved elements (Ca, Mg, C, O, K, Si…). The consequences are very important for understanding the genesis of aquifers (Touvre, Fr.), some oil reservoirs (Rospo Mare-Adriatic) and metalliferous sites (with hydrothermalism), and also the collapse process after lowering of the water table.

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Twidale's Rock: a granite block showing linked rock basins, channels and relief inversion

ALVAREZ DE BUERGO M.(1), GARCIA RODRIGUEZ M.(2), FORT GONZALEZ R.(3), CENTENO J.D.(4), GOMEZ-HERAS M.(5), SANZ M.A.(4)

(1) INSTITUTO DE GEOCIENCIAS (CSIC,UCM), MADRID, SPAIN ; (2) UNIVERSIDAD NACIONAL DE EDUCACIÓN A DISTANCIA UNED, MADRID, SPAIN ; (3) CEI Campus Moncloa, UCM-UPM and CSIC, Madrid, Spain, Instituto de Geociencias, IGEO, (CSIC-UCM), MADRID, SPAIN ; (4) FACULTAD DE GEOLOGIA, UNIVERSIDAD COMPLUTENSE DE MADDRID, MADRID, SPAIN ; (5) CEI Campus Moncloa, UPM -UCM and CSIC, Madrid, Spain, ETS Arquitectura (UPM) and Instituto de Geociencias, IGEO (CSIC-UCM), MADRID, SPAIN

This work shows the results of the study of a granite block, which will be named Twidale's Rock (TR) to pay tribute to the Geomorphologist C.R. Twidale. TR is located in the southern margin of the Amblés basin (Avila-Spain). Several weathering microforms will be studied to get conclusions on their origin, the exposure processes and the relations between petrophysical properties and the weathering progression.

The Amblés basin is an ENE to WSW elongated tectonic basin (general direction N76ºE), between the sierra de Ávila in the North and the sierra de la Paramera in the South. Several families of faults and escarpments with directions 20º, 30º, 63º, 95º, 107º, 120º and 136º, define the southern limit of the basin. During the Tertiary, the depression filled with detritic sediments, and during the Quaternary the basin underwent erosion and entrenchment. In the border of the basin the erosion dismantled previous regolith and weathering mantles, exposing granite bornhardts and minor landforms, like blocks and boulders with abundant weathering microforms.

TR is part of a group of erosion-exposed blocks; it is 12m wide, 21m long and 5m high. The upper part of the block shows interconnected rock basins covering more than 50% of the surface, with most of the outlets pointing towards the NE side, facing the valley. In this NE face, almost vertical, the outlets form channels and several taffoni, between the channels, leave the channels in prominence.

Some geomorphological elements in the NE face of TR (channels, taffoni, duricrust, pitting, etc.), were mapped, and some petrographical characteristics, petrophysical properties were measured and microenvironmental variables (temperature and relative humidity) were recorded. The study of the NE face of TR shows some correlation between petrophysical variables and the outlet-channels and taffoni, giving useful information to understand deterioration processes both in natural and built environments.

Poster presentations:

The use of the Schmidt hammer as a complementary tool for cosmogenic dating in Sierra Nevada (Southern Spain)

OLIVA M.(1), GÓMEZ ORTIZ A.(2), SALVADOR FRANCH F.(2), SALVÀ CATARINEU M.(2), VIDAL MACUA J.J.(2)
(1) Institute of Geography and Spatial Planning, Universidade de Lisboa, LISBOA, PORTUGAL ; (2) Department for Physical and Regional Geography, University of Barcelona, BARCELONA, SPAIN

The development of cosmogenic dating has substantially improved our knowledge on the timing of the maximum extent and subsequent deglaciation in Sierra Nevada, a high semiarid Mediterranean massif (Gómez Ortiz et al., 2012). However, there are still some uncertainties regarding the Late Pleistocene and Holocene environmental evolution in Sierra Nevada that need to be unveiled.

Several moraines are distributed in the highest northern cirques of the massif, at the foot of the Veleta (3398 m) and Mulhacén peaks (3478 m). Although topography is rather similar in both cirques, the number of moraines in each is substantially different. Former studies have described them as being originated during different time periods: while the two overlapping moraine arches in the Veleta cirque may have developed during the Late Glacial and the Little Ice Age (Gómez Ortiz, 2002), most of the seven generations of moraines in the Mulhacén cirque may have formed during the Holocene (Oliva & Gómez Ortiz, 2012).

The Schmidt hammer technique has been applied in all these moraines in order to find out if differences can be identified among them that can be related to different time phases. Up to 50 measurements were performed on stable boulders from the upper ridge of each moraine. The different rebound values may reveal differences in the exposure time of the boulders, therefore pointing to significant differences in the timing of deposition and stabilization of these boulders.

This method shows very similar values for the two moraines in the Veleta cirque (43-47), which may suggest a close timing for their formation instead of the former very different chronology. In contrast, data reveal notable differences among the moraines of the Mulhacén cirque (44-54), which may be interpreted as significantly different ages of formation of the moraines there located.

Based on these data, on the following campaign we will collect samples from these moraines for cosmogenic dating procedures.

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Subsurface erosion in a badlands area in Southern Italy: controlling factors analysis, types and frequency of pipes

CAPPADONIA C.(1), ANGILERI S.E.(1), ROTIGLIANO E.(1), BUCCOLINI M.(2), COCO L.(2)
(1) Universita di Palermo, PALERMO, ITALY ; (2) Universita di Chieti - Pescara, CHIETI, ITALY

Several of those Italian badlands areas, which are termed in the Apennines as “calanchi”, are affected by tunnelling erosion, due to piping process, which can involve the superficial portion of outcropping terrains, as well as up to some meters deep volumes. Erosion tunnels develop in from of simple or complex networks, having different length and diameter, varying from just a few centimetres up to some metres. The development and density of pipes are generally connected to a large fan of controlling factors referring to topography, climate, lithology, biological activity, coupled morphodynamic. Two different but nearby calanchi fronts located in Sicily (Southern Italy), where silty-clay deposits outcrops, have been studied. The calanchi fronts, were previously subdivided in hydrologic units by integrating GIS analysis and field surveys. Each unit was partitioned in a 4m side square grid and the density of pipes measured. For each survey grid field sheets, containing data on presence of resistant levels of outcropping rocks, vegetation cover, diameters of pipes and their spatial location, were filled out. A set of local topographic attributes (aspect, steepness, curvatures, roughnes, topographic wetness index) was derived by processing a 2m resolution dem. A detailed lithological map was also prepared, reporting some litho-structural factors influencing calanchi and pipes evolution: specifically, number, thickness and relative distance of arenaceous levels (more resistant materials). At the same time, by using digital aerial images vegetation cover types were recognized and mapped. Finally, soil sampling and laboratory allowed us to characterize the outcropping soil (texture, grain size and plasticity indexes). By applying multivariate regression technics, correlation between controlling factors (topography, lithology, mineralogy, sedimentology and geotechnical properties) and types and frequency of pipes are investigated and interpreted.

Bedrock Strength and River Metrics: Spatial and Statistical Correlations on the Incision of the Colorado Plateau, Southwest USA

BURSZTYN N., PEDERSON J.
Utah State University - Geology Department, LOGAN, UNITED STATES

There has been renewed debate over the mechanisms and timing of both uplift and erosion in the Colorado Plateau. Yet, in order to understand the patterns of topography and surficial processes in this landscape a third factor of bedrock properties must be considered. We are building a dataset of bedrock strength and exploring it in the context of topographic metrics. Included are rock-strength measures such as Schmidt-hammer compressive strength, Selby rock-mass strength, and laboratory tensile strength measures. To estimate the strength of units too incompetent to test directly, such as the shales prevalent in the region, we utilize functional relations between reach-scale rock strength and valley-bottom width, gradient, and unit stream power.

The Colorado River drainage across the Colorado Plateau can be broken up into bedrock reaches underlain by a variety of rock types including quartzite, sandstone, shale, limestone, and crystalline basement. Initial results indicate significant correlations between rock strength and channel and valley-bottom width, as well as gradient and unit stream power. High rock strength coincides strongly with narrow and steep canyon reaches in this landscape, but the most rapid incision coincides instead with reaches of low rock strength and stream power. This implies bedrock is a first order control on topography and process rates here, which is intuitive yet often overlooked.

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Impact of rock structure on drainage development: a case study from south-western pedimental region of West Bengal, India

BANERJEE A., BANERJEE A.
PANDIT RAVI SHANKAR SHUKLA UNIVERSITY, RAIPUR , CHHATTISGARH, BANKURA, INDIA

Rock structure generally indicate geological set up, presence of fracture, rock composition, hardness and other physical properties. Different geographical regions have different set up and related characteristics because of variation in rock structure. The genesis and pattern of drainage system depends upon the rock structure of a region. It is utmost important factor for fashion that a fluvial system has developed. The present study mainly deals with such types of problems. The study area being a part of easterly extension of Chotanagpur peninsular complex and in periphery plain with Pleistocene formation, hard rock basement complex and previous volcanic lava flows left some imprints in the study region. Geological, geomorphological and hydro chemical analysis has been carried out to understand the correlation between rock structure and drainage evolution in this undulating country. 12 sample sites have been selected in different part of Bankura and Purulia district in different litho geomorphic domain (Pedimental zone of Shallow, Moderate and Deep). A lithomorphic model has generated from sample studies to understand the variability of factors in drainage development. Based on this integrated studies, it has been noted that the lithology of the area mainly represented by amphibolites schist, hornblende-biotite gneiss, quartzite and granite belonging to Archaean and Lower Proterozoic Pleistocene and recent alluvial deposits mainly occur in eastern and northern part of the district. Therefore, in the present study, an attempt has been made to integrate the drainage pattern and evolution in different lithostratigraphic domains.

Temporal and Spatial Characteristics of Different Sandstone Geomorphology Types: from Zhangjiajie to China

QI D.(1), HUANG H.(1), CHEN A.(2), CUI Z.(3), ZHAI F.(4), CHEN D.(5)

(1) Institute of Geographic Sciences and Natural Resources of Research, CAS, BEIJING 100101, CHINA ; (2) Chinese Academy of Geological Sciences, BEIJING 100037, CHINA ; (3) College of Environmental Sciences, Peking University, BEIJING 100871, CHINA ; (4) Tourism College of Hunan Normal University, CHANGSHA 410081, CHINA ; (5) The Administrative Committee of Zhangjiajie Sandstone Peak Forest Geopark, ZHANGJIAJIE 427000, CHINA

China's sandstone landscapes is concentrated distribution in the southeast, southwest, northwest three large areas. It found in all climates and spaned from Paleozoic to Mesozoic Cenozoic, particularly in theMesozoic. Sandstone is main material basic for shaping the well-known attractions. Under different climate background and geological condition, different types of sandstone geomorphology were named and classified by Chinese in a specific time and place, and it is important to classify them for the science and the application. These names often appear in articles and sightseeing explanation, such as Danxia landform, Zhangjiajie landform, Zhangshiyan landform, Yeliu landform, Yuanmou landform, Daigu landform, Yardang landform and so on. It is an innovative named method for rock geomorphology research, but there is some confusion in classifying and naming the rock landform. It is necessary to make a principal to systematize and standardize the classification and the naming for the development of the petrographic geomorphology. The authors considers the "double name", means using both the place name and the landform name, and the "multi-name" can solve this problem.

Zhangjiajie sandstone peak forest landform is one of more ideal geomorphology research nomenclature. The thickness, age and uniformity of Devonian sandstone beds, along with the density, angularity and depth of the joint pattern, have been key determinants of the morphology and stability of more than 3000 thin and very high vertical sandstone pillars and peaks that cover an area of 80 km^2 within the core of the Geopark.; Zhangjiajie and its unique sandstone landscape must step from China to the World. Then it can be assigned in a manner that conveys their true place amongst world landforms and world heritage.

Keywords: Sandstone landform; Temporal and Spatial Characteristics; classify; name; Zhangjiajie Geopark; China.

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Thermal and structural controls on polygonal cracking in granite of La Pedriza de Manzanares (Spain)

GARCIA RODRIGUEZ M.(1), CENTENO J.D.(2), GOMEZ-HERAS M.(3), FORT GONZALEZ R.(4), ALVAREZ DE BUERGO M.(5)

(1) UNIVERSIDAD NACIONAL DE EDUCACIÓN A DISTANCIA UNED, MADRID, SPAIN ; (2) FACULTAD DE GEOLOGIA, UNIVERSIDAD COMPLUTENSE DE MADDRID, MADRID, SPAIN ; (3) CEI Campus Moncloa, UPM -UCM and CSIC, Madrid, Spain, ETS Arquitectura (UPM) and Instituto de Geociencias, IGEO (CSIC-UCM), MADRID, SPAIN ; (4) CEI Campus Moncloa, UCM-UPM and CSIC, Madrid, Spain, Instituto de Geociencias, IGEO, (CSIC-UCM), MADRID, SPAIN ; (5) INSTITUTO DE GEOCIENCIAS (CSIC,UCM), MADRID, SPAIN

Previous works on polygonal cracking in granite give some explanations on its formation. Some authors propose internal geodynamical factors as main controls, as it could be processes related to final stages of the magmatic consolidation or differential movement in fault planes because of their structural position. Some other authors prefer external factors related to climatic regimes, specifically, insolation rates and thermal differences to explain preferential orientations of this kind of pattern. However, to date is still not clear the extent of the relative influence of both internal and external geodynamical factors to explain this weathering pattern.

La Pedriza de Manzanares is part of a National Park in Madrid. This area includes part of the Late Variscan granites of the Spanish Central Range, eroded and uplifted to its present position during Alpine orogeny. This granite shows a complex fracture pattern (related to Variscan and Alpine processes) visible in a landscape alternating boulders and rock walls ranging from one to one hundred meters with abundant polygonal cracking patterns.

We analyze the relation between thermal and structural controls on the polygonal cracking found in La Pedriza's granite through measuring a series of parameters, including strike and dip of fractures, height from the ground, and shape of polygonal cracks and environmental temperature and relative humidity (by means of i-button sensors)

Polygonal cracking in this area appears always facing S, E or W in fracture planes with directions W-E and N-S. The most developed cracking appears at heights over 30 meters from the ground and in curved fracture planes, as described previously in other regions by other authors because of compressive stresses.

Genesis of incipient karst systems in saturated/semi-saturated and altered context: the example of « Graves » area (Gironde, France)

LANS B., MAIRE R.
CNRS-University Bordeaux 3, PESSAC, FRANCE

The beginning of the karstification process is capital in paleogeography (indicator of emersion) and karstology. The studied examples are situated at low altitude (5-25 m) in the Oligocene limestone on the left side of Garonne (Graves Vineyards). The observations made in the quarries of the Entre-Deux-Mers plateau, on the right bank (50-100 m), have shown the existence of isovolume alteration into the limestone. The same observations and petrographic analyses were performed in the Graves. The interest of this low area, covered by the Quaternary terraces of Garonne, is to have recent sinkholes and collapses. We are in the presence of small systems whose springs are located along the Garonne: Portets, Castres, Virelade, Podensac, Cerons. The flow regime shows slight variations and suggests a non karstic functioning as for alluvial aquifers. The example of Virelade system shows a big collapse of 30 m diameter and 17 m deep, formed in 1983. It indicates the existence of an ancient karstic void 10-20 m below the surface. The water table is visible at + 4 m in limestone covered by 8 m of alluvium. A line of ancient collapses is in connection with several losses located in the Barboue River. Similar observations were made in the near Gargale outlet. We are in presence of young karst systems with incipient drains related to compaction and partial evacuation of the ghost-rock by the water table fluctuations and the water transit towards the springs. These incipient caves probably date from the Middle-Upper Pleistocene. They were introduced by the existence of a hydraulic potential appeared during the last glaciations when the Garonne river dug directly the limestone. The grottoes developed into the Entre-Deux-Mers plateau benefited of a higher hydraulic gradient with a non-saturated flow. Virelade model approximates the model of the Fuie Cave in Charente, but the water pumping since the 1970' have promoted some collapses and the dewatering of some small springs.

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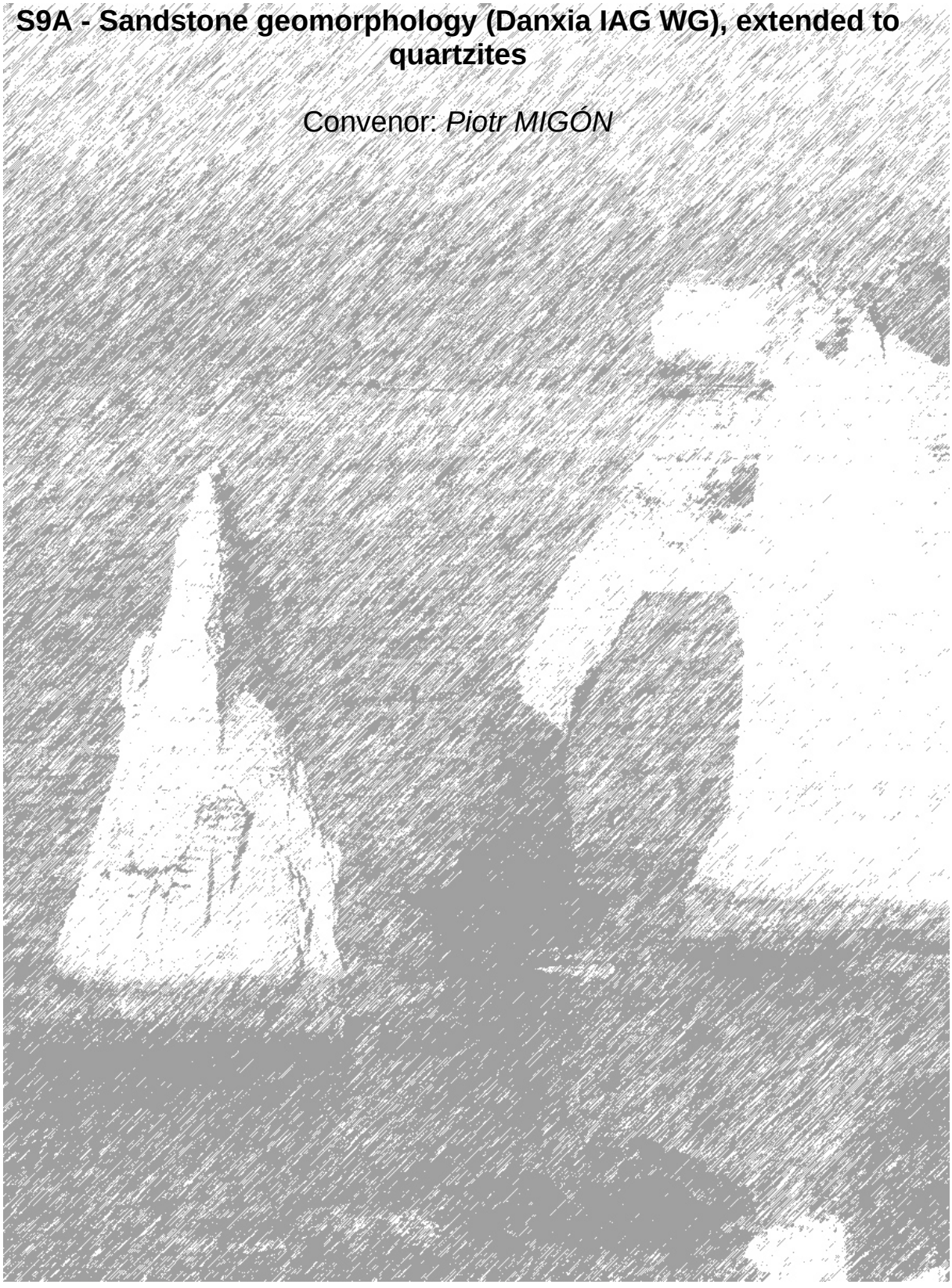
S9A - Sandstone geomorphology (Danxia IAG WG), extended to quartzites

Convenor: *Piotr MIGÓN*



Oral presentations:

Primary study on the global distribution and geomorphic development of red beds

PAN Z., PENG H., SIMONSON S., YAN L.
Sun Yat-sen University, GUANGZHOU, CHINA

In geology and geomorphology, red beds commonly refer to sedimentary rock series with the color of red as the dominant hue. They are the material foundation of Danxia landform, which is an original Chinese name used to describe erosional landscapes developed on red beds. Danxia landform in China has been studied for more than 80 years, but as a new branch subject in geomorphology, it is still insufficiently known outside China. The literature shows that red beds and Danxia landform are widely distributed in the world, but most studies were limited in the field of geology, relevant studies on red bed landform or Danxia landform were conducted based on sandstone landform, and thus, when compared with other rock geomorphology, this type of rock geomorphology is poorly understood, and there is no specific international research on Danxia landform at present. In July, 2009, the establishment of Danxia Working Group was approved by IAG Council, and global comparative study of Danxia-type geomorphology was included as a main work objective. In this paper, we will provide a review of existing research on red beds, Danxia landform and other similar studies. We will describe the distribution, ages, sedimentary environment, geological structure background, and geomorphic features of red beds in the world. Besides, some comparative analysis will also be included. We expect this review research on red beds throughout the world to make a clear reference, and draw attention from international colleagues to the global research of Danxia landform.

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Preliminary Study on Danxia Landform in China

HUANG J.(1), CHEN Z.(2), ZHANG R.(3), PENG H.(1), QI D.(4)
(1) School of Geography and Planning, Sun Yat-sen University, GUANGZHOU 510275, CHINA ; (2) Department of geology Science, Lanzhou University, LANZHOU 730000, CHINA ; (3) School of Geographical Science, Nanjing Normal University, NANJING 210097, CHINA ; (4) Institute of Geographic Sciences and Natural Resources of Research, CAS, BEIJING 100101, CHINA

Danxia landform is a special continental red beds landform which is characterized by red scarp slope. A great amount of work has already been done by Chinese scholars on Danxia geomorphology more than 80 years of history. In this paper, we make a brief overview on the field of China Danxia geomorphological study, including the definition of Danxia landform, types and distribution of Danxia landform in China, internal and external forces of landform processes, Danxia landscapes tourism development and its protection aspects.

The red layers of activation Diwa areas is primarily consist of sandstone, conglomerate, sandy conglomerate, mudstone, clastic rock material. In China, Diwa areas deposition had already begun since the last Triassic, the Jurassic and Cretaceous period is strongest. With the tectonic uplifting, occurred tilting, folding, fracture, and produce a series of joints, these within basins become into outflow erosion areas. Under water and wind erosion, denudation and collapse, weathering, biological, wave action, artificial role and other external force, different Danxia landform types development under the control of the different roles. Danxia landscapes is characterized by its red and escarpment.

By the end of 2012, Total 950 Danxia landscape sites hand been discovered in 28 provinces in China. Eighty percent of them are distributed in the crust uplifting red basins formed in Mesozoic and Cenozoic fault basins. Altitude from sea level to 5,000 meters, from semi-arid and arid areas to semi-humid and moist zones, fourteen climatic regions have Danxia landform distribution.

It is estimated about one fifth of national scenic spots is Danxia landscapes in China. Danxia landform is one of natural rock scenery. They are human's wealth and the earth heritage. Some endangered and famous Danxia scenic sites must be protected.

Keywords*:* Danxia landform; types and distribution; internal and external forces; geomorphic age; China

Study on the genesis of danxia landform in Longhushan area, southeast China

REN F.
Saint Louis University, SAINT LOUIS, UNITED STATES

This study, taking the Longhushan area as an example, aims at assessing the controlling factors to the development of danxia landform, which evolved from late cretaceous continental red beds. Geomorphometry analyses are applied by using remotely sensed images and DEMs (Digital Elevation Models). Lineaments are extracted based on the global one arc-second ASTER GDEM and Landsat ETM images. The result helps to quantify the spatial patterns of the danxia mountains. Subsequent comparison of lineament frequency rose diagram and density map to structural features imply their geological significance with the development of the danxia landform. The slope angle and aspect of danxia mountains are calculated from DEMs. Slope type of the danxia mountains are reclassified from slope angle raster. Statistics show that the steep slopes are dominant in the danxia landform region with the abrupt relief change from adjacent areas. The dominant aspect groups of Northwest and Southeast orientations may be the expression of the regional rift-related geological setting. The drainage network will be delaminated from DEMs. Longitudinal profile and the stream gradient index are parameters that will be used to evaluate geological, structural, and hydro-sedimentological factors that control the configuration of the red beds basin. These parameters allow the detection of anomalies of drainage that can respond to different factors such as lithology and/or tectonics. In order to quantify the denudation rate of the danxia landform, two principal low temperature thermochronometers are used in this study, apatite fission track analysis (AFT) and apatite (U-Th)/He analysis. Eleven samples were collected in all from the clasts in the red beds basin. Hopefully it will improve the insight into danxia landform development process in the area.
Keywords: danxia landform, remotely sensed imagery, DEMs, low temperature thermochronometers

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Contraverses over naming landscapes and implications ' Case of Zhangjiajie Global Geopark of China

HUANG H.(1), GU J.(1), SONG H.(2), XIAO S.(1), TIAN S.(3)
(1) Institute of Geographi Sciences and Natural Resources Reserach, Chinese Academy of Sciences, BEIJING, CHINA ; (2) Bureau of Land Resource of Zhangjiajie City, HUNAN PROVINCE, CHINA ; (3) Jishou University, HUNAN PROVINCE, CHINA

Recent movement on setting up geoparks at national and global scales has imposed considerable challenges to geomorphologists. The geologically and geomorphically distinct sites are of very important scientific, ecological and tourism values and provideanexcellentopportunity for geomorphologists to communicate the significance and substance of thescienceto the community. However, few geomorphologists have been engaged into the movement, although there are urgent issues requiring them to solve, such as naming a distinct site among the variety of landscapes that have either simailar landforms or similar litheology, climate, or the other similar aspects.

Zhangjiajie Geopark is located inHunan Provinceof China, and has been one of the top-listed tourism sites in China. Its unique landscape has developed in Devonian sandstone over an area of ~400 km^2andis characterized by more than 3000 sheer vertical sandstone pillars, peaks and walls of up to 350 m height. Due to the spectacular features, ithas been declared an UNESCO Global Geoparkrecently. Over the years, however, considerable debates have been under way on naming the distinct landscape. To clearify the confusion and promote the application of geomorphic knowledge in managing the geopark, a reserach center has been set up recently. This presentation introduces the major research activities of the center, typically on the detailed investigation of the causes behind the debates over naming the landscape and the promotion of geomorphic knowledge in geopark management and tourism development.

'Mo Hin Khao' a sandstone geotourism site in Thailand

SAMINPANYA S.(1), DUANGKRAYOM J.(2), JINTASAKUL P.(2), HANTA R.(2)
(1) Department of General Science, Faculty of Science, Srinakharinwirot University, BANGKOK, THAILAND ; (2) Northeastern Research Institute of Petrified Wood & Mineral Resources (In Honour of His Majesty the King) Nakhon Ratchasima Rajabhat University, NAKHON RATCHASIMA, THAILAND

"Mo Hin Khao", an attraction site, is located at the western edge of the Khorat Plateau, in the area approx. 0.32 $Km.^2$ of Phu Laenkha national conserved forest of Chaiyaphum province, Thailand. It has been created by weathering of the white sandstone namely Phra Wihan Formation (Cretaceous). The site situates on the dip slope of cuesta (strike N-S with low-angle dip, <15˚E) and its steep escarpment is to the west. The highlight is a group of five sandstone pillars of up to 12 meters high and the perimeters at the base ranging from 9.5 to 27.67 meters. The other groups of sandstone outcrop are the shorter pillars and hummocks. On top of them may be covered with polygonal cracks and their vertical surfaces show structures e.g. cross beddings and small and shallow holes. A stratigrapic study indicates the deposition of at least 4 sequences. Sandstone was classified as quartz arenite, sublitharenite and subarkose with mainly medium grains and there are some granules and course sands at the lower part of the beds. The mineralogy proved by petrography, X-ray diffractometer and electron probe microanalysis includes quartz feldspars (albite and orthoclase) muscovite, tourmaline, zircon, magnetite, amphibole and clay minerals, suggesting that the sediment source was more likely to be the older felsic igneous rocks. Geomorphic processes of the area started from the deposition of the sediment in the fluvial environment and after lithification the tectonic movement and uplift affected the sandstone beds resulting in folding structure (fold axis of NNE-SSW) and then the anticline-crest beds suffered from the high strain of extension causing two vertical fracture or joint sets (NW-SE and NE-SW) cutting in the beds at the anticlinal zone. The weathering and erosion have taken place intensively along the fractures and joints and now been leaving the remnants including anticlinal valley, escarpment and the pillar groups of the higher resistant sandstone.

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'Rougiers' and 'Ruffes' of southern France. A comparative study of geology, landforms and landscapes in the Permian basins of Lodève and Saint-Affrique (Aveyron, Hérault)

GIUSTI C.
UMR 8185 ENeC Espaces, Nature et Culture, PARIS, FRANCE

The Rougiers of Camarès is a geographical area coinciding with the Permian outcrops of the Saint-Affrique Basin (Aveyron) in the Massif Central, 20 km SW of Millau. This basin is limited to the east by the Mesozoic sedimentary formations of the Grands Causses, and to the south, west and north by the crystalline and metamorphic basement of the Monts de Lacaune, Albigeois and Rouergue. Though outcrops of coarse conglomeraticfacies may locally be extensive, most of the landscape is developed in a thick and predominantly reddish argillite formation interbedded with centimetre-thick carbonate horizons. Landforms mainly consist of hills and gullies, with structural or erosional platforms such as glacis or erosion surfaces.

The Lodève Basin (Hérault) 45 km west of Montpellier, is defined by another group of Permian formations, limited by the Caroux-Espinouse-Mendic gneissic and granitic basement in the west, by the Grands Causses in the north, and by the Cenozoic sedimentary formations of the Languedoc Lowlands in the south and east. The landscape ofthe Lodévois "ruffes" (latin *rufus*, reddish) could be quite similar to that of the Camarès "rougier", except for one key difference: the presence of thick and diverse basaltic formations of Pliocene and Quaternary age. The radiometric age obtained for several outcrops belonging to the corresponding N-S Escandorgue volcanic chain provide valuable benchmarks for reconstructing the last stages of landform development in the region. Other landmarks consist in elements of a regional erosion surface, the Piedmont Surface system, and of a lower partial planation surface, the Plan de Carlencas system.

Another difference between the rougiers and ruffes landscapes is of a bioclimatic nature and concerns the floristic composition of woodland vegetation: whereas the Lodève Basin entirely lies in an area of Mediterranean climate (*Quercus*), Camarès is more exposed to Atlantic influences (*Fagus*).

Sandstone versus conglomerate erosional landscapes - Why similarities? Why differences?

MIGON P.(1), WRAY R.(2)
(1) Department of Geography and Regional Development, University of Wroclaw, WROCLAW, POLAND ; (2) University of Wollongong, WOLLONGONG, AUSTRALIA

Sandstones have some of the most spectacular landscapes on Earth. These erosional landscapes are most distinctive if the beds are of only low to moderate dip. Differences in lithology, rock mass-strength, or resistance to weathering and erosion between beds usually give rise to stepped topographies, with strong rocks acting as cliff-formers and caprocks. Often, though not always, sandstone terrains are typified by angular shapes of major landforms, and these are related to the predominant mode of rock disintegration into joint-bound blocks of various size. Mass movements and erosion too are strongly controlled by discontinuities and leave angular scarps, deep clefts and alcoves. Rounded landforms do occasionally occur and generally are associated with thinly-bedded, weaker, poorly cemented and less resistant sandstones, where the breakdown is predominantly grain-by-grain.

Conglomerate terrains, by contrast, are commonly more rounded, with curved towers and tors, domes, spires and convex ridges. Excellent examples are seen in Montserrat – Spain, Sisteron – France, and Meteora – Greece, but particularly in south-eastern China where they are known as Danxia. The latter have formed on Mesozoic red beds which contain various lithologies, from coarse conglomerates to siltstones and claystones. The most distinctive rounded shapes are seen where thick conglomerates dominate. In many of these Danxia areas distinct bedding and regular jointing patterns is sparse, hence breakdown proceeds via release of individual clasts and disintegration of matrix rather than joint-controlled detachment of larger blocks, as in many sandstone areas.

However, at a smaller scale, there is often a remarkable geomorphological convergence between sandstones and conglomerates. Bedding caves, tafoni, flutes, runnels and hoodoo rocks are ubiquitous features in both rock types. They seem to be controlled mainly by selective grain-by-grain breakdown and porosity differences.

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Poster presentations:

A model simulation of the 'arenisation' weathering process in quartz-sandstones: a key factor for speleogenesis in the quartzite environment

MECCHIA M.(1), SAURO F.(2), PICCINI L.(3), DE WAELE J.(2)
(1) La Venta Geographic Explorations Association, TREVISO, ITALY ; (2) Department of Biological, Geological and Environmental Sciences, BOLOGNA, ITALY ; (3) Department of Earth Sciences, University of Florence, FLORENCE, ITALY

Arenisation is considered the main weathering process driving the formation of karst-like features and cave systems in the quartzite environment. We propose a numerical model useful to understand the timing and the possible situations in which this process works. Similar models are widely used for understanding the first phases of speleogenesis in limestone. In the quartzite environment not only dissolution is involved in the speleogenetic process, and all possible other factors have to be taken into account. Our model is based on the different SiO_2 concentration existing between waters in the external film at the surface of an open fracture (undersatured) and the intergranular porosity water (supposed to be at the saturation point). The chemical potential allows the removal of silica from the rock without significant movement of water. Dissolution causes an increase in porosity in the first layers of quartz grains in a water-filled fracture. When a critical value of porosity is reached in these layers, individual grains can disintegrate and be washed away by the flowing water, boosting the opening of the fracture.

The model addresses all the equations related to the chemical equilibrium of SiO_2, the chemical and physical characteristics of water, the flow rate in the fracture, and the porosity of the quartz-sandstone. The original width and length of the fracture, the texture of the rock (grain size) and the hydraulic gradient, are defined by the operator in order to simulate different situations.

The same principles are applied in two other models, the first related to the effect of arenisation by a film of undersatured water on a wall (simulating evaporation/condensation processes on cave walls) and the second related to weathering and arenisation in a flowing stream.

The results are finally compared with field observations and geochemical data from the Gran Sabana region, Venezuela, considered as one of the finest quartzite karsts in the world.

Distribution of red beds and classification of their erosion intensity in Guangdong Province, P.R.China'a remote sensing and GIS approach

SIMONSON S.
School of Geography and Planning, Sun Yat-sen University, GUANGZHOU, CHINA

Due to the lithologic character of red beds and human activity, land degradation is very common in red bed basins of humid Southern China. Extensive Cretaceous-Paleogene continental red bed basins are located in Guangdong Province, making it an ideal region for this study. The existing research on red beds is mainly limited to geology and Danxia landscape, which is a special kind of red bed landform that developed on thick, well lithified layers of red beds. However, little attention has been given to the geomorphic evolution of red beds composed of poorly lithified rocks and their associated erosion rates. By analyzing the spectral data and image texture features specific to the red beds, we intend to extract the remote sensing information of red beds in Guangdong Province from Landsat TM images taken in 2008. Once mapped, the spatial distribution of red beds in Guangdong Province can be determined. Multi-band imagery will be used in tandem with Digital Elevation Data (DEM) to map Normalized Difference Vegetation Index (NDVI), gully density and slope gradient. These parameters will be used to classify the red bed basins in Guangdong Province into different erosion intensity categories. We expect this approach to reveal the relationships between lithology, geomorphic evolution, and land degradation of red beds. We also hope this study can provide some foundation for the ecological restoration and environmental protection in red bed areas.

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Experimental geomorphology study on bedding caves at Mt. Danxiashan

PENG H., QIU Z., PAN Z.
Sun Yat-sen University, GUANGZHOU, CHINA

Bedding cave is a negative landform widely distributed in Danxia landform area. It is featured by rapid weathering of soft red bed intercalations, which exert great effect on the development of Danxia slope. However, in previous studies of Danxia landform, more attention was paid to the resistant sandy conglomerate that form the spectacular Danxia escarpment, while the physicochemical properties of soft red bed intercalations and their effect on the slope evolution of Danxia landform were neglected. This study aimed toexplore the weathering pattern of soft intercalations and their effects on the formation of bedding caves. Based on field investigation, three typical bedding caves were selected as study cases and some rock and water samples were collected to make further laboratory analysis.

Test results showed that the soft red bed intercalations of Danxia bedding caves belong to silty mudstone with high content of clay mineral and argillaceous cement. Due to strong absorbability, high porosity and low compressive strength, these soft intercalated rock layers were vulnerable to weathering and easily broken into loose pieces. The overlying and underlying rock layers, however, were composed of more resistant sandstone or sandy conglomerate with large particle size, which were mainly cemented by calcium and iron oxides, and they had low porosity and higher compressive strength. During the weathering process of soft red bed intercalations, more surfaces of surrounding rock mass are exposed to attack by external agents, the stress field of bedding caves changes and the overlying rocks may creep until collapse. Therefore, the lithologic character of soft red bed intercalations is a determining factor for the development of bedding caves and even the evolution process of Danxia slope.

China will start a national basic data survey on Danxia landform

PENG H., PAN Z., YAN L., SIMONSON S.
Sun Yat-sen University, GUANGZHOU, CHINA

Danxia landform refers to erosional landscapes developed on red beds with scarp slopes. It was named by Chinese geologists and has been studied for more than 80 years in China. However, due to lack of international exchange, Danxia landform drew little concern from international colleagues until the establishment of Danxia Geomorphology Working Group at 7thIAG conference, Melbourne, July 2009. The main objectives of IAG Danxia Geomorphology Working Group included undertaking a global survey of Danxia landform on the basis of the research work by Chinese scholar, and providing a platform of information exchange between geomorphologists from different countries.

In September 2012, our project “National basic data survey of Danxia landform” received a research funding from “the Special Program for Key Basic Research” of the Chinese Ministry of Science and Technology. The purpose of this project is to collect basic data about geologic and geomorphic elements of Danxia landform in China, and establish a database with the storage capacity of PB level. We intend to do field investigation in more than 300 typical Danxia landform areas in China, and it will be completed in 5 years. Before the field investigations begin, a classification system of survey elements and a technical standard for field survey will be developed. Then, the basic data about Danxia landform, which include location, area, regional tectonic background, the age and features of stratums, lithology, geomorphic type and morphology, will be stored by sorting code number to establish a database, which will be used as a data sharing platform to promote the comparison study of Danxia landform in and outside China. In addition, we expect this project can also provide technical and information services for environment protection, disaster prevention, scientific education and tourism in Danxia landform area.

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Inherited evolution of sandstone landforms in the Tadrart Acacus massif (central Sahara) and associated formation of banded iron speleothems and crusts

ZERBONI A.(1), VERRECCHIA E.(2)
(1) Dipartimento di Scienze della Terra "A. Desio", Universite degli Studi di Milano, MILANO, ITALY ; (2) Institute of Earth Sciences, University of Lausanne, LAUSANNE, SWITZERLAND

Sandstones are widespread on the Earth’s surface, representing the substrate for a wide range of landforms. They are common in the Sahara and have been shaped by geomorphological processes since the late Tertiary; but they are no longer in equilibrium with the present-day hydrological regime. In hyperarid central Sahara (SW Libya), the Tadrart Acacus massif is dominated by Paleozoic to Mesozoic quartzarenite. It is a NS elongated massif, dissected by a dendritic fossil drainage network and delimited eastward by a scarp with hanging valleys. To the east, it grades through a pediment to dunes of erg Uan Kasa. The walls flanking the wadis are vertical and dotted with rockshelters and caves. The main observed geomorphological features are related to etching and solutional processes occurring since the Tertiary. Etchplanation and tropical pedogenesis, which removed most of the sandstone bedrock, are the oldest processes that have taken place in the area under rainy and warm Tertiary climate. Subsequently, under the same environmental conditions, underground solutional processes occurred reaching some hundred of meters in depth. Vertical and horizontal tubes, caves, towers, pillars, and weathering pits are commonly observed features. Solutional processes were able to reach the ferruginous sandstone beds and contributed to iron leaching. Fe-rich solutions migrated within the discontinuities of the bedrock, precipitating as iron minerals within fractures, forming banded iron speleothems, and cementing gravel bodies at the mouth of underground drainage network. XRD and SEM analyses confirm that banded iron formations mostly consist of hematite, goethite, and clay minerals. Likely, Fe-rich solutions reached the deepest part of the massif and, upon resurgence, precipitated as Fe-oxy-hydroxides, probably due to biological mediation. After this period, Quaternary arid phases promoted diagenesis of Fe-oxy-hydroxides into hematite at low temperature, as well as their weathering.

Study on the geosciences and geotourism value of Kongtongshan Danxia Landscape in Pingliang, Gansu Procince, China

HUANG J.(1), CHEN Z.(2), ZHANG R.(3), QI D.(4), WANG S.(4), WANG Z.(5)
(1) School of Geography and Planning, Sun Yat-sen University, GUANGZHOU 510275, CHINA ; (2) Department of geology Science, Lanzhou University, LANZHOU 730000, CHINA ; (3) School of Geographical Science, Nanjing Normal University, NANJING 210097, CHINA ; (4) Institute of Geographic Sciences and Natural Resources of Research,CAS, BEIJING 100101, CHINA ; (5) The Administrative Committee of Kongdongshan Geopark, PINGLIANG 744000, CHINA

Kongtongshan Danxia landform Geopark is a natural region with geological landscape of extraordinary geosciences significance, special uniqueness and geoturism aesthetic value. With colorful natural landscape, ancient architecture and Taoism culture, Mt. Kongtongshan is not only a tourist site for sightseeing, leisure and entertainment, but also a key conservation district for geologic relics and ecological environment. It is an important base for geo-science research and education destination.

The Kongtongshan Formation conglomerate, developed under a dextral strike slip environment in late Triassic, is the material source of Kongtongshan Danxia Landform. Based on the regional dynamic environment of Mt. Kongtongshan area, we can recognize changing of Ordos Basin, gradually closing of the Paleo-Tethys Ocean from east to west and breakage of the northwestern China Craton. By means of sedimentary characteristics and structure, formation contrast, Optically Stimulated Luminescence(OSL) and Thermoluminescence(TL), the dynamic mechanism and tectonic attribute and evolution of the Kongtongshan Danxia landform can be comprehensively analyzed in this paper.

To estimate the tectonic uplifting rate of Mt. Kongtongshan area, calculate the geomorphic age of Mt. Kongtongshan and cliff retreating rates and erosion rates and so on, this paper presents four simple proposed by authors after sever years field-test. On May 18 and November 16 in 2012, we collected three gravel samples of the bottom of riverbed in the bedrock seated terrace of Jinghe River and its branch Yanzhi River. Calculating by Huangjin's Danxia Formula, the rate of tectonic uplifting here is 0.51m/10ka. The geomorphic age of Mt. Xiangshang, Huangcheng and Zhongtai is 13 Ma,11.5 Ma and 8.7 Ma.

Keywords*:* Danxia landform; geosciences and geotourism value; Mt. Kongtongshan; Pingliang; Gansu

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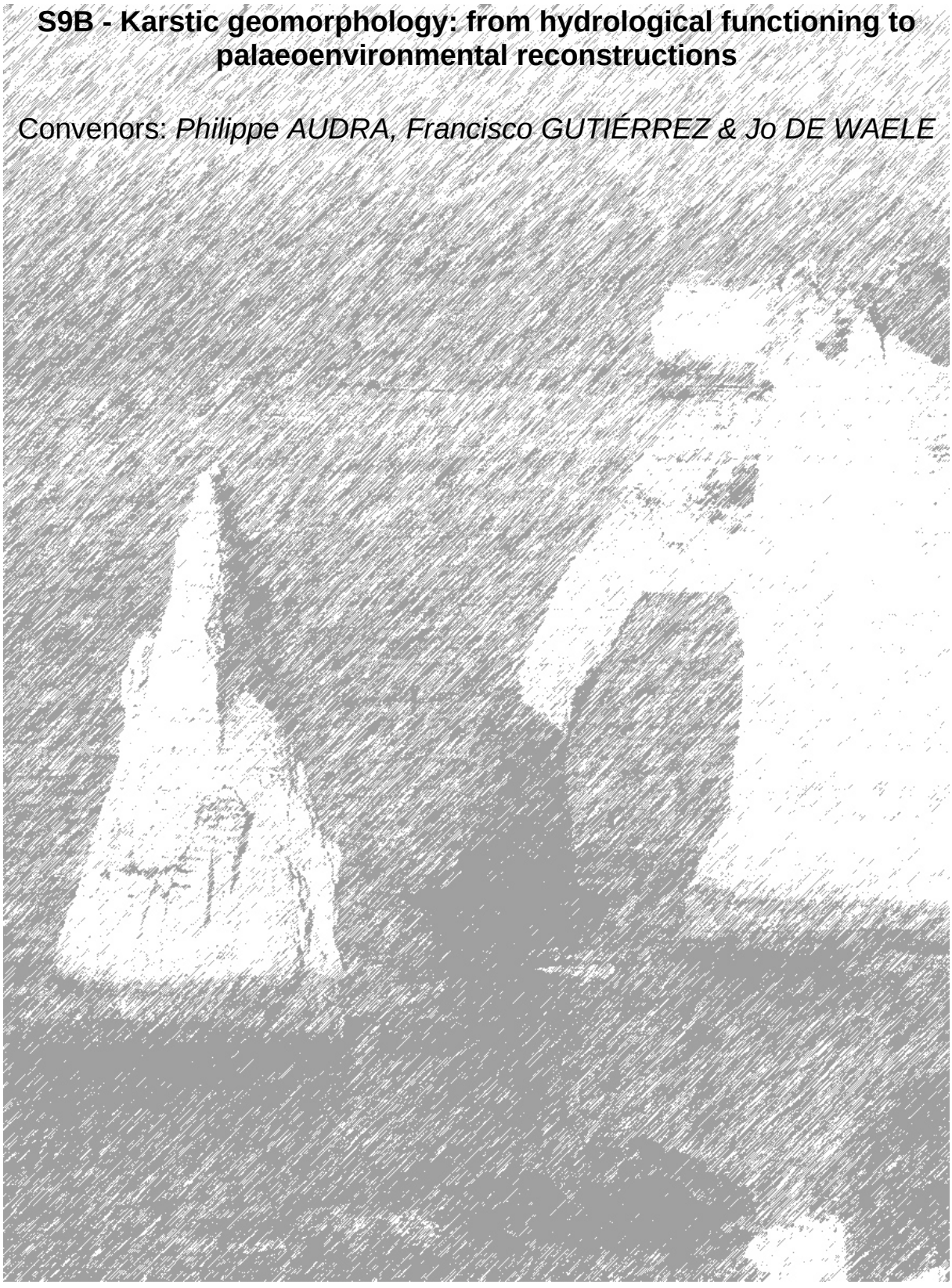
Origin of "Rock Cities", pillars and clefts in friable sandstone: new insight from study in Sandstone Quarry where landforms recently evolve

SCHWEIGSTILLOVA J.(1), SOUKUP J.(2), BRUTHANS J.(2), VACULIKOVA J.(2), MAYO A.(3)
(1) Institute of Rock Structure and Mechanics ASCR, v.v.i., PRAGUE 8, CZECH REPUBLIC ; (2) Faculty of Science, Charles University in Prague, PRAGUE 2, CZECH REPUBLIC ; (3) Department of Geological Sciences, Brigham Young University, PROVO, UNITED STATES

Various ideas exist concerning origin of landforms like rock cities (ruiniform landscape with pillars separated by clefts and narrow gorges), rock shelters and small vaulted hollows in friable sandstone. Sandstone surfaces and processes were studied in Strelec Quarry, the Czech Republic in Cretaceous marine quartz kaolinite-bond sandstone, where forms similar to landforms at natural exposures (clefts-conduits, hollows) are evolving at present time. The quarry offers a unique opportunity to characterize the erosion processes, which may form natural landforms prior stabilization by case hardening. Based on measurements of flow velocity, hydraulic gradient, relative erodibility, ambient and water-saturated tensile strength at natural and quarry exposures and SEM three distinct kinds of surfaces were distinguished: 1) Erodible sandstone; 2) Sub-vertical fracture-bounded surfaces that are non-erodible and formed tectonically (slip faces of microfaults); 3) Case hardened surfaces that start to form after exposure. In favorable conditions case hardened surfaces became non-erodible and reach the full tensile strength in just 6 years. Flow in openings with a discharge 1 ml/s and hydraulic gradient > 0.05 exceed the erosion threshold and initiates piping. In the first phase of conduit evolution, fast concentrated flow mobilizes erodible sandstone between sets of parallel fractures in the shallow phreatic zone. In second phase the conduit opening mainly expands vertically upward into the vadose zone by mass wasting of undercut sandstone slabs. Mass wasting is responsible for > 90% of mobilized sandstone. Sides of the mature conduits are protected by non-erodible fracture-bounded surfaces. Natural landforms were probably formed rapidly by piping and possibly overland flow and fluidization during or at the end of the glacial periods when sandstone was not yet protected by case hardening. Erosion proceeded along densely fractured zones.

S9B - Karstic geomorphology: from hydrological functioning to palaeoenvironmental reconstructions

Convenors: *Philippe AUDRA, Francisco GUTIÉRREZ & Jo DE WAELE*



Oral presentations:

Rare sulfate minerals (fibroferrite) and hypogene sulfuric speleogenesis in Baume Galinière Cave (Alpes-de-Haute-Provence, France)

AUDRA P.(1), BIGOT J.Y.(2)
(1) Polytech Nice - Sophia, University of Nice - Sophia Antipolis, BIOT, FRANCE ; (2) Association Française de karstologie (AFK), MONTPELLIER, FRANCE

The oxidation of sulfides sources (H_2S gas, pyrites oxidation, hydrocarbon leakages…) produces sulfuric acid that strongly reacts with its environment, with limestone dissolution and complex interaction with other minerals in presence. Such kind of cave development is referred as Sulfuric Speleogenesis, a subcategory of hypogene speleogenesis (i.e. with source of aggressivity and water rising from depth). It also produces uncommon mineral, mainly sulfates.

Baume Galinière locating in Southern France, in Vaucluse spring watershed. This small maze cave originates from the oxidation of small pyrite ores. Several speleogenetic phases are recorded, successively phreatic with calcite dykes and iron crusts, then in atmospheric environment involving sulfuric gases. Attenuated oxidation is still occurring through condensation of the air entering the nearby entrance. Characteristic features are present (especially corrosion notches), together with sulfuric speleogenesis by-products, such as sulfur, goethite, and sulfates (gypsum, jarosite, natrojarosite, fibroferrite). It is the second mention of fibroferrite, a rare cave mineral, which can develop only within low pH and RH conditions.

Together with others hypogenic caves surrounding the Vaucluse watershed, the Baume Galinière Cave owes its presence to deep water lifts along major faults, at the contact of the karst aquifer confined by impervious covers. It records the position of paleo-covers and their retreat, in relationship to the landscape evolution and the valleys incision, which responds itself to the uplifting and tilting of the Vaucluse block during Neogene.

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Interaction between the fluvial incision and the geological structures: the Torca La Texa shaft (Picos de Europa, Spain) case

BALLESTEROS D.(1), JIMÉNEZ-SÁNCHEZ M.(1), GIRALT S.(2), GARCÍA-SANSEGUNDO J.(1), MELÉNDEZ M.(3)
(1) University of Oviedo, OVIEDO, SPAIN ; (2) Institute of Earth Sciencies Jaume Almera-CSIC, BARCELONA, SPAIN ; (3) Instituto Geológico y Minero de España, OVIEDO, SPAIN

The Picos de Europa is an alpine karst that includes 270 km of large shafts and cave levels perched over the water table; nevertheless, only the speleogenesis of 4 % of the caves have been studied systematically. The aim of this work is to characterize the geomorphology, structural control and evolution of Torca La Texa shaft. The method includes speleological, hydrogeological, geomorphological, geochronological and structural techniques. Torca La Texa (4º 53' W 43º 16' N 1,305 m) is a multilevel cave (2.6 km long, 215 m depth) formed by four levels (43 % of the cave) perched at 1,273, 1,258, 1,238, 1,168 m, five *soutirage* conduits (5 %) and narrow canyons (52 %). A spring sited at 835 m represents the base level of the cavity. The cave levels show fluvial features modified by incision and often covered by speloethems. The *soutirages* include epiphreatic features and debrisflow deposits remobilized from the upper passages; the canyons were modified by gravity process in some places. Three speleothem samples from the second cave level were dated in 65, 156 and 181 ka, whereas the fourth sample is out of range of the U-Th method. The shaft is developed in a carboniferous limestone located at an antiform associated to an imbricate and overturned system thrust. Cave passages are forced by four families of joints (1: N120E/78SW; 2: N146E/52SW; 3: N100E/59SW; 4: N184W/60NW), the bedding (N123-186E/60SW) and the axis fold (N263E/41SE). The results evidence Torca La Texa was developed in relation to the progressive drop of the water table in a complex structural environment. The cave levels were developed in phreatic conditions and guided by the bedding and families of joints 2 to 4, while *soutirages*, shafts and canyons are formed downwards follow the bedding, families of joints 1 and 4 and the axis of the fold. The first and second cave levels were originated by fluvial process that probably finished 156-181 ka ago and with large flowstone should deposited until 65 ka ago.

Alteration of the Jurassic limestones series in the Charente karst basin: Impacts for the speleogenesis by ghost-rock process and the genesis of the large Touvre aquifer

DANDURAND G.(1), MAIRE R.(2), DUBOIS C.(3), VANARA N.(4), QUINIF Y.(3)
(1) ADES CNRS/Bordeaux 3, PESSAC , FRANCE ; (2) ADES CNRS/Bordeaux 3, PESSAC, FRANCE ; (3) Université de Mons, MONS, BELGIUM ; (4) LGP / Université de Paris-Sorbonne, PARIS, FRANCE

A new study of the karstic basin of the Touvre springs in Charente (2nd in France) shows the prominent role of alteration called “ghost-rock”. This peculiar process developed duringemersion of the carbonate platform during the Lower Cretaceous (45 Ma). Itwas demonstrated by the study of quarries, drillings and the young cave of La Fuie. These approaches highlighted the crucial role of ghost-rock process in the formation of karst landscapes of Charente.

Micromorphologicalanalyses from altered samples shows a micro-dissolution in various forms and the likely role of bacteria. Ghost-rock features are clearly identified by Liesegang rings, the alteration way which initially attacks sparitic crystal areas and continues by the dissolution of micrite.*Siderobacteria in grap-type cocci* form*iron*-oxide depositsas iron micropisolithes.

This decay process explains the genesis of maze caves and also the complexity of the Touvre aquifer. For the first time an active speleogenesis by ghost-rock process is demonstrated in Charente. La Fuie Cave was used as subterranean laboratory to highlight a new way to drain residualdeposits by flooding-dewatering of galleries associated with collapses from ascending chimney in a cave system.This discovery contradicts the classical theory of the formation of caves by slow dissolution of joints and fractures. Indeed, the high fluctuations of the water table generate typical maze caves coming from the erosion of the ghost rock network in the three dimensions.

Furthermore the large water reserve (1-2 km^3) of the Touvre springs is situated into the porous Jurassic limestone (slow drainage) while a small part is drained by the karst conduits (fast drainage). The erosion of porous rock is activated upstream by the losses along the valleys. Downstream there is also an headward erosionfrom the main spring.

The conclusion discusses three research perspectives concerning speleogenesis, hydrogeology of karst reservoirs and the role of paleogeography.

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Epigenic gypsum caves as indicators of climate-driven river incision and aggradation in a slowly uplifting region (Emilia Romagna, North Italy)

DE WAELE J., FORTI P., MARABINI S., PICOTTI V.
Department of Biological, Geological and Environmental Sciences, BOLOGNA, ITALY

Karst in Emilia Romagna (N-Italy) is mainly confined to gypsum outcrops. Large epigenic karst developed in several of these areas, with caves reaching up to 10 km in length. Larger cavities host active rivers and display series of cave levels. These stacked stream passages reflect both the uplifting Apennines and Quaternary climate changes, and the consequent entrenchment/aggradation of surface streams, representing local base-level.

Rivers flowing towards the Po plain adjust their stream profiles to tectonics with variable rates at the scale of >100 ky. At lower frequency, climate controls entrenching during low discharge periods, when the bedload is too limited to prevent stream erosion and vertical incision. High discharge periods allow the valley to widen by lateral erosion. These conditions enhance the carving of strath terraces and the aggradation of terrace fills. Recent datings of flights of terraces document the duration of aggradation around 2-3 ky during Late Glacial to Holocene, with surface streams remaining stable in a 5 m altitude range during which cave levels have the time to develop.

A detailed study allowed to reconstruct the entrenchment of the underground rivers in response to valley deepening. Age constraints on river straths, geomorphological observations and modeling show erosion to have occurred during cold periods. The widespread occurrence of antigravitative evolution in cave conduits is related to the aggradation of surface rivers, causing underground streams to carve upwards.

These studies indicate that detailed investigations on cave morphologies in multi-level gypsum caves may help to unravel the climatic and tectonic evolution of the area in fast and slow developing karst respectively. This evolution can be constrained by datings of terrace fills and speleothems. This model, valid for gypsum in temperate regions, can be exported to limestone in higher precipitation regimes, or to halite in arid areas.

The role of condensation in the evolution of dissolutional forms in gypsum caves: an example from the karst of Sorbas (SE Spain)

GÁZQUEZ F.(1), CALAFORRA J.M.(1), SANNA L.(1), FORTI P.(2), DE WAELE J.(2)
(1) Department of Hydrogeology. University of Almería, ALMERÍA, SPAIN ; (2) Italian Institute of Speleology, Department of Biological, Geological and Environmental Sciences, University of Bologna., BOLOGNA, ITALY

The karst of Sorbas (SE Spain) is one of the most important gypsum areas worldwide. Its underground karst network is composed of over 100 km of cave galleries which are distributed in seven levels. In this work, the morphological features, developed in the upper cave systems and induced by condensation-dissolution mechanisms, have been studied by means of Micro-Erosion Meter (MEM) measurements, monitoring microclimatic parameters and direct measurements of condensation water.

Rounded smooth forms, condensation cupola and pendant-like features appear on the ceiling of the shallower galleries (less than 10 metres deep) as a result of gypsum dissolution by condensation water. Meanwhile, gypsum speleothems formed by capillarity, evaporation and aerosol deposition such as coralloids, gypsum crusts and rims are frequently observed in the lower parts of the cave walls. Monitoring of erosion at different heights in a cupola revealed that the surface of the gypsum retreated 0.05 mm/year in a MEM station located at the highest part of this cave dissolutional form, while this value was negligible at the lowest site, proving higher dissolution rates close to the cave ceiling, where warmer, and thus lighter air flows. Direct measurements of the amount of water dripping from a metal plate hanging in the centre of a cave gallery indicate that this process mainly occurs between July and November in coincidence with rainless periods, as a consequence of external moist warm air entering the cave and water vapor condensing on the colder cave walls. Microclimatic parameters show that the thermal stratification, induced by differences in temperature and humidity between the air at the bottom of the conduit (10 ºC and 90% of relative humidity) and near the cave ceiling (13 ºC and saturated), controls the intensity of the evaporation-condensation mechanisms occurring at different heights in the cave galleries and also the gypsum speleothem growth.

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Cave geomorphology as a record of environmental changes: the El Pindal Cave (Cantabrian Coast, N Spain) case study

JIMENEZ-SANCHEZ M.(1), STOLL H.(1), GIRALT S.(2), MORENO CABALLUD A.(3), DOMINGUEZ-CUESTA M.J.(1), ARANBURU A.(4), MENDEZ-VICENTE A.(1), BALLESTEROS D.(1), VALERO B.(3), CHENG H.(5), EDWARDS L.(5)
(1) DEPARTMENT OF GEOLOGY UNIVERSITY OF OVIEDO, 33005 OVIEDO, SPAIN ; (2) Department of Environmental Geology and Georisks, ICTJA, Solé i Sabaris s/n, E-08028 BARCELONA, SPAIN ; (3) Department of Geoenvironmental Processes and Global Change Instituto Pirenaico de Ecología (CSIC), Avda. Montañana 1005, 50059 ZARAGOZA, SPAIN ; (4) Department of Mineralogy and Petrology University of Basque Country, Sarriena s/n,, 48940 LEIOA, SPAIN ; (5) Department of Geology and Geophysics, University of Minnesota, 55455 MINNEAPOLIS, MINNESOTA,, UNITED STATES

This study focuses on the use of caves as geomorphological records of regional and global events. Geomorphologic mapping, structural, sedimentological analyses and absolute dating based on U-series desintegration and OSL were applied to El Pindal Cave, located 24 m above sea level in the Cantabrian Coast (Asturias, NW Spain).

The development of the cave was controlled by E-W trending faults that would have favoured the emplacement of phreatic conditions probably associated to the evolution of the Deva River. The evolution of the cave is controlled by the following processes: gravity action, speleothem precipitation and fluviokarstic activity. A roof collapse took place prior to 6 ka and after 14 ka. Speleothem precipitation gave place to five generations of speleothems: (1) Flowstones older than 230 ka; (2) Stalagmites from the Upper Pleistocene to the Middle Holocene (37 to 4 ka), recording LGM of MIS2; (3) Stalagmites older than 7 ka; (4) Late Holocene stalagmites (from 3.3 ka to present) and (5) Stalagmites coeval or younger than 200 yr. OSL dating of detrital levels suggests: (1) the occurrence of a cave flooding episode at 120 ka (MIS 5) and (2) the activation of the alluvial fans to the South of the cave at 75-57 ka, as a response to a probable regional incision during MIS4. The comparison between geomorphological events in the cave and regional and global events demonstrates the potential of cave geomorphology as a record of environmental changes, complementing paleoclimate and palaeoenvironmental research based on other terrestrial and marine archives.

Keywords*:Cave, Karst, Marine terrace, geochronology, U-Th series, OSL dating, Cantabrian Coast.*

Morphogenesis reconstitution on Kelb valley, Lebanon: contribution of Jeita cave speleogenesis and karst landforms study

NEHME C.(1), DELANNOY J.J.(2), GÉRARD J.(3), JAILLET S.(2)
(1) Université de Savoie, BOURGET DU LAC, FRANCE ; (2) Universit? de Savoie, BOURGET DU LAC, FRANCE ; (3) Saint-Joseph university, BEIRUT, LEBANON

A geomorphological study has recently been conducted in Lebanon and aims at reconstituting the palaeogeographical stages of valleys related with the downcutting of the Mediterranean hydrographic network. This study focuses on the reconstitution stages of Kelb valley incision. Whereas geomorphic indicators are rare on the surface, we used sub-surface geomorphologic indicators revealed from the speleogenesis study of Jeita cave.
The study area is located downstream of the valley and close to the Mediterranean Sea. It is characterized by: i) a geological structure controlling the phreatic zone (dammed karst), ii) a cave network with 10 km of galleries located between 60 and 250m altitude, and iii) few relict landforms (marine terraces, relict valleys). A crossover analysis between speleogenesis stages, the geology of the sector and the relict landforms suggest three stages of Kelb valley evolution from Pliocene to quaternary period. The study highlights on: i) the paragenesis process in Jeita upper galleries along with Kelb river aggradation in respond to Pliocene transgression, ii) the incision of Jeita canyon due to the reorganization of the drainage (fluvial and karstic) system during Quaternary, iii) implications of the Mount Lebanon tectonic uplift and the transgression/regression of the Mediterranean sea during these episodes. The reconstitution of Kelb valley downcutting is extended to the adjacent Antelias valley, where some identified paragenetic caves are located at an altitude close to Jeita upper galleries. Finally, this study can suggest a new chronostratigraphy to marine terraces identified along the western flank of Mount-Lebanon. These terraces up to 300 m. altitude were thought to be quaternary in age while altitudinal correlation between Jeita upper galleries and marine terraces (160 to 250m) of Kelb valley suggest another chronology: Lebanon high marine terraces could be of Pliocene age, while lower terraces were formed during quaternary period.

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Thermal Carbonic and Sulfuric Acid Speleogenesis in Cave Provalata, Republic of Macedonia

TEMOVSKI M.(1), AUDRA P.(2), SPANGENBERG J.(3), MIHEVC A.(4), BIGOT J.Y.(5)
(1) Temovski_m@yahoo.com, PRILEP, MACEDONIA ; (2) Polytech'Nice-Sophia, Engineering School of Nice - Sophia Antipolis University, BIOT, FRANCE ; (3) Laboratoire des Isotopes Stables, Institut de Minéralogie et Géochimie, Université de Lausanne, Anthropole, LAUSANNE, SWITZERLAND ; (4) Karst Research Institute ZRC SAZU, POSTOJNA, SLOVENIA ; (5) French Association of Karstology, MONTPELLIER, FRANCE

Cave Provalata (Republic of Macedonia) is a rare case of a successive carbonic and sulfuric acid speleogenesis, separated by complete infilling of cave passages with clays. It is a small but remarkable hypogenic cave with abundant gypsum deposits, mostly covering thick corroded calcite crust, with cupolas, ceiling and wall channels, feeders and replacement pockets as some of the most characteristic morphological features. Morphological and mineralogical analyses suggest hypogenic origin in two phases: the first by thermal CO_2 rich waters, the second by sulfuric acid dissolution, which were separated by complete infilling of cave passages with clays. In the first phase cave passages were formed by dissolution along fractures due to cooling of rising carbonated thermal waters. They were later covered with thick calcite crust, deposited after shifting to shallower environment. The cave was completely filled with clays in Early Pleistocene, due to deposition of pyroclastic rocks and travertine deposits in lacustrine environment in Mariovo Basin. After draining of Mariovo Lake and establishing fluvial drainage, Buturica River incised first in the lacustrine deposits, then in Cambrian marbles, creating its superimposed valley, which lowered the water table and allowed washing of the clay deposits. The second phase started after introduction of H_2S in the thermal waters, which produced sulfuric acid at or near water table, rapidly dissolving the calcite crust and marble host rock. Most of the dissolution happened above water table due to condensation corrosion which produced abundant gypsum deposits as replacement gypsum crust, that later detached and pilled as gypsum blocks. At the contact of sulfuric acid with the clay deposits, alunite, jarosite and natroalunite were formed. $^{40}Ar/^{39}Ar$ dating gave maximum age of 1.6 Ma (alunite) and 1.46 Ma (jarosite). The cave continued to evolve downwards due to lowering of the water table as Buturica River incised its valley.

Flank margin caves on a passive continental margin: naracoorte and the other southern australian examples

WHITE S.
La Trobe University, PARKVILLE, VICTORIA, AUSTRALIA

Flank margin caves (FMC) have been predominantly described, using the Island Karst Model,along the margins of the freshwater lenses just beneath the flanks of the enclosing land mass on carbonate islands such as in the Bahamas or the Marianas. This model has been used to explain karst development on young carbonate islands with poorly cemented eolianites. Karst in this setting differs from that formed in well-cemented limestones as usually found in continental settings. However karst on some continental margins, especially the southern Australian coast, are not in well-cemented telogenic rocks but in highly porous, highly permeable marine and eolian calcarenites. The gradual uplift over the past 50 Ma of the southern edge of the continent has resulted in Flank Margin Caves, which formed in a continental coastal setting. Many of these caves are now positioned significantly further inland and reflect the neotectonics of the Southern Australian passive continental margin rather than solely the Pleistocene glacio/eustatic sea-level fluctuations. The inter-relationship of tectonic setting, the distinctive characteristics of FMC and the speleogenesis of coastal karst assists in the understanding of the karst landscape evolution of significant karst areas of southern Australia, particularly in the Naracoorte area.

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New perspectives on the genesis of the Miocene collapse structures of the Island of Gozo (Malta)

TONELLI C.(1), GALVE J.P.(2), SOLDATI M.(1), GUTIÉRREZ F.(2)
(1) Università di Modena e Reggio Emilia, MODENA, ITALY ; (2) Universidad de Zaragoza, ZARAGOZA, SPAIN

The geology of the Island of Gozo (Malta) is characterised by large paleosinkholes controlled by subvertical annular faults (traditionally called “solution subsidence structures”) whose dimensions can reach hundreds metres in diameter and vertical displacement, being comparable in size to the largest sinkholes of the World. Despite their unusual dimensions, unusual structure and peculiar associated erosional landforms, varying from large depressions to rounded bays and buttes, these structures have never been investigated from a karst perspective. The theories of formation proposed in the 70's, based on sedimentological and structural observations, are still under debate. According to them, the paleosinkholes would have been formed in the sea floor due to subsidence caused by the collapse of huge cavities developed in carbonates or related to deep-seated dissolution of evaporites. The thickening of stratigraphic units in some paleocollapses, showing cumulative wedge-outs, reveal that subsidence occurred progressively in the sea floor (synsedimentary subsidence). Recent detailed geological and geomorphological surveys have been carried out with the aim of revisiting the origin of these paleosinkholes. The collected data have been compared with the characteristics and geological setting of similar examples of karst collapses documented in the World. Based on our literature review and mechanical constraints, gradual subsidence resulting from progressive interstratal karstification of evaporites seems to be most likely alternative. However, the currently available subsurface stratigraphic data do not indicate the presence of significant evaporitic units. Being the Maltese paleosinkholes related to processes developed under different hydrogeological conditions than those existing today, the relationships between their formation and the Miocene paleogeographical setting have been studied to see which alternative could better explain their genesis.

Karstic evolution and Human occupation in the Mas d'Azil Cave (Ariège, Pyrénées, France): new research and new results

JARRY M.(1), BRUXELLES L.(2), BON F.(3), FRITZ C.(4), LACOMBE S.(5), LELOUVIER L.A.(1), MARTIN H.(1), PALLIER C.(6), RABANIT M.(7), TOSELLO G.(8), WATTEZ J.(9), ARRIGHI V.(10), SALMON C.(10)

(1) INRAP and University of Toulouse TRACES UMR 5608, TOULOUSE, FRANCE ; (2) INRAP, University of Toulouse TRACES UMR 5608 and GAES, University of Witwatersrand, Johannesburg, NÎMES, FRANCE ; (3) University of Toulouse and TRACES UMR 5608, TOULOUSE, FRANCE ; (4) CNRS and University of Toulouse TRACES UMR 5608 (CREAP), TOULOUSE, FRANCE ; (5) Binghamton University (SUNY) and University of Toulouse TRACES UMR 5608, NEW YORK, UNITED STATES ; (6) INRAP and ASM Lattes UMR 5140, TOULOUSE, FRANCE ; (7) INRAP and PROTEE, MONTPELLIER, FRANCE ; (8) University of Toulouse TRACES UMR 5608 (CREAP), TOULOUSE, FRANCE ; (9) INRAP and Dmos UMR 5140, PARIS, FRANCE ; (10) INRAP, TOULOUSE, FRANCE

The cave of Mas d'Azil, with the Arize river running through it, is one of the most important – and impressive – karstic context in Southern France. It is also an important place for Prehistoric research, especially for the knowledge of the Magdalenian and Epipaleolithic cultures. However, few synthetic studies are available, contrasting with the celebrity of the site. Under the upstream porch, the left bank still holds cultural sequences from the end of the last glaciation to the Neolithic, intercalated with flood silts. In contrast, the right bank, where the deep galleries are located, was considered sterile or already completely excavated.

Recent preventive (rescue) archaeology operations were conducted on the right bank that have significantly restored the potential of this cave. This paper will present the first results of our work, which is the beginning of a future boarder research program. Thus, the remains of *in situ* stratigraphy offer a new history of the cave where human occupations, such as some unpublished older and recent Aurignacian, are punctuated by the evolution of the cave and its filling, during the LGM episode. Layers of fluvial sediments were deposited before the Aurignacian but also after.These sediments buried archaeological remains under several meters of deposits. They also partially filled all the lower part of the cave and closed some galleries. This event also permits us to revisit the dating of the rock paintings of the Gallery Breuil, considered anterior to the Magdalenian, by setting a *terminus ante quem.* After the re-opening of the cave, human occupations belong to the Middle Magdalenian. *In situ* cultural horizons were discovered under a layer of Mesolithic ashes. The phenomenon of floods recorded here, could be extrapolated across the regional geomorphology and gives, for the first time, strong arguments for to date the formation of the alluvial terraces of the Arize River and to link it to the Garonne valley.

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Isturitz, Oxocelhaya and Erberua Caves (Pyrénées-Atlantiques, France): geoarchaeological studies

VANARA N.(1), GARATE D.(2), BIGOT J.Y.(3), CANEROT J.(4), LANS B.(5), MAIRE R.(5), MAGNE L.(6), DANDURAND G.(5), PARENT G.(7), LAUGA M.(7), DOUAT M.(7), BRAMOULLE Y.(7), LABARGE A.(8), RIVERO O.(2), DARRICAU J.(9), NORMAND C.(2)

(1) CNRS - UMR 8591 - Physical Geography Laboratory, Bellevue-Paris and Paris 1 - Panthéon-Sorbonne University, PARIS, FRANCE ; (2) CNRS - UMR 5608 - TRACES Laboratory and Toulouse 2 - Le Mirail University, TOULOUSE, FRANCE ; (3) French Association of Karstology (A.F.K.), MONTPELLIER, FRANCE ; (4) 3, chemin Cordeau 31200, TOULOUSE, FRANCE ; (5) CNRS - UMR 5185 - ADES Laboratory, BORDEAUX, FRANCE ; (6) Center of Karstic Studies, ROUEN, FRANCE ; (7) The "Pyrénées-Atlantiques" Regional Caving Organization (C.D.S. 64), PAU, FRANCE ; (8) ."Médiations en Préhistoire" Association, SAINT-MARTIN-D'ARBEROUE, FRANCE ; (9) Gaztelu Association, SAINT-MARTIN-D'ARBEROUE, FRANCE

Isturitz, Oxocelhaya and Erberua Caves are located in the foothills of the western Pyrenees. The landscape is hilly and is crossed by a wide valley with a small river, the Arberoue. Downstream, the river disappears into the limestone of Gaztelu Hill: this underground flow created the Erberua Cave. Above this natural tunnel we observe three fossil staged caves: Oxocelhaya, Isturitz and Rocafort. The Gaztelu Caves provide a major European Prehistoric archaeological site. The first recorded data came from the Isturitz Cave (1895), then from the Oxocelhaya Cave (1929) and finally from the Erberua Cave (1973) giving evidence of human occupation during the Mid-Upper Palaeolithic period. These archaeological remains are not uniformly distributed. In Erberua, some of the paintings suggest a Gravettian use of the cave but the works date from the Magdalenian time (Middle and/or Upper). In Oxocelhaya Cave, the settlement may date from Aurignacian time but the art works generally date from the Magdalenian time. In Isturitz Cave, the importance and diversity of the Aurignacian objects are exceptional and prove the permanent nature of this settlement where numerous activities took place. Also during the Gravettian time, an enormous quantity of material is proof of a very important human presence. During the Middle Magdalenian time, the activities are marked in particular by hundreds of portable art, this is why this cave has been described as one of the most important aggregation sites of the Pyrenees. The research team is multidisciplinary and was established in 2011 around twelve main objectives. Our contribution concerns the first two stages and includes speleologists, geologists and karstologists. The first stage was the charting of the numerous listed activities and the second stage will analyze their organization according to the topographic, geological and karstologic specificities of the Gaztelu Hill.

Geomorphology of the paleo and recent hydrographic network on the karst plateau (example Una Korana plateau, Croatia)

BOCIC N.(1), PAHERNIK M.(2), MIHEVC A.(3)
(1) University of Zagreb; Faculty of Science; Department of Geography; Subdepartment of Physical Geography, ZAGREB, CROATIA ; (2) Croatian Military Academy "Petar Zrinski, ZAGREB, CROATIA ; (3) Karst Research Institute, POSTOJNA, SLOVENIA

Karst plateaus generally have a complex geological and geomorphological evolution. One of the largest plateaus in the Dinaric karst is Una-Korana plateau extends along the northeastern edge of the Dinarides. Provides the Dinaric direction (NW-SE) across three countries: Slovenia, Croatia and Bosnia-Herzegovina with a length of 120 km. Width is 10 to 20 km, and the area is about 1800 km^2. It is mostly built of Mesozoic carbonate rocks of the Adriatic carbonate platform, and main structures and faults extend Dinaric direction. The main morphological characteristic is flatness in the macro level. Because of the carbonate rocks, area is highly karstified. In micromorphological sense dolines prevail (with high density) on the surface and caves in the underground. Area intersected five major rivers which are cut in deep canyons and have no major tributaries. On the entire area, more or less preserved, traces of surface paleohydrographic networks were observed. The aim of the study was to reconstruct and analyze paleohydrographic network and recent features to know about its evolution, impact and development of karstification of this karst plateau. With the methods of field work we also analyzed the data from topographic maps 1:25.000. Analysis of data was performed with the GIS tools. For the first time we reconstructed paleohydrographic network in this area, we analyzed its hydromorphometry, paleo and recent network relationship with geological, structural and karst characteristics of the area and finally its morphoevolution.

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Canol, a proposed new karst international geopark in the Northwest Territories of Canada

FORD D.
McMaster University, ORILLIA, CANADA

Arctic and sub-arctic karst terrains are little represented in the UNESCO World Heritage and International Geopark programmes. Karst is well developed in the Western Lowlands, Franklin and Mackenzie Mountains north of Lat. 60^o N in the Northwest Territories. Most of this vast area was glaciated repeatedly by Laurentide continental or by Cordilleran glaciers but, due to Ice Age aridity, there was an ice-free corridor through the central Mackenzies. The postglacial climate includes a summer warm season but mean annual temperatures everywhere are below 0^o C and precipitation is generally only 250 - 600 mm. Permafrost is widespread to continuous in the lowlands, continuous in the mountains.

East and west of the Mackenzie River between Lats. 65^o and 67^o N there are extensive spreads of platformal dolomites of Cambrian-Silurian age, underlain by redbeds and salt and overlain by the remarkable Bear Rock Fm (Devonian), a re-cemented dolomite-gypsum solution breccia. A sample transect of the Mackenzie Mountain karst in these strata is being proposed for a new Geopark. It begins at 1700 m asl on dolomite plateaus in the ice-free corridor, where felsenmeere and patterned ground dominate at the surface but karst groundwater circulation via taliks produces elegant steephead valleys (*reculées*) that were locally adapted to host small cirque glaciers. To the east, a tectonic polje and a dry canyon in the dolomites are succeeded by foundered terrains over the salt. At the Laurentide ice limit a terminal moraine created a karst basin of 90 km^2 with rapid underground drainage. Within the glaciated zone at 1000 m asl, glacier-scoured dolomites display the greatest extent of solutional pavement reported from arctic regions, succeeded by a possibly unique “dissolution-drape” terrain of sinkholes, dry valleys, lakes, caves and scablands on the breccia. Considered together, the Canol park karst landforms are the most varied and striking yet described from arctic regions.

Dissolution rate of limestone under doline in the Akiyoshidai karst plateau: Evaluation from weathering experiment and hydrological observation

HATTANJI T.(1), AKIYAMA S.(1), MATSUSHI Y.(2), MATSUKURA Y.(1)
(1) University of Tsukuba, TSUKUBA, JAPAN ; (2) DPRI, Kyoto Univsersity, UJI, JAPAN

The spatial variation in limestone dissolution rates is significant for landform evolution of karst terrain. This study aims to estimate the current rate of dissolution in a solution doline on the Akiyoshidai karst plateau in Yamaguchi Prefecture, combining field weathering experiment and hydrological observation. In the weathering experiment, limestone tablets (rock disks of 3.5 cm in diameter and 1 cm thick) were buried in soil (depth of 50 cm and 15 cm) at four sites from the crest to the bottom of the doline. In these sites, soil moisture contents and ground temperatures were monitored at 10-min intervals, and measurements of CO_2 concentration in the soil air and soil water sampling were carried out manually about every two months. The experiments and monitoring were conducted over 768 days from 2009 to 2011. The dissolution rates of tablet were high (1–3%/y mass loss) at the sites where soil moisture saturated for a long time after precipitation, and low (0.1–0.6%/y) where the period of high soil moisture was short. The result of a regression analysis revealed that the dissolution rates were strongly controlled by the ratio of the duration of saturation (degree of saturation > 97%) to the whole time of the experiment (R^2 = 0.65).Electrical resistivity tomography for the surveyed doline showed low resistivity (50–100 Ω•m) zones in soil near soil-rock interface for both wet and dry seasons, indicating that these zones were water-saturated throughout the years. In the case of water saturation throughout years, the denudation rate of limestone would be 137 mm/ky, which is slightly faster than the highest long-term denudation rates inferred from cosmogenic ^{36}Cl concentrations at the same doline. Low resistivity zones with high soil moisture also existed beneath some parts of the slope as well as the bottom of the doline, which implies that such slopes have a fast dissolution rate equivalent to the bottom of doline.

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Origin and nature of notches on the carbonate slopes of the Carmel Mountain, Israel

SHTOBER-ZISU N.(1), AMASHA H.(1), FRUMKIN A.(2)
(1) University of Haifa, HAIFA, ISRAEL ; (2) Hebrew University, JERUSALEM, ISRAEL

Some of the best known landforms associated with the Carmel Mountain (Israel) are "Notches". The term is used to describe horizontal "C"-shaped indentations, developed on slopes or cliffs, regardless of their location or shaping mechanism. These morphological features, apparent on carbonate rocks, take the shape of half tubes that extend over tens or hundreds of meters, along stream valley slopes. Although this morphological phenomenon is worldwide observed, little is known about its origin.

The present study suggests that the notches are dissolutional cavities cut into particular limestone or dolomite beds in accordance with specific chemical and mineralogical properties of the lithic material. The rate of chemical erosion in the Mediterranean climate is estimated at 10-40 m/Ma (Gerson, 1976; Yaalon, 1997). Given these rates, notches of coastal origin should have been eroded by now; they could not have been preserved since the Miocene or Pliocene epochs. The same explanation is relevant to the theory that suggests that the notches are associated with stream banks: well developed notches have been found at an altitude of 370 m.a.s.l. along the northeastern escarpment of the Carmel, with no relation to stream valleys. Additionally, assuming that the notches did develop along channel banks during the Pleistocene epoch would imply that the rate of tectonic uplift should be double that estimated in previous studies.

It is suggested that the notches developed under subaerial conditions, formed by runoff accumulated along the slopes. The notches are not necessarily linked to past water table levels. It is possible however, that they represent past climate conditions, when abundant soils covered the slopes. As the sediments and the soils were stripped off, the notches were exposed.

At present, bioerosional processes, carried out by cyanobacteria or additional organisms, continue to act upon the carbonate substrate, contributing to the further development of the notches.

Hydrogeological characterisation of evaporite Karst Wetlands in southern Spain

ANDREO B.(1), LINARES L.(2), CARRASCO F.(1), RENDÓN M.(3)
(1) UNIVERSITY OF MALAGA, MALAGA, SPAIN ; (2) Academia Malagueña de Ciencias, MÁLAGA, SPAIN ; (3) Consejería de Medio Ambiente de la Junta de Andalucía, MÁLAGA, SPAIN

In southern Spain there is an extensive outcropping of Triassic versicolour clays and evaporites (gypsum and halite), together with sandstones, limestones and dolomites of different ages, in variously-sized blocks, as well as Miocene sediments. All these materials are highly deformed, with a disorganized and chaotic internal structure. The Triassic materials (Keuper) have traditionally been categorised as presenting low permeability. However, the presence of evaporites generates a geomorphological karst evolution, both at the surface (exokarst) and beneath it (endokarst), which increases the porosity and secondary permeability. Thus, these materials are really a karst aquifer in the evaporite enclaves, although the existence of low permeability materials (clays, sandstones) means that the whole clayey-evaporitic unit presents some hydrogeological complexity. These aquifers are fed by the direct infiltration of rainwater and runoff through swallow holes, while discharge takes place by springs to river beds or into wetlands.

The wetlands associated with these Triassic evaporitic-clayey materials are found in different geomorphological situations: in interfluve or watershed areas, near river beds and in intermediate positions. The origin of the basins containing these wetlands is related, most cases, to processes of dissolution/karstification of the evaporite materials. When the water table of the aquifer lies below that of the bed of the wetland, the latter is a source of recharge to the aquifer; these wetlands are termed "recharge wetlands", and are usually ephemeral and contain water of low salinity. The springs and wetlands located at lower levels are associated with longer flows, with greater residence time in the aquifer, and typically drain water of high salinity, which is sometimes saturated in NaCl. Finally, there are wetlands located in an intermediate position between the aquifer recharge and discharge areas; these are known as "transition wetlands".

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Conceptual model of the hydro-sedimentary behaviour of an estuarine karst: Example of Radicatel springs in the Seine Estuary (Normandy, France)

CHEDEVILLE S.(1), LAIGNEL B.(1), RODET J.(2), TODISCO D.(3), HAUCHARD E.(4), MASSEI N.(1), HANIN G.(1)
(1) Université de Rouen, UMR CNRS 6143 Morphodynamique Continentale et Côtière, MONT-SAINT-AIGNAN, FRANCE ; (2) CNRS, UMR 6143 Morphodynamique Continentale et Côtière, Université de Rouen, MONT-SAINT-AIGNAN, FRANCE ; (3) Université de Rouen, UMR CNRS 6266 Identité et Différenciation des Espaces, de l'Environnement et des Sociétés, MONT-SAINT-AIGNAN, FRANCE ; (4) Université de Rouen, UMR CNRS 6143 Morphodynamique Continentale et Côtière ; Communauté de l'Agglomération Havraise (CODAH), MONT-SAINT-AIGNAN ; LE HAVRE, FRANCE

Karst processes occur all around the world in different bedrocks carbonated or not. These processes, related to chemical weathering in association or not with mechanical erosion, create voids on the surface (dolina) and within the bedrock (karst conduit). These voids may contain allochthonous (supply of sediments from mechanical erosion), autochthonous (insoluble residues from chemical weathering of the bedrock) karstic filling or a mixture of both, according to the hydrodynamics and sediment sources.

In order to better understand the role of karst functioning in sediment transport in chalky context it appears essential to characterize 1) erosion/deposition of intrakarstic sediments and, 2) the controlling factors of the sedimentary transfer. Both can be studied at an experimental site in Seine Estuary: the Bruisseresse spring (Radicatel). The latter is an anthropogenic gallery considered as a karstic conduit,managed by the CODAH (COmunauté D'Agglomération Havraise) for water supply. The Bruisseresse is an exceptional site for studying the current karst sedimentation, comprising a sedimentary filling, rainfalls, turbidity and chalk aquifer water table time series, all dating back to 1988.

Several types of data were used: 1) the study of sediment by boreholes, 2) the use of a Suspended Particulate Matter (SPM) trap, and 3) the measurement of the current sedimentation height by an altimeter. All of these data allowed understanding of the sedimentation processes in the gallery.

The main results are: 1) the establishment of the time correspondence between sediment filling and turbidity time series,which allowed a better understanding of the sediment transfer processes, 2) the identification of controlling factors on karst sedimentation (turbid floods, variations of tidal coefficients and large-scale climate oscillations especially the North Atlantic Oscillation). The results allowed to establish a conceptual model of the hydro-sedimentary dynamic in an estuarine karst.

Towards a better comprehension of rainfall-runoff relation in karst system at various time scales. Case study on the Lez aquifer (Southern France)

TAVER V.(1), JOHANNET A.(1), BORRELL V.(2), PISTRE S.(2), VINCHES M.(1)
(1) Ecole des Mines d'Ales, ALES, FRANCE ; (2) Universite Montpellier 2, MONTPELLIER, FRANCE

Karst aquifers represent the largest underground resources for fresh water around the world providing it to 25% of the population [Ford and Williams, 2007]. They are still underexploited because of the difficulty to understand their behavior, they can thus be considered as a promising water resource for the future [Bakalowicz, 2005]. Due to complex processes of formation, these geomorphologic systems are very heterogeneous in space. Such a complexity leads to various hydrological behaviors, at different time scales, associated with unsaturated or saturated zones.

Due to the difficulty in measuring physical parameters and capitalizing on physical properties of such complex systems, the systemic approach [Mangin, 1975] was preferred in this study in order to improve the knowledge about these aquifers. Following such an approach, rainfall and runoff time series were considered as input-output signals of a complex system. In order to better apprehend the various behaviors operating at different time scales, the rainfall-runoff relation was studied at different time scales, by resampling signal at various dyadic time scales (2T; 4T; 8T; 16T; 32T, were T is the smaller sampling period). Resulting time series were studied using three approaches a) statistical description and normality tests of time series and their distribution, b) time series analyses (correlation, spectral analysis…) [Mangin, 1984], c) modeling dyadic rainfall and runoff time series relations using neural networks model (machine learning) [Kong A Siou et al., 2011].

Applied to the *Lez* karst aquifer, which provides the city of Montpellier (400 000 inhabitants, Southern France) with fresh water [Fleury, 2008], these methods allow the characterization of the aquifer's behavior at each time scale. These tools thus allow apprehending the response times of the aquifer in various conditions and provide information about its vulnerability to climate modification.

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Groundwater monitoring network in the classical Karst (NE Italy, SW Slovenia)

ZINI L., CALLIGARIS C., GRILLO B., CUCCHI F.
Dipartimento Matematica e Geoscienze, TRIESTE, ITALY

Data analysis coming from Classical karst groundwater monitoring network highlights the complex circulation of the hydrostructure. Only the collaboration between Italyand Sloveniacould lead, trough a reasoned groundwatermonitoring network, to plan the best transboundary aquifer management and protection.

The monitoring stations are 14: Timavo, Filtri, Doberdò and Sardos Springs, Colombi, Comarie, Lindner, Giant, Massimo, Jerko, Trebiciano, Kanjaducah, Kacna, Š kocjan caves. The Mathematics and Geosciences Department of Trieste University is monitoring all the water points since 1995 in cooperation with slovenian partners (Park Škocjanske Jame and ZRCSAZU). The network permits to highlight the contribution to the flow from the different parts of the hydrostructure. During the flood the flow is conditioned by the Reka river regime while, during low-water, the circulation is more influenced by the infiltration due to the rainfall and from the Isonzo river contribution. The circuit connecting Škocjan cave sinkhole with Timavo springs is characterized by a series of large pipes that allow the flood impulse transfer within 1 to 3 days.

The monitoring carried out showed that during the floods the most part of the circuits are under pressure and only a comparative analysis of levels, temperature and conductivity permits to correctly evaluate the water transit times. Infact, if the rising water level in the caves is simultaneous due to the increasing hydraulic load upstream, the changes in conductivity and temperature are different from site to site and allow to intercept the incoming flooding water and to estimate correctly the water velocity propagation.

Different is the behaviour in the north-western sector where the circulation is dispersed and base flows are underlined. In this case, the beginning of the floods is often delayed compared to the springs outflow and it is partially due to the stop up water coming from the Reka – Timavo circuit.

Poster presentations:

The evaluation of geomorphological features of the karstic cave discovered in Rabat, Sardasht, north-west of Iran

KHEZRI S.
Kurdistan university, Sanandaj, IRAN

Duringexcavations in the east of little Zab river and close to the site of the ancient city of Rabat, a cave entrance was revealedin 2012-06-05. For more investigation on natural and human features, a group of experts went into the cave. The results of their field survey indicate that the cave clearly originated as the result of tectonic forces and solution of limestone. The main natural features of the cave include cauliflower stalactites and pearls of cave landforms. Due to the role of tectonic, the cave was impassable and only a short distance from the entrance, about 20 meters, is now accessible. Within this part, there is no sign of human habitation. The availability of karstic features such as avens, sinkholes, vauclusien and travertine springs and karrens within ten kilometers around the Rabat cave mouth show a possibility of connection between the caves, avens and karstic springs. Thus it is possible to have a great cave in this area. This cave, along with other natural and man-made features of the areas, such as natural waterfalls and ancient hills in Rabat city and the little Zab river basin are great potentials for geotourism and archeotourism development. Therefore, further investigation is needed through field work to identify the possibility of any connection between the caves, avens, and karstic springs. In addition, another investigation should focus on the relationships between the caves and ancient civilization of the areas. This requires a group of geomorphologists, geologists and archaeologists to do more field survey on the different features of the areas.

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Exploration and recognition of the 'Dolaneh' cave, Sardasht, Iran

KHEZRI S., ZAHERI S.
Kurdistan university, Sanandaj, IRAN

A cave in Sardasht, northwest of Iran, in filed survey was explored in 2008 by author (Saeed Khezri). During the filed study, one aven and another cave were explored within five kilometers buffer of the first cave. The first cave latter named as “Tuzhal” and second cave named “Dolaneh” cave. Tuzhal cave was introduced in 2008. But in fact, a hole as wide as 1 meter was the only entrance of the Dolaneh cave appeared from outside. Thus a team including four persons entered the Dolaneh cave in order to evaluate its dimensions. Then exploration and recognition of unknown parts of the cave was started. Further geomorphological survey in the area revealed more holes and Karstic landforms distributed as far as 2 km around the Dolaneh cave entrance. The evidence proved that there is a junction between Tuzhal and Dolaneh caves and other around avens and Karstic springs. Further caving by professionals is needed to recognize all parts of the caves and karstic landforms in the area.

Hydrodynamic of the Coulomp karst spring, the largest in French Southern Alps

AUDRA P.(1), NOBÉCOURT J.C.(2)
(1) Polytech Nice - Sophia, University of Nice - Sophia Antipolis, BIOT, FRANCE ; (2) CRESPE, VENCE, FRANCE

The Coulomp Spring (elevation 1306 m) is the largest of the Var River watershed (Q ≈ 1 m^3/s). The catchment of the Coulomp Spring is about 30 km^2. It culminates at the Grand Coyer (elevation 2693 m), which is located east to Annot City, between the Var and Verdon rivers. Karst features are almost absent due to the presence of thick covers of marly limestones (> 600 m), clays, and sandstones. 1 km of the underground river is known in the Chamois Cave, a 12 km-long cave system, which gives a partial knowledge of the flow inside the karst. 3 years of spring monitoring and dye tracings complement the understanding of its dynamic. Recharge occurs both as concentrate inputs through discrete sinkhole where canyons cut the limestone aquifer and as diffuse infiltration through marly limestone covers. Consequently, the Coulomp spring mixes complex responses with flash floods sometimes associated with turbidity peaks, large floods up to 30 m^3/s after intense autumnal precipitations, and a still significant recession discharge (> 400 L/s) in low water due to the storage in the sandstone covers and the thick vadose zone. Hydrographs study in different conditions (snowmelt cycles, storm after long recession or after long recharge periods) give a better picture of the different components of the recharge, of the flow paths, and of the velocities in the different parts of the karst system.

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Characterising tufaceous accumulations in groundwater discharge zones by means of geophysical surveying (ERT, GPR) and trenching. The Isona-Basturs complex (Pyrenees, NE Spain)

ZARROCA M.(1), PELLICER X.M.(2), GUTIÉRREZ F.(3), CARBONEL D.(3), ROQUÉ C.(4), LINARES R.(1)
(1) Universitat Autònoma de Barcelona, ES-08193 BELLATERRA, SPAIN ; (2) Geological Survey of Ireland, DUBLIN, IRELAND ; (3) Universidad de Zaragoza, E-50009 ZARAGOZA, SPAIN ; (4) Universitat de Girona, E-17071 GIRONA, SPAIN

The Isona-Basturs spring complex constitutes the main groundwater discharge zone of a confined karst aquifer in the eastern Pyrenees, NE Spain. Here, groundwater flowing through a limestone aquifer overlain by impervious argillaceous formations discharges along fractures generating perched springs and lakes fed by upward flows. Accumulation of tufa deposits from the calcium-carbonate rich waters over the last 350 ka has generated striking tufa mounds several tens of meters thick with groundwater discharge paleolakes. Currently active groundwater discharge is associated with contemporaneous lakes. The Isona-Basturs complex is of special interest because of the coexistence of relict tufa mounds related to paleosprings and active springs with vents, lakes and mounds in their initial phases of development. The combination of detailed geomorphological mapping, shallow geophysical surveying by electrical resistivity imaging (ERI) and ground penetration radar (GPR), as well as trenching, has allowed us to propose a geomorphic and stratigraphic model for the system and obtain information about its paleohydrological functioning and the timing of soft-sediment deformations in recent lake deposits that might be attributable to paleoearthquakes.

Comparison of DInSAR derived displacement maps for sinkhole activity detection in the Ebro Valley mantled evaporite karst (NE Spain)

FRANCISCO G.(1), GALVE J.P.(1), CASTAñEDA C.(2)
(1) University of Zaragoza, ZARAGOZA, SPAIN ; (2) Agricultural Research Center of Aragón, ZARAGOZA, SPAIN

The results of various advanced Differential Interferometric Synthetic Aperture Radar (DInSAR) techniques applied to sets of ERS SAR, ENVISAT ASAR and ALOS PALSAR images covering two time spans (1995-2000 and 2003-2010) have been compared in a stretch of the Ebro River valley (NE, Spain) affected by evaporite karst subsidence. The extensive geomorphological investigations carried out in the analyzed sector reveal that active subsidence associated with sinkholes affects a significant proportion of the floodplain and lower terraces. Previous deformation data derived from ERS-1 and ERS-2 images processed by the Small Baseline Subset (SBAS) technique provided valuable quantitative deformation data for some sinkholes but missed most of the known areas with evidence of ongoing dissolution-induced ground settlement. The performance of different SAR images and interferometric techniques detecting and measuring ground subsidence has been assessed and compared using detailed geomorphological maps and the available data on subsidence rates and deformation on human structures. The improvements of the new deformation maps generated with ENVISAT and ALOS data processed with the Stable Point Network (SPN) technique include: (1) New areas affected by subsidence overlooked by geomorphological surveys have been detected. (2) The spatial density of subsidence magnitude and rate data has increased. In spite of the lack of coherence and DInSAR deformation data in a large proportion of the area affected by known active subsidence, the improvement in the spatial resolution of the new displacement maps has helped to better define the active subsidence areas. The usefulness of DInSAR displacement data in combination with data obtained by other techniques (geomorphological analysis, geophysical surveys, trenching) for managing the subsidence risk associated with different human structures (apartment buildings, industrial states, railways, roads) is illustrated through several case studies.

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Application of the trenching technique to sinkhole hazard analysis

CARBONEL D.(1), GUTIÉRREZ F.(1), MCCALPIN J.(2), GUERRERO J.(1), ROQUÉ C.(3), LINARES R.(4), ZARROCA M.(4), GALVE J.P.(1)
(1) Universidad de Zaragoza, ZARAGOZA, SPAIN ; (2) Geo-Haz Consulting Inc., COLORADO, UNITED STATES ; (3) Universitat de Girona, GIRONA, SPAIN ; (4) Universitat Autónoma de Barcelona, BARCELONA, SPAIN

The trenching technique is generally applied to obtain information on the paleoseismic record and seismogenic potential of active faults. Recent studies carried out in the mantled evaporite karst on the Ebro Valley (NE Spain) reveal that this approach may be used satisfactorily for the characterisation of specific sinkholes and the assessment of the hazard associated with them. Backhoe trenches are excavated in locations selected on the basis of detailed gemorphological mapping. Geophysical surveys may help to increase the success rate of the trenches, constrain their extent and provide complementary subsurface information. The detailed study and numerical dating of the sediments and structures exposed in the trenches, including a retrodeformation analysis, allows the reconstruction of the deformational history of the sinkholes. The trenches may provide valuable practical information for subsidence risk management including: (1) Precise limits of the subsidence structures underlying the sinkholes. (2) The subsidence mechanisms (sagging, collapse, suffosion). (3) The subsidence magnitude and the contribution of the different structures and mechanisms. (4) The kinematic behaviour; episodic vs. progressive. (5) The age of the sinkholes and long-term subsidence rates. (6) Bracketing age of subsidence events, recurrence intervals and in some cases the identification of triggering factors. This information may be used as an objective basis to forecast the future behaviour of problematic sinkholes and select the most adequate mitigation measures.

Contribution to the studies about the Brazilian Karstic areas: the geomorphological cartography as a subsidy to the analysis of the evolution of the Karst in the Karstic region of Currais de Pedras (KRCP)

GONCALVES F.(1), MAGALHÃES JR. A.(1), RODET J.(2)
(1) GEOSCIENCES INSTITUTE - FEDERAL UNIVERSITY OF MINAS GERAIS, BELO HORIZONTE, BRAZIL ; (2) UMR/CNRS, 6143, GEOLOGY LABORATORY OF THE UNIVERSITY OF ROUEN, ROUEN, FRANCE

The Brazilian karstic geomorphology has advanced significantly and one of its main tools for such development is the cartography of karstic areas. Most of the known caves in Minas Gerais' state occur in carbonates of the Bambuí Group (Neoproterozoic). This group is composed of sedimentary and metasedimentary rocks that cover a large area in São Francisco's Craton. The CPKR is located in the southeastern area of São Francisco's Craton, where carbonates outcrop from Lagoa do Jacaré formation occur. The cartographic representation of CPKR's geomorphology was elaborated based upon the interpretation of satellite images, aerial photos, topographic, geomorphological and geological maps and fieldwork. An area of 13,627km² was mapped in the scale of 1:45.000. The geomorphological units were mapped based on the similarities of the shapes, materials and their relations with the altimetry, as follows: karst exposed; residual tabular surface flat to smoothed with sections elaborated from karstification processes; wide flat to smooth undulating with sections elaborated from karstification processes; steep slopes and straight dissection presenting ravine processes; wide surface smoothed elaborated mainly from process of lateral migration of river channels; remnants of ancient fluvial deposits and alluvial plain. The morphotectonic component was added to the mapping from trace structural lineaments. Topographic profiles and cartograms containing morphometric data complete the set of elements that compose the mapping. After analyzing this set, we found out that the investigated karst can be divided into two systems, as follows: (i) that attached to the base level and (ii) that separate the base level by escarpments with gradient and slope middleweight of 200 m and 30^0, respectively. This setting reflects directly on the planimetric pattern distinct of the caves that comprise each system and shows the current and past of the hydrodynamics as one of the main responsible for this.

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Mapping and interpretation of karst landforms: dolines and depressions, their significance and hydrological functioning

PARISE M.(1), PEPE M.(2)
(1) CNR-IRPI, BARI, ITALY ; (2) University of Basilicata, POTENZA, ITALY

Karst landscapes are strongly controlled by lithological and tectonic factors, that are crucial elements to control the rate of development of the solution process. In lowland karst, identification of the original landforms is heavily complicated, due to the subtle morphologies, and the likely interactions with man and his actions. In many cases, karst landforms may be easily modified or cancelled by human activities. The present article aims at highlighting the difficulties in the identification, mapping and interpretation of the most significant landforms in the karst of Apulia, including dolines of different origin, depressions, and different types of karst valleys. We will stress the need to make an effort in combining what is visible at the ground surface with the subterranean features (caves, shafts, etc.). This latter point is extremely important as concerns the hydrological functioning of the karst landforms, especially on the occasion of the most significant rainfall events. Through the description of karst geomorphological maps from different sectors of the Apulian karst, in southern Italy, we will discuss the problems in mapping these features and the importance in understanding their functioning.

Lithology, rock relief and karstification processes in coral minamidaito island in the nansei archipelago, Southeast Japan

KNEZ M.(1), SLABE T.(1), URUSHIBARA-YOSHINO K.(2)
(1) Karst Research Institute, Research Center of the Slovenian Academy of Sciences and Arts, Postojna, Slovenia; Yunnan International Karst Environmental Laboratory, Kunming, China, POSTOJNA, SLOVENIA ; (2) Department of Geography, Hosei University, TOKYO, JAPAN

MinamidaitoIsland is a karstified coral island located on the Philippine plate. The first karstification occurred during the Pliocene between the lower and the upper Daito Layer. The top surface of the lower Daito Layer was karstified and soils formed. During the Pleistocene, karstification continued from 1.6 Ma until the last glacial period. The terrain of Minamidaito Island, which resembles an uplifted atoll, continued to specificly karstify until the middle of the last glacial period when the sea level dropped by 100 meters. Since then karstification similar as today is taking place. Geological studies were performed to study reef carbonates in detail. Among them, biointrasparite limestone of framestone and bafflestone types with transitions to grainstone and dolomitized biointrasparry limestone of framestone and bafflestone types dominate. Calcimetric analyses established that in certain locations the distribution of limestone and dolomite differs from the distribution previously described. Although the characterisitics of coral limestone and dolomitized limestone put a distinctive stamp on the rock relief, it remains an important trace of the formation and development of this unique karst landscape. Rock relief reveals the unique formation of coastal karren, the development of the surface in the interior of the island, and the most characteristic periods of cave development.

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Using stochastic laws of sinkholes formations at solving construction engineering problems in karst aeras

MAKHNATOV S., TOLMACHEV V.
JSC Antikarst and Shore Protections, DZERZHINSK, RUSSIAN FEDERATION

It is established that in a covered karst the formation of the karst sinkholes in time and space under certain conditions subject to stochastic laws. In particular, distribution of independent sinkholes is close to the Poisson law. Sinkholes diameters at the large areas subject to the lognormal distribution. At the small areas like construction sites, the distribution of sinkholes diameters is close to normal distribution. These stochastic laws allow to assess the probability of the defeat areas as well as some buildings karst holes, to make efficient line structures drawing (pipelines, railways and roads) and to choose the smallest karst hazard. The experts can assess the negative consequences of the karst formations on structures. It is possible to assess the risk of karst and the relative level of the so-called relative level of karst risk. It refers to the ratio of the karst risk to the allowable karst risk. Karst risk level is the basis for the study of the anti-karst complex measures, the structural design parameters, the exploitation, the monitoring of facilities and the environmental monitoring. Examples of practical realization of the above approach are shown.

Clay cortex in epikarst as an indicator of age and morphogenesis - case studies from Lublin-Volhynia Chalkland (East Poland, West Ukraine)

DOBROWOLSKI R., MROCZEK P.
Faculty of Earth Sciences and Spatial Management, Maria Curie-Skłodowska University, LUBLIN, POLAND

Clay cortex from the contact zone of host rock (chalk) and filling deposits was examined in palaeokarst forms (pockets, pipes and dolines of different age) from the Lublin-Volhynia chalk karst region. In the light of the sedimentological and micromorphological analyses it seems possible to work out a model forming the basis for genetic and stratigraphic discussions.

(1) Dolines with the Paleogene and/or Neogene mineral infillings are characterized by:

(a) homogeneous, residual type of massive clay diffusively passing into the chalk monolith, and at the same time (b) relatively thick weathered zone.

(2) Pipes with glaciogenic mineral infilling from the Saalian Glacial are characterized by:

(a) sharp contact of rock and clay, (b) narrow weathering zone of carbonate rock, (c) diffusive nature of the contact zone between residual clay and mineral infilling, and (d) contamination of clay with clastic material.

(3) Pockets with glaciogenic mineral infilling and traces of the Weichselian periglacial transformation are characterized by: (a) strong contamination of chalk with quartz grains, (b) diffusive transition between clay and infilling deposit: from clayey matrix with single quartz grains (at the contact with chalk) to clayey coatings and intergranular bridges (in the infilling deposit), (c) intensive weathering (cracking) of mineral grains in the infilling deposit.

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Gypsum's role in the sinkholes of the tagliamento River Valley (NE Italy)

CUCCHI F.(1), ZINI L.(1), CALLIGARIS C.(1), FORTE E.(1), PETRONIO L.(2), ZAVAGNO E.(1)
(1) Dipartimento di Matematica e Geoscienze, TRIESTE, ITALY ; (2) OGS - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, TRIESTE, ITALY

In an area of several kilometers in the Tagliamento Valley, between the villages of Ampezzo and Villa Santina (Friuli, NE Italy), are present frequent points of absorption associated with large and deep sinkholes collapsed in the shallow cemented fluvial-glacial deposits, in the recent alluvial deposits overlying a karstified evaporitic bedrock.

In the Quinis village the situation is particularly complex, some houses are affected by failures and in the past, in the fields around the village sudden sinkholes were recorded and some building were demolished also in the centervillage. During the last years a tightening in the phenomena took to the necessity of a deep and multidisciplinary study in order to define the vulnerability of the different areas. For the purpose, were realized 20 piezometer (equipped with devices), 3 seismic lines, 1 electrical tomography, the establishment on the buildings of a topographical monitoring network, 2 assestimeters and a groundwater tracing test campaign.

The main vulnerable areas were identified with the presence of holes or caves in the gypsum and soft and unconsolidates alluvial horizons. The big variations in the groundwater levels recorded during the past years and linked to the regime imposed by the dam outflow, underlined an increase in the karstification processes inside the gypsum bedrock and in the above deposits.

3D researches on conduits and karsts networks

JAILLET S., SADIER B., DELANNOY J.J.
Laboratoire EDYTEM, Universite de Savoie, LE BOURGET DU LAC, FRANCE

Underground karst is an object that can be studied using 3D approaches, and new technological breakthroughs now allow revisiting subterranean karst. Lasergrammetry in particular allows fast dense point clouds acquisition. Their protocol allows to shape analyses without any contact and to reduce the time spent within the cave. When studying underground topographic matters, pipe sections are usually considered as spindly skeletons. Stations are sampled one after another, in polar geometry (distance, direction, angle). Gallery sections allow to recognize large changes in conduit dimensions. Lasergrammetry, based on Lidars uses, help to acquire very numerous point measurements during minimal time. The point cloudis then meshed to obtain a TIN model. This oneis significantly helpful to inform about neighbouring information and topology. This is of prior importance to the rest of the analyses, in particular to identify morphology breaks or segmentation operations. The model conformity must be checked. Once these treatments are achieved, it is possible to analyse the numerical clone.These analyzes wereapplied to different objects: drains, walls, speleothems... It was shown that the use of 3D analysis on a numerical clone may be fruitful. It allows breakthroughs compared to classical approaches. First of all, it allows investigation of all the objects. Indeed, height, darkness, limited residence time, conservation constraints and limited moves within high patrimonial value objects are limiting factors to an *in situ* analysis. This completeness when investigating underground karst allows to notably statistically validate results that, used to be limited and reduced to preselected objects. The aim here was to explore the potential of 3D modelling of underground environments, keeping in mind the ever geomorphologic issues that drive our research.

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Dissolution phenomena and subsidence in Bosco-San Cataldo Mine (Sicily)

LIGUORI V., MANNO G.
DICAM - Universita degli Studi di Palermo, PALERMO, ITALY

Topographic surface of the central south Sicily is relate by depressions, for subsidence phenomena. The rocks that form this area are Messinian evaporites, in particular they are limestones, gypsums and salts (NaCl and KCl). The solubilisation of these rocks cause morphologic changing both surface and underground landscape. The subsidences are localized mainly in the mines areas where happened the salts extraction, at the present moment their location depending by underground mines extension. Indeed the subsidence phenomena are most clear above disused mine, where the falls of the tunnel vaults, speed up sinkholes origin. An example of these phenomena is observable in the San Cataldo-Bosco mine close the Caltanissetta city. The mine began its activity with sulfur extraction in the period between 1930 and 1954. In 1956 the mine, with discovery of the salt seam, it began the salts extraction. The presence in this area of dissolution morphologies, is highlight both areal imagery analysis and geologic-geomorphologic survey. The subsidence development is precede by morphologies like karst sinks in the bottom of these depressions is observable an area more low with preferential adsorbent of the surface waters. The making of these sinks create inevitably changes in surface and underground water flow. The underground waters flooding the tunnel mine and dissolve the salts, this phenomena is connect also with aquifer layer. In winter time depression are usually full of water originating small lakes, on the contrary, in summer time these lakes are totally dry. In order to reduce the risk produced of the sudden developing of these depressions that change in to sinkholes, would be essential to confirm the trigger causes of these phenomena and to start a monitoring campaign. The results thus obtained can define new hypothesis of intervention for the security of these areas and to apply some techniques already tested.

Understanding of the nature and evolutionary history of the karst of Ha Long bay

DO T., NGUYEN XUAN N.
Vietnam institute of geoscience and mineral resource, HA NOI, VIET NAM

HaLong to be awarded by UNESCO as a world natural heritage of outstanding value to the geological history, geomorphology of karst limestone. Now, Ha Long is not only belongs to Vietnam, but also the common heritage of mankind. So understanding the nature and evolutionary history of the karst of Ha Long bay is doing useful and necessary. This paper can be generalized as follows:

1. In addition to the basic conditions to Halong Karst formations such as limestone of Bac Son formation, dissolved phenomenon, rainfall in the humid tropical conditions, the role of marine, mechanical corrosive effects of the sea play important role.
2. Neo-tectonic movement to trend downward, the decision for the formation and development of the Karst landscape of Ha Long.
3. Continental development phase of Ha Long lasting and continuous throughout MZ-KZ and has created the landscape with the style Karst peak-cluster-valley, characteristic for Halong Karst.
4. Marine incursion in Halong Karst early, about 40,000 years ago and went through several stages of sea level change to the composition of the sea line and terrace types .
5. The nature and evolutionary history Halong Karst distinct nuances differ Karst south-east of China.

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Geomorphological analisys of karst depression in the Yucatan Peninsula, Mexico

FRAUSTO MARTINEZ O.(1), IHL T.(2), BUATISTA F.(2), AGUILAR Y.(2), FRAGOSO P.(1)
(1) universidad de quintana roo, COZUMEL, MEXICO ; (2) UNAM, MORELIA, MEXICO

Geomorphological studies in the humid karst areas of Yucatan Peninsula give evidence that depression formation represent a mosaic of different landforms at several scales having spatial heterogeneity and all have been subjected to changing structural, rock type and climatic conditions . The methodology applied in the present work used digital elevation models (DEM) and topographic vector data to differentiate between geomorphological regions that are latter subjected to spatial and morphometric analyses to establish a typology of karstic depressions (dolines -or sinkholes-, uvalas and poljes), which will produce a more detailed differentiation of karstic relief. The objective of the present work was to analyze and explain the variations in density, distribution pattern and configuration of depressions within the relief. Our study was based on geomorphological maps of Yucatan, Mexico at scale 1: 50 000, aimed at achieving an initial zoning considering the amplitude of the relief and the slope steepness of landforms, and identifying the spatial patterns of depressions. The results increased the available knowledge of the karstic to understanding the genesis and intensity of regional processes in karts relief.

Towards a multicriteria approach to subsidence hazards in karst with application to French case studies

PERRIN J.
BRGM, ORLÉANS, FRANCE

Subsidence is a major geohazard occurring in karst region such as sinkholes developing by suffosion in the overburden overlying karst or less frequently breakdown of karst void ceiling. This hazard can cause significant engineering problems and difficulties for planning and development. Therefore decision-makers request from karst scientists the elaboration of methodologies for reliable predictions of future spatio-temporal distributions of such hazards (i.e., sinkholes). Typically an objective is to carry out karst subsidence susceptibility and hazards maps in the framework of risk prevention planning.

However, karst subsidence is a complex process to characterize due to the inherent high spatial heterogeneity of karst and research actions are needed to improve our process-understanding in order to propose adequate methodologies.

The ongoing project aims at evaluating a number of potential conditioning factors for karst presence susceptibility on the one hand and for karst subsidence susceptibility on the other hand. The evaluation is carried out on three well documented case studies which are representative of contrasted geological contexts: barren karst and mantled karst. For each site, an inventory of karst subsidence and karst feature objects is carried out. Then the explanatory power of each potential conditioning factor is tested using a spatial statistical analysis that evaluates the correlations between inventoried objects and conditioning factors. Ratings of each relevant conditioning factor is determined based on their respective explanatory power and susceptibility maps can be obtained by combining the relevant conditioning factors together with their rating (multi-criteria approach).

This methodology will also be tested in the near future for karst in the chalk and gypsum.

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Fluctuations of water levels in karst lakes near Staszów (Niecka Nidziańska, Poland)

ZIELIŃSKI A.(1), ZAGÓRSKI P.(2), SHCHERBA V.(3)
(1) Jan Kochanowski University in Kielce, Institute Geography, KIELCE, POLAND ; (2) Maria Curie-Sklodowska University, LUBLIN, POLAND ; (3) Moscow State Humanitarian University of Sholokhov, MOSCOW, RUSSIAN FEDERATION

Near Staszów, which is situated in the north-eastern part of Niecka Nidziańska, there are numerous small but relatively deep lakes. They are of karst origin. Their occurrence is connected with a specific geological feature of the area. Karsting rocks are developed in the forms of gypsum and limestone, which are covered by non-karsting, water resistant Tertiary loams and impervious fluvioglacial sediments, which are next covered by vistulian and pleistocene sands.

21 lakes were the objects of the research. Winter 2011 was the time when, by using Global Positioning System (GPS, Leica System 500). At the same time, the benchmark points were installed on the chosen bodies. Using them, 9 measuring series were undertaken in order to define the changes of their water levels. The lakes are situated between 180,3 to 217,5 meters over the sea level. The results show that among the non-tide lakes, the most sensitive are the ones which are the highest over the sea level. The amplitude of the water level was 34 cm in the lake situated to the north of the so called four Peatland lakes and 32 cm in the Lake Szyja near Lake Jasne. The most stabilized water level, 14 cm, was observed on the lakes situated between Lake Szyja and Lake Jasne and the one to the north-east of Lake Jasne. Among the non-tide lakes, the water level decreased the most, within the analysed time, on the lakes: Kacze (26 cm) and Odrodzone (24 cm). Among the lakes with outflow, the water level decreased the most on Lake Torfowe I (26 cm), and the least in Lake Łajba (6 cm). Interestingly, the flowing lakes underwent some considerable fluctuation of water level. The highest amplitude was observed in a small body lying between Lake Jasne and Ciemne. It was 69 cm. The reason of such relatively big water level changes was the activity of beavers, which have recently inhabited the area at the lake. Their tracks were also noticed at Lake Ciemne.

Central Algarve tufa platforms, Southern Portugal. Geomorphological characterization and genesis

GUERREIRO P.(1), CUNHA L.(1), RIBEIRO C.(2)
(1) Centro de Estudos de Geografia e Ordenamento do Território, COIMBRA, PORTUGAL ; (2) Centro de Geofísica de Évora, ÉVORA, PORTUGAL

Modern and fossil carbonate tufa outcrops exist in the Algarve (S Portugal), where climate is Mediterranean and all modern incrusting springs are intermittent and fed by Jurassic aquifers. The major Pleistocene tufa on the Algibre flexure southern slopes are in the Cadouço, São Lourenço and Rio Seco streams basins. There were identified fluvial barrier tufas and low energy fluvial tufas.

The Algarve has three main geomorphological domains: the Paleozoic flysch mountains, the Meso-cenozoic karst hills and the littoral Plio-Pleistocene detrital platform. Located in the Eurasian-Nubian plates boundary, the whole system have been deformed by distensive and compressive tectonics, which give rise to a complex groundwater system. Neotectonical activity has been reported in many works.

Feio (1952) identified Pliocene and Quaternary marine platforms up to 160 m *a.s.l.*, but also mature levels at 200 m along with other plain surfaces.

The largest tufa platforms lie in unconformity with the current drainage system, where outcrops are dominated by low gradient facies, *v. g.* detrital bedded lime muds. Machados platform is dominated by bryophytes and other rapid flow facies, and cemented riverbed upstream. These outcrops lie down on larger areas in Loulé and Lagos e Relva, at altitudes between 160-200 and 120-150 respectively.

Environmentally conformal tufas occupy some sectors of the modern Cadouço, Rio Seco and São Lourenço streams. Modern tufa range from spring dominated mounds in Lagos e Relva and barrier and low gradient fluvial dominated tufas (*v. g.* São Lourenço and Loulé).

The ocean proximity enables the formation of eustatic platforms, which provided substratum for tufa accumulations. Vertical movements, including salt tectonics, and lowstands promoted fluvial incision and later tufa developments in modern streams.

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The karst of Vang Vieng, Lao P.D.R.

RENOUARD L.
Université Paris 7-Diderot, PARIS, FRANCE

The karstic range of Vang Vieng is situated a hundred kilometers north of the capital Viengchan. Amonst the many laotian karstic areas, it is one of those whose exploration and study are the most advanced to this day. The karst and its underground caves are efficient markers of the environnemental evolutions. The underground deposits constitute perfect archives of ancient climats and evironnements. The story of a region is a writen in the architecture of underground systems. Thus in the Vang Vieng karst, the disposition of he caves on distinct levels shows the evidence of ancient water levels. These are the stages of the uplift due to himalayan tectonic.

Whe shall here report progress on the latest results and the research to be pursued, while also looking at the relation between the populations and the fragile environnement, which present both restraints and oppportunities.

Tape-compass-clinometer, DistoX or total station, what is the best method to elaborate a cave survey? A case study in El Pindal Cave, Spain

BALLESTEROS D., DOMINGUEZ-CUESTA M.J., JIMÉNEZ-SANCHEZ M., GONZALEZ-PUMARIEGA P.
University of Oviedo, OVIEDO, SPAIN

Topographic bases used to carry on studies on caves linked to different aspects such as conservation, tourism, speleogenesis, engineering works, etc., usually proceed from cave speleological surveys. A cave survey is performed from data collected through 1) the classical approach involving tape, compass and clinometer use; 2) the modern technique in caving working with DistoX, a laser distance meter build-in digital compass and clinometer; or 3) the modern topographical approach based on the use of the a total station. Nowadays, the advantages and limits of these approaches are not properly established. The aim of this work is to establish which one is the best technique to archive the cave survey comparing together the survey lines elaborated with each one. The comparison was done at El Pindal Cave, Spain (43o24'N 4o32'W 24 m), with 627 m long and 27 m vertical range. The section of the cave ranges from 2x3 m to 49x8 m, including passages with less than 0.4 m diameter between both sectors. The results show that: a) the classical caving method is quick and represents a good approximation the whole of the cavity (the error is 2.84 % compared to the total station), but at local scale, the accuracy is highly variable up to 15 % (5±5 %); b) the DistoX option is the quickest and most versatile providing a survey with 0.33 % global error and 0.72±0.04 % error at a passage scale; c) the most accurate survey is performed by total station, although it is not easy to use and is restricted to broad and accessible passages. Results suggest that the three techniques provide acceptable surveys varying in its accuracy and versatility: the total station is the best method to elaborate a cave survey of the widest and more accessible passages, the DistoX is the most proper to carry out the survey of other passages and the classical method can be restricted to caves where environmental conditions (such as presence of a lot of water) hamper the use of the former two methods.

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A stalagmite record of western iberia climate from the last glacial cycle

DENNISTON R.(1), HOUTS A.(1), HAWS J.(2), POLYAK V.(3), WANAMAKER, JR. A.(4), ASMEROM Y.(3), BENEDETTI M.(5), BICHO N.(6)
(1) Cornell College, MOUNT VERNON, IOWA, UNITED STATES ; (2) Louisville University, LOUSIVILLE, KENTUCKY, UNITED STATES ; (3) University of New Mexico, ALBUQUERQUE, NEW MEXICO, UNITED STATES ; (4) Iowa State University, AMES, IOWA, UNITED STATES ; (5) University of North Carolina Wilmington, WILMINGTON, NORTH CAROLINA, UNITED STATES ; (6) Universidade do Algarve, FARO, PORTUGAL

Stalagmites from Buraca Gloriosa (BG) (39º32'N, 08º47'W), a cave located in west-central Portugal, track environmental change during the last glacial cycle. U/Th dating of these samples has allowed for the construction of growth models with centennial-scale precision. Growth is discontinuous, and although not yet fully developed, age models suggest hiatuses coincident with Heinrich events, likely in response to cold and/or dry conditions as suggested by regional pollen data.

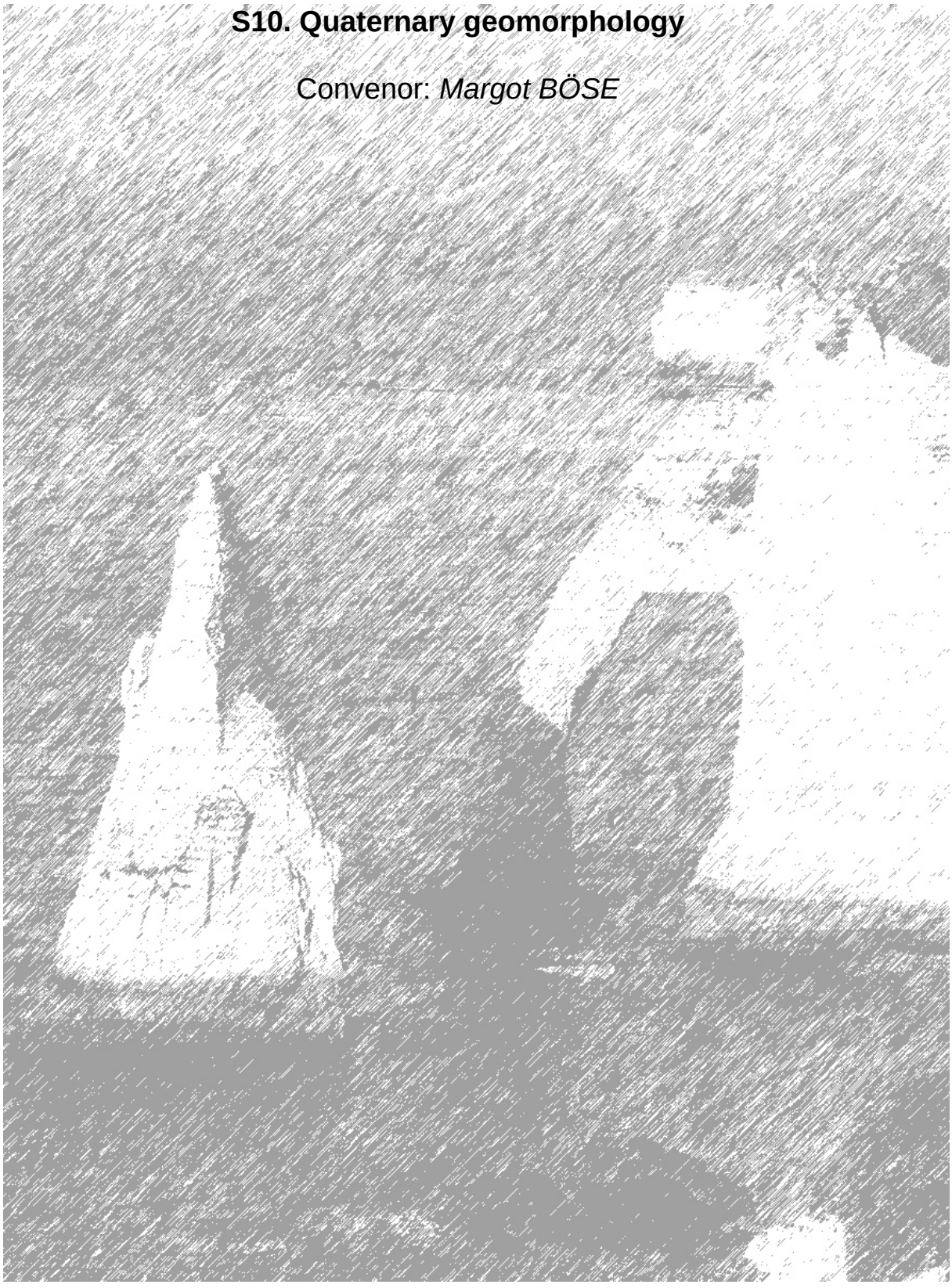
The BG stalagmite oxygen isotopic time series exhibits millennial variations of 1-2‰ that are similar in structure and timing to Dansgaard/Oeschger (D/O) events as recorded in the Greenland ice core. Stalagmite oxygen isotopic values can reflect any of a suite of controls, some of which do not always exhibit a straightforward relationship with climate, but similar isotopic values and trends of coeval BG stalagmites suggest that BG stalagmite calcite crystallized under isotopic equilibrium with cave dripwater, and thus most likely reflect climate dynamics.

Based on the temperature dependence of oxygen isotopic fractionation that occurs during calcite crystallization, as well as modern relationships between air temperature and the oxygen isotopic ratios of meteoric precipitation, warmer (colder) regional temperatures are correlated in this regional with lower (higher) precipitation oxygen isotopic values. This observation is consistent with local oxygen isotopic minima (maxima) that characterize D/O interstadials (stadials) in the BG time series. However, the slope of the precipitation oxygen isotopic ratios/air temperature relationship is shallow and thus temperature likely exerted only weak controls on stalagmite isotopic variations. Instead, the seasonality or source of precipitation is considered a more likely mechanism.

While the BG stalagmite record is still being developed, these data have the potential to fill temporal and spatial gaps in the high-resolution continental paleoclimate record from southwestern Europe.

S10. Quaternary geomorphology

Convenor: *Margot BÖSE*



Oral presentations:

From Morphostratigraphy to Chronostratigraphy - Modern Quaternary Geomorphology as a Basic for Climatic Research

BÖSE M.
Freie Universitat Berlin, Institute of Geographical Sciences, BERLIN, GERMANY

The onset of geomorphological studies was characterized by the description and systematization of landforms, resulting in a relative morphostratigraphical order of neighbouring topographical forms. With the acceptance of climatic changes – rapidly evolving for the Quaternary owing to the recognition of repeated extended glaciations and warm phases – stratigraphy of the sediments and morphostratigraphy of the landforms complement each other, for example in former glaciated areas and other accumulation areas. Modern geomorphology is closely linked with developing research topics such as advanced knowledge about climatic changes and new methods in geochronology as well as the application of quantitative methods. Research on previous climatic changes has gained new impulses from analysis on ice cores in both polar regions and from deep sea core drillings, while terrestrial research has been refined by various methods opening new archives.

In addition, increasingly detailed knowledge of terrestrial and perimarine environments enhances the possibility to distinguish between Holocene natural, climate-driven processes, including events, and the human impact on the landscape.

As Quaternary research comprises various research approaches, including geomorphology, and nowadays offers a number of proxy data for climatic research of the past, it is indispensable for future research. Understanding the past makes it possible to develop models for the future – including climatic impact on the terrestrial surface.

One major issue at present may be the relation between global, regional and local effects of climate changes and varying, previously often very local human impact.

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Morphogenesis of SE part of the Lodz region, Central Poland, during late Saalian (MIS 6, WARTANIAN STAGE)

WACHECKA-KOTKOWSKA L.(1), CZUBLA P.(2), GÓRSKA-ZABIELSKA M.(3), KRÓL E.(4), BARCZUK A.(5)
(1) University of Lódz, Faculty of Geographical Sciences, Department of Geomorphology and Palaeogeography, LODZ, POLAND ; (2) University of Lodz, Faculty of Geographical Sciences, Laboratory of Geology, LODZ, POLAND ; (3) Adam Mickiewicz University, Institute of Geoecology and Geoinformation, POZNAN, POLAND ; (4) Institute of Geophisics, Polish Academy of Sciences, WARSAW, POLAND ; (5) Warsaw University, Faculty of Geology; Institute of Geochemistry, Mineralogy and Petrology, WARSAW, POLAND

The investigated area is located on the border between the Polish Highlands and Lowlands, on the northern slopes of the remnant Mesozoic hills of the Przedbórz Highland. The main forms of landscape were formed during the last glacial episode in that region, from glaciation and deglaciation of the Wartanian Stage of the Middle Polish Glaciations, the Odranian Glaciation (Late Saalian, MIS 6, Middle Polish Complex, 180-120 kBP). We can distinguish four glacimarginal zones, connected with advance and recessional Wartanian stages, Radomsko Hills (I), Dobryszyckie Hills (II), Bełchatów Plateau (III) and Piotrków Plateau (IV).

The results obtained can contribute to a reinterpretation of the Warta ice-sheet limit and in the light of new petrographic data, heavy minerals composition, anisotrophy magnetic sensibility analysis it has been proved by the authors, that the Wartanian ice-sheet reached further, by about 80-90 km to the South of Łódź, leaning against the Northern slopes of the Radomsko Hills, along the Radomsko-Przedbórz line, where it formed four glacimarginal zones.

Investigation funded by grant No N N306 721140

Distribution, formation and chronology of Late Quaternary sediments in the Central Spanish Pyrenees

HIRSCH F., RAAB T.
BTU Cottbus, Chair of Geopedology and Landscape Development, COTTBUS, GERMANY

After more than 150 years of research the Pyrenees are still object of Quaternary research aiming for a better chronology of Pleistocene glaciations. Within the scope of the research project *Post-LGM pedogenesis and geomorphodynamics in the Aragon Pyrenees*, funded by the DFG (Ra 931/3-1 & 2), soils and sediments in the Gallego and Aragon valley were used to reconstruct the Late Quaternary landscape development. Our research reveals a considerable reshaping of LGM landforms prior to the onset of the Holocene. Soil genesis is most distinct in sediments that are dated to the Late Pleistocene by OSL ages. Further phases of geomorphodynamics can be distinguished during the Holocene with truncated soil profiles and the correlate sediments of soil erosion. We associate the phases of soil translocation during the Holocene with the human impact. In both valleys the Pre-Holocene geomorphodynamics on the LGM deposits show clear analogies with findings from Pleistocene periglacial landscapes in Central Europe.

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Overview of Last Deglaciation sedimentological, palynostratigraphical and 14C chronologies in mountain lake sediments: Towards improved knowledge of the MIS2/MIS1 transition in the Mediterranean Alps

GUITER F.(1), BRISSET E.(2), BOURLES D.(3), BRAUCHER R.(3), ANTHONY E.(3)
(1) IMBE Aix-Marseille University, AIX EN PROVENCE, FRANCE ; (2) CEREGE/IMBE Aix-Marseille University, AIX EN PROVENCE, FRANCE ; (3) CEREGE - Aix-Marseille University, AIX EN PROVENCE, FRANCE

We present a synthesis of several palaeoenvironmental studies carried out on high-altitude lake sediments in the Southern Alps (Ubaye and Tinée valleys). Twelve sequences from south and north-facing lakes located at altitudes ranging from 2000 to 2400 m were compiled. Pollen stratigraphy was correlated with the stratigraphic positions of 30 ^{14}C-dated samples as well as with sedimentological features in order to specify the regional framework of the last glacial retreat. Laminated blue clay muds observed at the base of the lacustrine profiles undoubtedly record the presence of glaciers above the considered lake altitudes, that is, 2400 m in south-facing cirques and 2100 m in north-facing ones, since the Older Dryas (*ca.* 21,000-17,000 cal. BP). At the end of the Younger Dryas(*ca.* 12,000-11,000 cal. BP), the sedimentation characteristics of the 12 studied lakes rapidly changed from organic-poor glacial till to organic-rich dark-brown gyttja. Catchments above 2000 m were then definitively ice-free. Slope soils were thus progressively colonized by vegetation while biogenic sedimentation became predominant in the lakes. These results are discussed within the regional chronological framework, supported by cosmogenic nuclide dating, and then confronted with the history of glacier retreat at a larger scale.

Changes in relief of the Azau Valley in Central Caucasus Mts resulting from impact of volcanic activity and glaciers` oscillations during the last 1100 years

LAJCZAK A.
Jan Kochanowski University, Institute of Geography, KIELCE, POLAND

I analysed changes in the relief of the partly glaciated Azau Valley in the Central Caucasus, neighbouring to Elbrus volcanic cone (5643 m a.s.l.) resulting from intensification of volcanic activity and valley glaciers' oscillations during the last 1100 years. Field research, analysis of topographic maps and photographs from the last 140 years as well as information in literature were the basis for my work. I identified the most important geomorphological processes modelling the valley: a lava flow, floods of jökulhlaup type, glaciers' transgressions and recessions, erosion of moraines and mass movements on the slopes. I distinguished eight sections of the Azau Valley varied in their relief and being under the differentiated influence of the listed geomorphological processes. The valley under question, represents the Alpine type area of typical cascade like transfer of waste material from the slope to the valley systems and further along its floor. Hanging tributary valleys on the Azau Valley slopes are valleys exporting waste material while the main valley functions as the valley importing waste material. In the period of absence of visible volcanic activity of Elbrus, the fastest changes in the Azau Valley relief take place during the recession of the valley and slope glaciers and of ice cap on this volcano. Findings proof interdependence of intensity of material aggradation in the valley and the amount of moraine deposits which can quickly erode and be transported to the stream channel, easily accessible weathered material derived from marginal ice-free areas as well as on the volume of ice melting water discharging great loads of sediment.

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Late Holocene environmental and climatic conditions in Adventalen valley (Svalbard) based on sedimentological studies of ice-wedge polygon terrain

OLIVA M.(1), NEVES M.(1), VIEIRA G.(1), PINA P.(2), CARDOSO M.(1), FREITAS C.(3)
(1) Institute of Geography and Spatial Planning, Universidade de Lisboa, LISBOA, PORTUGAL ; (2) Centre for Natural Resources and the Environment, Instituto Superior Técnico, LISBOA, PORTUGAL ; (3) Department of Geology, Universidade de Lisboa, LISBOA, PORTUGAL

Ice-wedge polygons are widespread features in the surroundings of Longyearbyen (Svalbard). Two study areas were selected in Adventalen valley in order to examine the role of the soils and sediments in the formation and development of these ice-wedge networks: (1) one located in a glacio-fluvial terrace on the northern bank of Advent river, (2) the other in the lowest part of Todalen alluvial fan, in the southern bank of the river.

Tens of pits along transects were opened in order to examine the sedimentary record in these areas where polygons are present. The study of the sediments may reveal changes in the environment, which in turn may reflect climate variability. The thickness of the active layer at the end of summer (50-110 cm) determined the depth down to which sections were examined. Moreover, in the cliffs of the Advent river we excavated exposures up to 2 m depth to better analyze the sedimentary sequence. Samples were collected from the different lithostratigraphic units for standard laboratory analyses (grain size, organic matter content, XRF). Ten samples were processed for AMS C^{14} dating to establish the chronological framework of the environmental evolution.

Results suggest significant landscape changes in the area over the Late Holocene. The peat layer detected in the basal layer of the northern section is found widespread across the valley and it has been dated back to 3.4-2.8 ka BP. Subsequently, an alternation of organic-rich units and aeolian layers is indicative of changing environmental conditions between 2.8-1 ka BP. A more intense wind deposition is likely to have occurred during the last millennium, especially in the southern bank of the river.

Therefore, in the framework of the ANAPOLIS project, our research provides a better understanding of the environmental conditions (and climate) more favorable for the development of ice-wedge polygons in this arid Arctic environment during the Late Holocene.

Typology and chronology of terraces around the lake Van: highlighting changes in palaeogeography of the lake basin during the Late Pleistocene

CHRISTOL A.
Laboratoire de Geographie Physique, FECAMP, FRANCE

The Lake Van (1648 m) is a palaeoclimatic and palaeoenvironmental reference for the Middle East. According to previous studies, its evolution appears close-related to climatic and palaeohydrographic changes. This presentation aims at characterizing terraces of the lake basin, which are correlated to ancient lake levels (the regional base-level), to highlighting palaeogeographic changes at the end of the Upper Pleistocene. We adopt a geomorphological approach including sedimentary facies and stratigraphic analysis, altimetric measurements on field and datings (OSL and ^{14}C). The geochronological approach is focused on fluvio-lacustrine sequences under the surface of the terraces.

The morphosedimentary archives around the lake have recorded high amplitude variations of the Lake Van and of its volume, with five main transgressions each one has been followed by important regressions. These latter are induced by an incision of the former lacustrine sediments and the development of erosional terraces on both sides of valleys and on shore for the most recent regression. Some erosional terraces are developed in the substratum and have been caused by a very low lake level. The terrace systems in the main tributary valleys show the diversity of the terraces in terms of elevation (from 1750 to 1650 m above the present lake level), surface size, edge amplitudes and volume of sediments eroded. These morphologies show in each studied valley associations of cut-and-fill terraces and stepped terraces with different ages. Our results concerning all the terraces give ages from 135 ka (MIS6) to 13.7-11.5 ka (from ^{14}C cal BP and OSL). The different types of terraces are evidences of base-level variations during a low lake level in fluvial conditions but also of conditions during the lake regression which can be more or less fast and with some intermediate lake stands or not. These aspects reveal the sensitivity of this hydrosytem to changes in palaeohydrography and to climate forcing.

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Late Quaternary climate and landscape evolution in north Gujarat: a multiproxy study of the Pariyaj Lake archive, western India

RAJ R.(1), SHARMA A.(2), PRASAD V.(3), VERMA P.(3), TRIPATHI J.(4)
(1) Department of Geology, The M. S. University of Baroda, VADODARA, INDIA ; (2) School of Earth & Environmental Sciences, Central University of Himachal Pradesh, DHARAMSHALA, INDIA ; (3) Birbal Sahni Institute of Palaeobotany, LUCKNOW, INDIA ; (4) School of Environmental Sciences, Jawaharlal Nehru University, NEW DELHI, INDIA

Early Holocene in western India is marked by a regional tectonic uplift, which resulted in readjustment of drainages and formation of ponds and lakes that provides excellent archives to study past climatic changes. A multidisciplinary study was carried out on a sediment core from the Priyaj Lake of northern part of the Gujarat alluvial plains to reconstruct climate, palaeoenvironment and tectonics and their role in the evolution of area during the late Quaternary. Based on geological, geomorphological, palynological and phytolith investigations, five climatic phases have been identified during the last ~12,000 cal. yr BP. Phase I (89-75 cm), is dominated by algal elements, moist deciduous arboreals and non arbors, indicating high lake level and wet climatic conditions. Abundance of burnt phytoliths and micro-charcoal fragments are indicative of human activity. Presence of *Artemisia* pollen and dominance of pooid phytolith morphotypes is indicative of prevalence of winter precipitation activity during this phase. Phase II (75-63 cm), shows low pollen yield, decreased algal content, indicative of low lake stand. Phase III (63-35 cm) shows large proportion of pollen belonging to deciduous and dry deciduous i.e *Prosopis* and *Accacia* plants in the upper part of the phase indicates changing landform conditions and beginning of dry climatic condition. The decreasing trend in the pooid and multifaceted phytolith morphotypes also indicates gradual decrease in the precipitation activity. Phase IV (35-25 cm) is a barren zone which falls in the mid Holocene period, (~5000 BP) indicates excessively dry climatic phase. In Phase V (25-5 cm) there is an increase in the percentage of pollen and phytolith indicating increased precipitation as a result of amelioration in climate.The excessive dry phase of Pariyaj lake correlates well with the mid Holocene dry phase of Rajasthan lakes and climatic data of other part of the Indian subcontinent.

Landform Evolutions: Sedimentary Records from Lake Borsog, Eastern Shore of Lake Khuvsgul, Mongolia

ORKHONSELENGE A.(1), KRIVONOGOV S.K.(2), MINO K.(3), KASHIWAYA K.(3), YAMAMOTO M.(3), NAKAMURA T.(4)
(1) School of Geography & Geology, National University of Mongolia, ULAANBAATAR, MONGOLIA ; (2) Institute of Geology & Mineralogy, Siberian Branch of Russian Academy of Sciences, NOVOSIBIRSK, RUSSIAN FEDERATION ; (3) Institute of Nature and Environmental Technology, Kanazawa University, KANAZAWA, JAPAN ; (4) Center for Chronological Research, Nagoya University, NAGOYA, JAPAN

This study presents landform evolutions recorded from new sedimentological, geochronological and diatom data from a 13-m core of sediment from Lake Borsog, a former bay of Lake Khuvsgul (also known as Hovsgol and Khubsugul) in northwestern Mongolia. Lake Borsog was separated from Khuvsgul during the early stages of a post-glacial transgression and possesses a high-resolution record of the Holocene. The data show three short events of higher-rate sedimentation (0.102 cm/yr, 0.085 cm/yr and 0.139 cm/yr) at 7.4–7.1 ka cal. BP, 4.8–4.5 ka cal. BP and 1.0–0.9 ka cal. BP, which are possibly related to lake level drops, reduction of lake area, progradation of the delta of the Borsog River and higher erosion of the exposed lake shores. The drops in lake level match the previously documented drops of the level of Lake Khuvsgul at ca. 7.2–7.0, 4.5–4.1 and 2.1–0.5 ka cal. BP, suggesting continued mutually-related and climatically-controlled evolution of both lakes after their separation.

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New insights on the Quaternary stratigraphy of the coarse-grained Golo river alluvial plain (east-Corsica margin)

MOREAU J.
IFREMER, PLOUZANE, FRANCE

The Golo river is the main river of Corsica, flowing to the Mediterranean Sea. It takes its source in the highest summit of Corsica, the Monte Cinto (2706m), runs along a small watershed (1005 km²) in a very incisive and steep profile (5.3%). The Golo river shows a well-developed terrace system on the ‘Marana-Casinca plain’ on the northeast-Corsica. This alluvial plain should be considered as the first depositional area shaped by the major changes of the Quaternary sediment fluxes provided by the Golo watershed. Previous studies on the deltaic plain provided a detailed geological map based on superficial outcrops. But there is no absolute delta geochronology, neither information about the depth of the substratum underneath the alluvial terraces, nor about terraces organization in depth. This study is based on new geophysical and geological acquisitions performed during 5 fieldworks since 18 month. The acquisition of an integrated dataset with several electric resistivity tomography (ERT) profiles, H/V measurements, OSL and Be10 dating were realized. The combination of the new geophysical data with the synthesis of lithological logging information available on the delta plain provides a refined stratigraphic framework of the Golo delta. As an example, we imaged a succession of stepped terraces in the upstream part of the plain. In depth, data provide constraints on the extent and the thickness of the alluvial terraces, about 20 meters for the oldest and less for the more recent ones. The H/V method confirms by a regional surface imaged on the ERT survey the existing boundary between the alluvial deposits and an undifferentiated basement. ERT data also allowed the identification in the northern part of the plain of a paleo-valley-shape underneath a topographic depression. 200 meters-width and 150 meters-depth incision can be displayed. The new evidences of palaeo-valley incisions on the deltaic plain allow to discuss the Quaternary evolution the Golo delta plain.

Influence of bedrock on the fluvial morphodynamics in the Pleistocene Dives River (NW France)

JAMET G., DELCAILLAU B., DUGUÉ O.
Université de Caen Basse-Normandie/ M2C UMR CNRS 6143, CAEN, FRANCE

During the Plio-Pleistocene cold periods, the Dives River was an important tributary of the Bay of Seine sedimentary basin and displayed four major steps of alluvial units below the last incision of the bedrock. Unlike previous work, this study provides a comprehensive fluvial morphodynamics investigation. This study aims to establish a relative chronology of events in the Dives fluvial history and to understand the control on those events. We reviewed stepped-terraces system from previous studies and add new data based on cartography, excavations and seismic tomography (DAQLink III). Moreover, we analysed the drainage network, alluvial deposits and morphostructural data using geomorphological modelling tools (DEM). Results allowed us to 1) describe a new longitudinal profile of the last Weichselian incision, 2) establish a morphostratigraphical framework that displays the origin, the geometry and the depositional dynamics of alluvial bodies and 3) discover geomorphological anomalies that indicate reorganisations of the Pleistocene Dives streams.

The fluvial architecture displays a lithostructural control. The lower terraces exhibit a strong contrast in regard to depositional dynamics on each side of the two major knickzonesinthe longitudinal profile (*i.e*. Morteaux-Couliboeuf and Quétiéville). The alluvial deposits of Ecajeul is an evidence of a capture linked to an adaptation to the monoclinal structure according to eastward coastal rivers migrations. The stepped-terraces in the downstream part of the Dives basin are interpreted as the result of cyclic backward erosions and rapid adjustments of streams. These preliminary results allow to discuss the possibility that subbasins of the present-day coastal area are inherited from a palaeogeography disconnected from the present-day Dives basin. A radiochronometric approach will be required to understand the time scale of landscape response to changes in bedrock uplift rate and to record Interglacial/glacial climate.

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Late Holocene flood phases in the Upper Dniester river basin: response to climate change and human impact in the Carpathian Foreland

GEBICA P.
University of Information Technology and Management, RZESZOW, POLAND

Research in the valleys of Upper Dniester, Strvjaz and Stryj Rivers, in the Eastern Carpathian Foreland, documents the occurrence of 3-4 Holocene terraces and several alluvial fills within the lowest of these terraces, 4-6 m high, dating back to the Late Vistulian, Atlantic, 3500-3000 BP, 2200-1700 BP, 5^{th}-7^{th}, 10^{th}-12^{th} and 14^{th} – 16^{th} centuries AD. Flood phases distinguished in the Upper Dniester basin correlate well with previously established phases of enhanced fluvial activity in the valleys of Upper Vistula, the Wisłoka and the San in the Western Carpathian Foreland. Among these periods are phases determined by climate as well as reflecting human activity and phases recording coincidence of both these factors. The Roman period (1^{st}-4^{th} centuries AD) was a time of enhanced human activity and flood deposition. An episode of tree fall during the 5^{th}-6^{th} century floods is linked to the regression of agriculture, reforestation and increase in frequency of floods connected with growth of precipitation (1500-1350 BP). Subsequent phases of grater fluvial activity (10^{th}-12^{th} and 14^{th}-16^{th} centuries AD), record increasing human activity, as well as correlation with wet and cool climate phases (the first half of the 11^{th} century and the beginning of the Little Ice Age).

Heinrich Events and Late Pleistocene geomorphic instability on the central Portuguese coast

BENEDETTI M.M.(1), DANIELS J.M.(2), HAWS J.A.(3), FORMAN S.L.(4)
(1) University of North Carolina, WILMINGTON, NC, UNITED STATES ; (2) University of Denver, DENVER, CO, UNITED STATES ; (3) University of Lousville, LOUISVILLE, KY, UNITED STATES ; (4) University of Illinois, CHICAGO, IL, UNITED STATES

Heinrich Events (HE) are semi-periodic iceberg outbursts into the North Atlantic Ocean from the Laurentide ice sheet that occurred in the Late Pleistocene. HE are recorded as layers of ice-rafted continental sediment in deep sea sediment cores as far south as 37N latitude. Recent studies suggest that sea level rose by ~5m during HE, and summer sea surface temperatures dropped by more than 10C. These conditions impacted maritime and coastal systems across the region, and especially on the coast of Portugal where HE are linked to cold/arid conditions, forest decline, hillslope erosion, marine transgression, and discontinuities in the archaeological record.

The Estremadura region of central Portugal presents several examples of HE-driven geomorphic change. Landscape instability between 11-70 ka BP is indicated by fluvial valley fills, aeolian sands, and colluvial deposits on coastal bluffs with ages that cluster around HE1, HE2, HE3, HE4, and HE6. Currently all 13 OSL ages on these deposits overlap a HE within the 1 sigma error range. These data support a biogeomorphic response model first proposed by James C. Knox in 1972, which predicts maximum hillslope erosion and sediment yield following climatic transitions from arid to humid. They are also consistent with archaeological studies reporting erosional discontinuities due to cold arid conditions during HE4, at the Middle-Upper Paleolithic transition. Fluvial deposits at Praia Rei Cortiço demonstrate a transition from meandering to braided channels at the end of the last interglacial stage, and back to meandering before the current interglacial. Many Portuguese rivers were likely braided throughout the glacial stage, given the unstable climate associated with HE and Greenland stadials. Finally, littoral deposits on raised coastal platforms in the study area record local sea level rise of at least 4m during HE4 and HE6, supporting the concept of eustatic sea level forcing by HE.

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Holocene record of hydrological changes in the Nile delta using Sr isotopes: an exemple of climatic forcing, societal management and local geomorphological responses (Maryut lagoon, Egypt).

FLAUX C., CLAUDE C., MARRINER N., MORHANGE C.
CEREGE, AIX-EN-PROVENCE, FRANCE

Understanding the Holocene drivers and timing of coastal water budget changes in deltaic settings is a key issue to constrain modern deltaic modifications in the face of relative sea level, continental waterflow and human management. In the Nile delta, these drivers act cumulatively and mediate the coastal ecosystem, agricultural activities, freshwater resources and population vulnerability to coastal changes.

The strontium isotopic composition of carbonate ostracod shells from Holocene lagoon sediments in the Maryut (NW Nile delta) have been used to quantify the interplay between relative sea-level variations and Nile flow changes in the Maryut's water budget during the past 7,500yrs. 87Sr/86Sr ratios allow five hydrological stages to be defined. (1) The marine transgression of the area is dated to ~7.5 ka cal. BP. (2) Between ~7 and ~5.5 ka, in the context of the so-called African Humid Period (AHP), freshwater inputs became progressively predominant in the Maryut's hydrology and coastal progradation led to the progressive closure of the Maryut lagoon. (3) The termination of the AHP is reflected in the 87Sr/86Sr stratigraphy between ~5.5 and ~3.8 ka, by a progressive hydrological shift from a Nile-dominated to a marine-dominated lagoon. (4) From ~2.8 to ~1.7 ka, 87Sr/86Sr ratios shift towards lower Nile-like values and is attributed to irrigation works since the early Ptolemaic period (i.e. since ~2.3 ka). (5) The final phase of the record covers the period between ~1.7 to ~0.2 ka. 87Sr/86Sr indicate high freshwater inputs, except between 1.2-1.1 to ~0.7 ka, when a Maryut lowstand and brackish water intrusion is attested. Our work shows that strontium isotopes are sensitive to variations in the palaeo-water budget of Nile lagoons, collectively mediated by basin-scale climate change and local-scale societal impacts.

Poster presentations:

The Geological Society of London Engineering Group Working Party on Periglacial and Glacial Engineering Geology

GILES D.(1), MARTIN C.(2), GRIFFITHS J.(3), MORLEY A.(4), LUKAS S.(5), EVANS D.(6), MURTON J.(7), CULSHAW M.(8), DONNELLY L.(9), DE FREITAS M.(10), WINTER M.(11)

(1) University of Portsmouth, PORTSMOUTH, UNITED KINGDOM ; (2) BP, LONDON, UNITED KINGDOM ; (3) University of Plymouth, PLYMOUTH, UNITED KINGDOM ; (4) Arup, LONDON, UNITED KINGDOM ; (5) Queen Mary College, LONDON, UNITED KINGDOM ; (6) Durham University, DURHAM, UNITED KINGDOM ; (7) University of Sussex, BRIGHTON, UNITED KINGDOM ; (8) BGS, NOTTINGHAM, UNITED KINGDOM ; (9) Wardell Armstrong, MANCHESTER, UNITED KINGDOM ; (10) Imperial College, LONDON, UNITED KINGDOM ; (11) TRL, EDINBURGH, UNITED KINGDOM

The Engineering Group of the Geological Society of London has established a Working Party toundertakea state-of-the-art review on the ground conditions associated with former Quaternary periglacial and glacial environments and their materials, from an engineering geological viewpoint. The proposed final report is not intended to define the geographic extent of former periglacial and glacial environments around the world, but to concentrate on ground models that would be applicable to support the engineering geological practitioner.

The Working Party will be considering the following topics with respect to engineering geology: Quaternary Setting, Geomorphological Framework, Glacial Conceptual Ground Models, Periglacial Conceptual Ground Models, Engineering Materials and Hazards, Engineering Investigation and Assessment along with Design and Construction Considerations.

This paper will present the progress of the Working Party and will outline the approaches taken and proposed output of the group.

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Geochronology of the planning surfaces in the Center-Western portion of the Paulista Peripheral Depression (Brazil) using Optically Stimulated Luminescence

DIAS R.L., PEREZ FILHO A.

Institute of Earth Sciences (IG), University of Campinas (UNICAMP), CAMPINAS, BRAZIL

The relief in the state of São Paulo, Brazil, is divided into five geomorphological provinces, characterized from their genesis, structure and lithology. The Paulista Peripheral Depression corresponds to one of them, with the shape of a corridor with mountainous topography of approximately 50 Km wide, located between two other provinces: the Cuestas region and the crystalline elevations of the Atlantic Plain.

The proposed study intends to identify and interpret the planning surfaces, defined by Penteado (1968), using absolute dating and correlation of surfaces: Neogenic I, Neogenic II, high and low fluvial terrace and recent alluviums formed during the Quaternary, using the Optically Stimulated Luminescence (OSL) in different material of soil formation, located in the respective surfaces. This technique enables the attribution of specific periods of the landscape evolution to determined known or modeled using absolute dating. This method has demonstrated great potential in dating quaternary deposits, since it can reach ages of up to 10^6 years.

The results obtained will enable making the relations between genesis and such shapes, and possible past environmental conditions, where the semi-arid conditions were predominant, later followed by the craving of the fluvial channel in hot and moist conditions. Soon, it will be possible to build a regional scenario of the climate oscillations that occurred during the Quaternary, also taking into consideration the influence of neotectonic activities in the elaboration of such planning surfaces.

Therefore, this study intends to contribute to the discussions on the genesis of relief forms and their correspondence to climatic oscillations that occurred in recent period in nature's time scale, in the Brazilian territory.

Key-words**:** Paulista Peripheral Depression (Brazil), Quaternary, Climatic Oscillations and Optically Stimulated Luminescence (OSL).

Mid-Holocene Wetland Evidences in West Coast Zone, Korea

YANG D.Y., LIM J., LEE J.Y., KIM J.Y., YI S., KIM J.K.
Korea Institute of Geoscience and Mineral resources, DAEJEON, SOUTH KOREA

We first discovered a natural-type wetland in the site of Kimpo Airport, which has perfect wetland characteristics of a variety of ecological environment even though it has been formed in the center of city within recent 20 years. The current wetland is formed in an unused field within the site of Kimpo Airport. The site is on the floodplain of Gulpo-stream which flows northeast and is joined the Han River flowing northwest. The most of water sources in the lowland of 4-6m in elevation of northeastern basin is originated from the southwestern mountainous part of the basin.

We found out the evidences of mid-Holocene wetland from the results of multi-proxy records of sediment core OS3 of the wetland. Three sedimentary units, from unit I to III in ascending order, are distinguished based on sedimentary textures and vertical color variation. Unit I consists mainly of dark brownish gray, fine silt with a few plant fragments. Unit II is characterized by two peat layers. It shows bluish to dark gray fine silt with some plant fragments and organic matters. Unit III is composed of mainly yellowish brown to brownish gray very fine silt. The radiocarbon ages of 5 samples from sediment core OS3 were determined by the accelerator mass spectrometer (AMS) method. There is a hiatus between units I and II by erosion. Unit I is the latest Pleistocene sediments older than 19960 cal yBP, but the sediments of units II and III were formed in 6370-4600 cal yBP. Kimpo wetland is somewhat similar to Pyeongtaek and Cheolipo wetlands in geology, geomorphology and geochemistry, which are located in floodplain and beach sites, approximately 80km and 120km southwest of Kimpo site, respectively. We will report the mid-Holocene wetland evidences of this site with comparing those of Pyeongtaek and Cheolipo wetlands. Also, we will discuss the characteristics of these wetlands comparing with East Asia Summer monsoon data and rainfall data of Dongge Cave during mid-Holocene.

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Geochemical record of biogenic-carbonate sedimentation in deposits of spring mires in Poland

DOBROWOLSKI R.(1), MAZUREK M.(2)
(1) Institute of Earth Sciences, Maria Curie-Sklodowska University, Lublin, Poland, LUBLIN, POLAND ; (2) Institute of Geoecology and Geoinformation, Adam Mickiewicz University in Poznan, POZNAN, POLAND

Peatlands are thought to be geoarchives in which deposits and their physico-chemical parameters can be useful when studying changes in the natural environment as well as those caused by human activity. Of much value in this respect are spring mires belonging to the rare alkaline soligenous type. The deposit-building peat-calcareous tufa series are an excellent analytical material for Late Glacial-Holocene paleo-environmental reconstructions. The similarity of objects in various morphogenetic units of Poland, the uniform mechanism of their formation, encourages comparisons of depositional records and in consequence allows conclusions concerning climatic and hydrological changes. Geochemical data, correlated with radiocarbon ages, document differences in sedimentary environments resulting from conditions of circulation of groundwater and its physico-chemical properties as well as from changes in the conditions of sedimentation. Physical features and the chemical composition of deposits, especially the concentration of macro-components, are a record of the character and intensity of natural chemical denudation processes taking place in the catchment feeding spring mires. The pattern of decline in the Ca/Mg ratio is indicative of selective lessening of carbonate leaching in the catchment and a drop in Ca concentrations in the groundwater supplying the mires in question. Changes in the hydrogeochemical environment (reduction-oxidation conditions) may be conducive to the precipitation, chemical sorption, oxidation and reduction of some chemical components. Differences in the Cu/Zn and Fe/Mn rates in profiles reflect transformations of the reduction-oxidation conditions obtaining during the sedimentation of deposits. Deposits of spring mires are also a record of the history of atmospheric supply. The intensity of human impact will show in changing heavy metal concentrations in the near-surface layers of deposits, and in an increase in the eutrophication index.

Are fluvial terraces reliable chronological markers in the history of valley development? The Ariège, north-Pyrenean piedmont, France

DELMAS M.(1), CALVET M.(1), GUNNELL Y.(2), BRAUCHER R.(3), GUILLOU V.(3), BOURLES D.(3)
(1) Université de Perpignan-Via Domitia, EA 4605 Médi-Terra, PERPIGNAN, FRANCE ; (2) Université Lumière-Lyon 2, UMR 5600 CNRS Environnement, Ville, Société, LYON, FRANCE ; (3) Aix-Marseille Université, CEREGE CNRS UMR 7330, AIX-EN-PROVENCE, FRANCE

The treads of fluvial terraces are commonly used to reconstruct the past longitudinal profiles of graded rivers. They also constitute timelines in the landscape, marking the stages of channel incision and allowing mean rates of valley downcutting to be calculated. Based on those two assumptions it becomes possible to discuss the magnitude, frequency and relative impacts of climatic and tectonic forcing on river behaviour. However, doing so requires not only reliable means of establishing an accurate chronology of the terrace system but also appropriate clues to the graded character of the stream palaeoprofile, i.e. evidence that floodplain construction and channel incision were coeval in all segments of the valley. Here, we explore these issues in the upper Garonne basin, where a system of four glaciofluvial terrace straths formed by the Ariège river permit (i) an estimate of terrace ages based on vertical sampling profiles of the cosmogenic isotope ^{10}Be; (ii) the production of a Quaternary chronosequence for the suite of well characterized soil profiles capping the terrace treads; (iii) a correlation between the successive generations of terraces and the successive generations of frontal moraines of the Ariège glacier, which were previously dated also by ^{10}Be; and finally (iv) a discussion of conditions conducive to time-transgressive floodplain aggradation in the case of the lower terrace, which grades upstream to Würmian moraines.

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The complex studies of quaternary sediments in the Yenisei River

MASHUKOV A.(1), MASHUKOVA A.(2)
(1) Siberian Federal University , KRASNOYARSK, RUSSIAN FEDERATION ; (2) Siberian Federal University, KRASNOYARSK, RUSSIAN FEDERATION

The high speed of the river flow contributes to washing up to 5 tons of suspended solids per year from one square kilometer of the bottom surface.This is why most of the rocks forming the terrain under the influence of chemical conditions, temperature and pressure, changed their chemical composition.

There were studied the Quaternary sediments of the region close to Krasnoyarsk, whose age is no more than 10 thousand years. The samples were studied by using the X-ray and Mössbauerspectroscopy methods.

The three fractions,–namely strong-magnetic (Fe3O4– 87,3%, Fe2O3 – 0,7%), soft-magnetic (Fe2O3– 21,7%) and non- magnetic (FeO – 53,1%, FeOOH – 46,9%) – were extracted by using the magnetic separation method for determining the minerals – magnetization carriers.In the strong-magnetic fraction, the main iron-containing mineral is magnetite. As to hematite, it is probably localized on the surface of magnetite grains. The carriers of the magnetization of soft-magnetic fractions are hematite grains. The Δand δvalues indicate strong non - stoichiometry of wüstite. The compounds of FeOOH and FeO do not contribute to the residual magnetization.

One could see the increase in the saturation magnetization within the temperature range (20 - 250) degrees C. Then there is the drastic decrease in the temperature range (250 - 300) and after that there is its increase in the range (300 - 350). The phase change are observed at 400 degrees C and 500 degrees C. By using the X-ray analysis, there were detected Albite, Ankerite, Orthoclase in the non-magnetic fraction.

The above-mentioned studies show the prospects of applying the complex research in geology. The Mössbauer spectra can identify the types of magnetic minerals in complex compounds. The identification of the iron-containing natural minerals helps to reveal the stability of the residual magnetization in geological time scales.

Late Quaternary depositional sequences and landforms in relation to sea-level changes in the Osaka intra-arc basin, Japan: a borehole database analysis

ITO Y.(1), OGUCHI T.(1), MASUDA F.(2)
(1) The University of Tokyo, KASHIWA CITY, JAPAN ; (2) Doshisha University, KYOTANABE, JAPAN

Development of the upper Pleistocene to Holocene depositional sequences in the Osaka intra-arc basin was reconstructed, based on the analysis of subsurface geology and geomorphology, using numerous and high-density borehole data and GIS. The upper Holocene sequence (I) and the lower late Pleistocene sequence (II) underwent several significant phases: 1) formation of alluvial fans and terraces during regression from marine isotope stage (MIS) 5 to MIS 2; 2) formation of a boundary between the two sequences during rapid sea-level fall of during ca. 30–20 ka; 3) development of ravinement surfaces by wave and tidal erosion during the transgression from MIS 2 to MIS 1; 4) development of barrier systems and coastal cliffs during the transgression to the maximum high-stand of 6–5 ka; and 5) progradation of alluvial fans, deltas and strand plains during the high-stand since 5 ka. Depositional facies and systems of the two sequences are different among the western study area around Kobe, the central area with the Nishinomiya-Amagasaki lowland, and the eastern area with the Osaka plain, due to differences in sediment flux, wave, tide, shore current, basement and surrounding landforms. Development of the sequence II could be also affected by tectonic differences. Especially important insights are: 1) geomorphological changes with the formation of ravinement wave surfaces during the transgression, and 2) geomorphological changes of sea beds in relation to different rates of sea-level rise.

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The Nile delta : climate pacing and vulnerability to Holocene change

FLAUX C.(1), MARRINER N.(1), MORHANGE C.(1), KANIEWSKI D.(2)
(1) CEREGE, AIX-EN-PROVENCE, FRANCE ; (2) ECOLAB, TOULOUSE, FRANCE

The Nile delta lay at the heart of ancient Egyptian civilization, however little is known of its morpho-sedimentary response to basin-wide changes in Holocene hydrology. Here, we present two well-resolved records from the Nile delta (based on around 320 radiocarbon dates) to reconstruct the timing and rhythm of catchment-scale modifications during the past 8000 years. We also use chronostratigraphic data from 194 organic-rich peat and lagoon points to quantitatively reevaluate the drivers of Nile Delta surface dynamics during the Holocene. On the orbital timescale, we find that Nilotic hydrology and sedimentation have responded to low-latitude insolation forcing while, on sub-millennial timescales, many of the major phases of deltaic modification were mediated by climate events linked to El Niño Southern Oscillation type (ENSO) variability. Between 8000 and 4000 calibrated (cal) 14C yr B.P., spatially averaged sedimentation rates were greater than subsidence, meaning that delta aggradation was the dominant geomorphological process at the regional scale. Since ca. 4000 cal yr B.P., a sharp climate-driven fall in Nile sediment supply, possibly coupled with the human-induced drainage of deltaic wetlands, has rendered the depocenter more sensitive to degradation by sea-level rise and extreme flood events. The reconstruction suggests that the Nile delta has a particularly long history of vulnerability, although the present sediment-starved system does not have a direct Holocene analogue.

Deglaciation and postglacial evolution of relative sea level in the western part of the Saint-Lawrence River estuary and in the Gulf of St. Lawrence, Canada

HETU B.
Université du Québec Rimouski, RIMOUSKI, CANADA

Resulting from the combined effect of the general rise of global sea level concomitant with the deglaciation (Flandrian Transgression), of the glacio-isostatic uplift, that varies from one area to another depending on the thickness of glaciers, and of the migration the glacial forebulge, the postglacial evolution of relative sea level (RSL) in the Canadian Maritime provinces presents great complexity. In terms of post-glacial RSL evolution, the Maritime provinces can be subdivided into three major regions: (1) the northwest region where crustal uplift was more important than Flandrian Transgression, (2) the southeast region where subsidence of the crust and submergence associated with the FlandrianTransgression were dominant, (3) and the region in between representing a transition zone with a complex sequence of events. The middle region first experienced a phase of rapid emergence immediately after deglaciation, it was followed by a period of low sea level of variable amplitude depending on the sector and, it finally entered a phase of submergence that is still continuing. The study area overlaps the three regions. It includes the Saint Lawrence River estuary up to Rimouski, the western part of the Gulf of St. Lawrence (Gaspé area) and north shore of the Baie des Chaleurs. Several new data, including mapping of old shorelines, stratigraphic data, several new AMS dates, and four new RSL curves were used to analyze the deformation of the crust under the weight of glaciers. The data collected allow for the first time to locate the boundary between zones 1 and 2, to better understand the behavior of the crust in the northern part of the third region (Baie des Chaleurs) and, more generally, to better understand the behavior of the crust in the regions under the influence of several ice caps.

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Interfluvial negativ microform in Romanian Plain. Morphometric and genetic analysis

GRECU F.(1), GHITA C.(1), BENABAS C.(2)
(1) University of Bucharest, Faculty of Geography, BUCHAREST, ROMANIA ; (2) University of Constatine, CONSTANTINE, ALGERIA

The landforms developed on loess and loessoid deposits are a common feature of the central and eastern sections of the Romanian Plain. Most of the topographic surface is covered by such deposits, which over the time have encouraged the emergence of specific landforms, in accordance with their response to the surface-sculpturing agents. From geomorphological point of view, negative microforms (“crovurile”) are depressions (ease subsidences) in loess or loess deposits covered plains, having circular or ellipsoidal shape, with diameters from few meters to 1-2 km, and a depth of 1-3 m. The evolution of these landforms is further controlled by subsidence, wind erosion and raindrop impact.The main objective of the study is to decipher the dynamics of these microdepressions (from Mostistea and Central Baragan Plains) using some morphometric parameters: Surface (S), Perimeter (P), Length (L), Width (l), Depth (D) as well as microdepression`s alignment and different coefficients (indicators of shape). The investigation shown big differences between the microdepressions in the two areas of study and, especially, on desposits type: Holocene sands areas and loess or loess deposits. In the Central Bărăgan Plain, on the Holocene sands in the northern section, loess dolines are smaller, less elongated and less sinuous, while in the central part of the plain they are larger, deeper, more sinuous and rounded. Likewise, in the northern part, the number and density of the microdepressions have higher values. At the same time, to the north, microdepressions are more numerous and their density is higher. Taking into account the features of the investigated loess wells one can define three “genetic” classes of microdepressions, depending on the genetic conditions and morphometric features.

Relative sea level changes in the MAgdalen Islands (Québec, Canada) since the last glaciation

M. RÉMILLARD A.(1), HETU B.(2), BERNATCHEZ P.(3), ST-ONGE G.(1)
(1) Canada Research Chair in Marine Geology, Institut des sciences de la mer de Rimouski (ISMER) & GEOTOP, Université du Québec à Rimouski, RIMOUSKI (QUEBEC), CANADA ; (2) Département de biologie, chimie et géographie & Centre d'études nordiques, Université du Québec à Rimouski, RIMOUSKI (QUEBEC), CANADA ; (3) Research Chair in Coastal Geoscience, Département de biologie, chimie et géographie & Centre d'études nordiques, Université du Québec à Rimouski, RIMOUSKI (QUEBEC), CANADA

Global sea level rise is currently at the forefront of the most potentially damaging effects of climate change and is therefore one of the major challenges humans will have to face during the 21st century. In the maritime provinces of Eastern Canada, the relative sea level (RSL) rise has been exacerbated by subsidence that followed deglaciation.The Magdalen Islands, located in the middle of the Gulf of St. Lawrence, have undergone submersion at a rate of 3.5 mm/yr since the 60s. Consequently, the coastline of the archipelago is currently at risk of submersion (70%) and erosion (65%). It is imperative to understand past and present RSL changes in the Magdalen Islands region, and throughout the Maritimes, in order to generate accurate projections and develop appropriate adaptation strategies against these hazards. Here, we present preliminary sedimentological and radiocarbon dating results from different outcrops of the archipelago in order to reconstruct 1) Wisconsinan glaciation patterns in the Magdalen Islands region in order to better understand the sea level changes related to this glacial period, and 2) RSL variations and the environmental changes in the Magdalen Islands since the last glaciation.
Our initial results revealed that the southern part of the Magdalen Islands was affected by a marine transgression during the MIS3 in a boreal environment and under periglacial conditions. During the MIS2, the archipelago was glaciated by an ice flow from the Escuminac ice cap, whose centre of dispersion was located in the Gulf of St. Lawrence. The glaciation of the MIS2 was followed by a new marine transgression reaching at least ~ 20 m above sea level, and then by a second periglacial phase. Finally, preliminary sediment core data from the southern islands will be presented and will allow a more precise paleogeographical and chronostratigraphic framework, especially for the last deglaciation.

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The use of geomorphology in the paleolimnological studies

SAPELKO T., LUDIKOVA A., KUZNETSOV D., NAUMENKO M.
Institute of Limnology of Russian Academy of Sciences, ST.PETERSBURG, RUSSIAN FEDERATION

In recent decades, the number of studies of sedimentary archives from coastal lakes located at different elevations to reconstruct relative sea-level changes has been progressively increasing. In our studies, coring “staircases” of small lakes has been preformed to reconstruct the lake-level changes of Lake Ladoga (the largest lake in the European Russia) and Lake Kanozero (southern Kola Peninsula, NW Russia). Four small lakes at different elevations in Putsaari Island, northern Lake Ladoga, and three small lakes in Kanozero area, have been investigated to trace major lake-level fluctuations in post-glacial time. Changing relief configuration resulted from the isostatic rebound and related reorganization of drainage system has been found most influencing on the large basins configurations and level changes. An attempt to evaluate the dynamics of small lakes paludification processes following the isolation from the large lake was also made. It has been concluded that lake’s elevation and surrounding topography largely predetermined the post-isolation history of all study lakes.

Chronological framework for late-Pleistocene to Holocene landscape evolution in the Upper Rhine rift valley near Heidelberg/SW-Germany as based on optically stimulated luminescence (OSL) dating

KADEREIT A.(1), MÜLLER C.(1), HOLZHAUER I.(2), MEISENBERG O.(3)
(1) Heidelberger Lumineszenzlabor, Geographisches Institut, Universitat Heidelberg, HEIDELBERG, GERMANY ; (2) Heidelberger Lumineszenzlabor, Geographisches Institut, Universit?t Heidelberg, HEIDELBERG, GERMANY ; (3) Helmholtz Zentrum München, Deutsches Forschungszentrum für Gesundheit und Umwelt (GmbH), NEUHERBERG, GERMANY

The late Pleistocene to Holocene transition was a time of major changes in the geomorphological evolution of landscapes. In the Upper Rhine rift valley in SW-Germany, fluvial and aeolian pedo-sedimentary archives recorded and stored the landscape history from Upper Weichselian to Holocene times. Periglacial-fluvial systems with predominantly braided accumulating rivers in Pleniglacial times changed to late-Weichselian mainly single-channel incising rivers and to Holocene mainly meandering rivers that were fixed within their own overbank deposits. Additionally, the transitional period was favorite for the preservation of aeolian deposits on the flood-free level of the lower terrace of the river Rhine emerging in a landscape under still periglacial conditions and a sparse cover of vegetation. Contemporaneously, more intensive tectonic subsidence in the eastern part of the rift valley hampered direct connection of the tributaries from the Black Forest mountains and Kraichgau hills to the gaining river Rhine. Therefore, a secondary south-north draining Kinzig-Murg channel system evolved which connected to the river Rhine likely stepwise in Holocene times. Earlier investigations to reconstruct the landscape history and to establish a temporal framework were mainly based on pedostratigraphical and palynological analyses as well as ^{14}C-dating of organic remains mainly from peat bogs of the Kinzig-Murg channel system. Only few ages based on thermally stimulated luminescence (TL) datings ofdune sands exist so far. Here we investigate the potential of optical stimulated luminescence (OSL) dating to reconstruct the history of the fluvial and aeolian landscape. We report on the methodical challenges and the adopted single-aliquot regeneration (SAR) dating protocol(s) as well as on the dating results. These will be interpreted in view of recent pedo-stratigraphical findings in the study area as well as results from investigations in the Hessian part of the Upper Rhine valley.

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Fluvial quaternary sedimentation in high valley of Macaé River, state of Rio de Janeiro, Brazil

MARCAL M., RAMOS R., HINGEL R., FEVRIER P.
Universidade Federal do Rio de Janeiro - UFRJ, RIO DE JANEIRO, BRAZIL

The study of the forms and materials in quaternary drainage basin provides important elements for paleoenvironmental reconstruction. Along the channel occur different feature that represent the history of the basin and considers them as a process-response system. It is assumed that those features can be an evidence of the relations of different parts that compose the systems, its processes, duration and intensity.

Thispaper aims to show the spatial distribution and morphostratigraphic characterization offluvial terraces deposits through graphic logs in the high valley of Macaé river and it contributes. The Macaé river is located on the northern coast of Rio de Janeiro State, Brazil, and has its springs in *Sierra Macaé de Cima* mountain range, the peak is 1,560 meters high, in Nova Friburgo Municipality. The river flows east to south-east and is 136 kilometers long and discharges into the Atlantic Ocean.

The fluvial terracesmapping was done through the interpretation of aerial photographs orthorectified in the scale of 1:10,000 and satellite imagery from Google Earth software and field works. Graphic logs were constructed in the scale 1:20 and schematic sketch along the scenic outcrops were analyzed. The lithofaciological characterization was based on Miall (2006).

The fluvial terrace consists in a feature typically flat and high in relation to the contemporary channel or fluvial plain, usually separated by plain for a recent steep slope. It was recognized three morphostratigraphic units (1)“Reafeiçoado” Terrace topographically higher, this is about 10-15 meters from the current trough, (2)Accumulation Terrace, flat features related to ancient flood plain and this is about 3-7 meters from the current trough, and (3)Flood Plain, aligned with the main channel being 1-3 meters above the current river channel. The sedimentary record of these deposits contains essential information to the geomorphological-stratigraphic interpretation of fluvial dynamics.

Evolutionary analysis of a slope at the right margin of Mogi Guaçu river in Conchal ' SP

NASCIMENTO D., PEREZ FILHO A.
UNICAMP, CAMPINAS, BRAZIL

The present work is an evolutionary analysis of a slope at the right margin of Mogi Guaçu river in Conchal – SP, emphasizing the spatial organization of vegetation and its relation to the distribution of soil classes along the slope. Based on the systemic approach, the importance of climate oscillations from the late Pleistocene is emphasized in relief modeled and consequently in the spatial distribution of vegetation cover.

The evidences of morphoclimatic cycles corresponding to glacial and interglacial phases materialized in the landscape according to Bigarella & Mousinho (1965) not only respond by changing the vegetation cover, but also by changing the various processes active in relief sculpture.

Absolute dating by Optically Stimulated Luminescence method (OSL) of superficial formations will allow evaluating the temporal relationships between vegetation and the respective slope segments. The method has proved to be very effective in the dating of events during the Quaternary, with time span of 100 years before present up to 1 million years, and as Corrêa (2002) highlights the advantage of OSL dating is the exploration of a physical property of crystalline solids, unlike the C14 dating, which gives greater reliability of the results obtained.

Samples were collected at a depth of 80 cm to 100 cm in different units of the slope with varied vegetation and soil types. The datings of parent material of the soils have pointed to 9500 ± 1130 years to the top of the slope, 3,650 ± 330 years in colluvium, 1900 ± 225 and 1150 ± 160 for terraces TI and TII terraces respectively (STORANI, 2010), therefore allowing to infer ages for vegetation established in the different units of the slope and soil types.

Based on the identification of slope units associated with the types of soil and through the OSL dating is possible to verify that *cerrado* vegetation located at the top of the slope, aged approximately 12,000 years, corresponds to the Upper Pleistocene.

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The Monte Netto (Northern Italy) loess-paleosol sequence: implication for the Upper Pleistocene geomorphologic and palaeoenvironmental evolution of the central Po Plain

ZERBONI A.(1), TROMBINO L.(1), LIVIO F.(2), BERLUSCONI A.(2), MICHETTI A.M.(2), SPÖTL C.(3), RODNIGHT H.(3)
(1) Dipartimento di Scienze della Terra "A. Desio", Università degli Studi di Milano, MILANO, ITALY ; (2) Dipartimento di Scienze Chimiche e Ambientali, Università dell'Insubria, COMO, ITALY ; (3) Institut für Geologie und Paläontologie, Universität Innsbruck, INNSBRUCK, AUSTRIA

The isolated topographic hills located in the central Po Plain (Northern Italy) represent the top of Quaternary growing anticlines; the pedosedimentary sequences at Castenedolo and Ciliverghe are key archives for the palaeoenvironment of the area. A new loess-paleosol sequence, resting upon fluvio-glacial deposits, is exposed in a clay pit on the top of the Monte Netto, a large flat hill consisting of Late Quaternary deposits. At the top of the hill two secondary anticlines, tens of metres in size and deforming the strata were recognized. The lower part of the sequence (fluvioglacial gravel to silt, weathered at its top) is overlain by a complex cover of loess, consisting at least of three distinct layers intercalated with pedogenic horizons, showing different degrees of weathering. The most weathered horizon is located on the top of the anticlines representing the core of the hill; it testify a strongly rubified paleosol, developed on loess after a long cycle of pedogenesis. This is overlain by several thin paleosols developed on loess and showing a decreasing degree of weathering towards the top of the sequences. OSL and ^{14}C-AMS dates indicate an Upper Pleistocene to Holocene age of the upper part of the sequence, while geoarchaeological evidence suggests a possible Mid-Pleistocene age for the deepest paleosol. The upper pedosediments are disturbed by a gravity graben, due to co-seismic bending-moment faults, and are characterised by several sub-vertical parallel fissures, regarded as secondary brittle deformation successively affected by illuvial clay infilling. Deformation features are evidence of repeated Upper Pleistocene to Holocene earthquake surface faulting, consistent with the moderate seismic activity of the area. The sedimentation and weathering of the following loess-paleosol horizons was promoted by the continuous evolution of the gravity graben, underscoring a strong tectonic control on the stratigraphic and morphological development of the hill.

Analysis of long term anemometric data relating to coastal stations of Calabria

CALISE G.(1), BELLOTTI P.(1), DAVOLI L.(1), PELINO V.(2)
(1) Department of Earth Science - Sapienza University of Rome, ROMA, ITALY ; (2) C.N.M.C.A. Italian Air Force, ROMA, ITALY

The aim of this work is the analysis of anemometric data recorded by weather stations along the Calabrian coast for a period ranging from 1951 to 2010. The data were supplied by the Italian Air Force for a total amount of 536,006 data recorded. Four stations, near the coastline, were selected because have worked longer; three stations located along the Tyrrhenian side (Capo Palinuro, in the southern Campania region, Bonifati and Lamezia Terme in Calabria) and one on the Ionian coast (Crotone in Calabrian region).

The data were organized in decades, as well as in seasonal and annual groups. Subsequently, through the use of the programming language Matlab, they were plotted as frequency histograms of classes Beaufort and circular diagrams for the direction, intensity (in knots) and frequency of the wind. The use the Beaufort scale provides simple use of these data for an application to the study of wave climate.

The final analysis showed a significant increase in wind frequency in the last two decades. For the Tyrrhenian coast this increase started in 1987 and was recorded by all the three Tyrrhenian stations. For the Ionian side the increase of the wind frequency started in 1995. In both areas the situation is not further changed. The annual plots have shown also some exceptional years for the direction, intensity and frequency of the wind, different for the various stations.

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Timing of deglaciation on the Southern Swiss Alps

SCAPOZZA C.(1), AMBROSI C.(1), CASTELLETTI C.(1), SOMA L.(1), DALL'AGNOLO S.(2)
(1) Institute of Earth Sciences, University of Applied Sciences and Arts of Southern Switzerland (SUPSI), CANOBBIO, SWITZERLAND ; (2) Swiss Geological Survey, Federal Office of Topography swisstopo, WABERN, SWITZERLAND

The detailed Quaternary geological mapping of Southern Switzerland (Mendrisiotto and neighbouring regions in Italy) and the compilation of several radiocarbon dating data allow the reconstruction of the geometry and chronology of the Last Glacial Maximum (LGM) in the Southern Swiss Alps (Episodio Cantù). Moreover, they allow obtaining a detailed chronostratigraphy of the main recessional stadials during the Lateglacial and the beginning of the Holocene. The defined glacial stadials were correlated with the Greenland isotopic record of the borehole NGRIP.

For the LGM and the Pleniglacial, data are not exclusively from the Ticino glacier (Verbano lobe and a part of the Ceresio lobe), but also from the Adda glacier, which came from Valtellina (Lombardy, Italy) and occupied the Mendrisiotto by the Lario and Ceresio lobes. The analysis of calibrated maximal and minimal ages of the LGM allow proposing an age of the Episodio Cantù comprised between ca. 25'500 and 18'000 ^{14}C BP (≈ 30'200–21'250 cal BP). The Episodio Cantù was then correlated with the Greenland stadial GS-3, comprised between 27'400 and 22'700 cal BP.

For the Pleniglacial and the transition Pleniglacial/Lateglacial, the first recessional phases after the LGM were placed between ca. 22'500 and 21'000 cal BP, and correspond probably with the two first cold events of the Greenland stadial GS-2c. The first Lateglacial stadial was the Melide phase, and may match with one of the two cold events of 20'450 and 19'850 cal BP. Then, five glacial stadials were highlighted for the Oldest Dryas (Biasca, Faido, Airolo, Fontana and All'Acqua), two for the Younger Dryas (Maniò and Alpe di Cruina) and one (Val Corno) in correspondence with the Greenland Holocene event GH-11.2. Thanks to the correlation with the Greenland isotopic record, it was also possible to propose a relationship between the stadials defined in the Southern Swiss Alps and the "classical" glacial stadials defined in the Eastern Alps.

Quantitative geomorphological analysis of drumlins in four Ontario, Canada drumlin fields

JOHN M., EYLES C.
McMaster University, HAMILTON, CANADA

Drumlins are enigmatic subglacial landforms that have been interpreted to form by a number of processes including incremental accumulation of till, erosion of previously deposited sediment, catastrophic meltwater floods, and sediment deformation. However, relatively little is known about the controls on drumlin formation, such as spatially variable glacial processes or substrate characteristics, and how these controls may be identified from variations in drumlin morphology within a single drumlin field. This paper explores a computational method that allows identification of drumlins and extraction of their morphological characteristics from existing topographic digital data for four drumlin fields across southern Ontario, Canada all created from various ice advances. Spatial and non-spatial analysis of the form and distribution of drumlins across the study area identifies drumlin characteristics such as size, elongation ratio, symmetry and long axis orientation and shows that drumlins are not randomly distributed across the region and their form characteristics have distinct regional trends. Kernel density analysis is used to identify the regional trends in drumlin characteristics and illustrates a trend toward grouping of drumlins with similar morphological attributes within a single field. Factors that appear to influence the form and distribution of drumlins in the study area include sediment thickness, length of time beneath the ice, bedrock topography, ice velocity and direction of ice movement. Exploration of landform symmetry includes identification of a distribution of particularly well- developed asymmetric and elongate drumlins coincides with the location of a broad bedrock low and is interpreted to identify the former location of a fast-flowing ice stream.

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Phytolith and isotopic studies applied to geomorphologic analysis in the Southern Espinhaço Mountain Range, Brazil

COE H.
UERJ, SAO GONÇALO, BRAZIL

Phytoliths are particles of silica formed as a result of absorption of silicic acid in the soil solution by plant roots and then precipitate in plant cells. They enable paleoenvironmental reconstruction, indicating climate change and its effects on vegetation, offering clues about factors that may influence geomorphologic processes. Phytoliths analysis complemented by carbon isotopes in samples of two sandysoil profiles located in a slightly inclined slope inthe Southern Espinhaço Mountain Range, Minas Gerais, Brazil, allowed to identify variations in environments where geomorphic processes occurred. In both profiles, phytoliths are very weathered. This makes identification of the types and calculation of phytolith indexes difficult, but highlights the intensity of erosion in the area. The results also show the dominance of big phytoliths, because they are more resistant to erosion, and low proportions of short cells phytoliths, more fragile ones. Organic carbon stocks are higher in P2 than in P1, due to the presence of an organic horizon, formed because of better conditions of accumulation and decomposition of organic matter. It does not occur in P1, where the runoff until nowadays is more effective due to the proximity of the outcrop and to the low presence of lower strata of vegetation cover. These factors accounts as well for the larger diameter of the gravels in P1, giving evidences of a more effective action of mechanical weathering near the outcrop. The stock of phytoliths of P1 follows a normal trend of decrease with depth, while P2 presents a very large increase in the organic horizon. In these profiles, the lithologic basement formed by quartzite rocks is the same, but the processes of accumulation seems to have occurred in different ways, alternating drier and more humid conditions than that of nowadays. Furthermore, the high degree of alteration of phytoliths seems to indicate high intensity of physical erosion and also gechemical loss in this area.

Glacial flows and deglaciation stages during the Late Wisconsinan in the Gaspé area, Québec (Canada)

HOUDE-POIRIER M., HÉTU B., BERNATCHEZ P.
Département de biologie, chimie et géographie, Centre d'Études Nordiques et Research Chair in Coastal Geoscience, Université du Québec à Rimouski, RIMOUSKI (QUÉBEC), CANADA

The Late Wisconsinan glaciation model in the Gulf of St. Lawrence involves the coexistence of Laurentide Ice sheet and regional ice centers in Maritime Canada. Gaspé area, at the extreme east of Gaspé Peninsula, was at the confluence of three of these ice masses: 1) the Gaspé ice cap, centered on McGerrigle Mountains, extending east to the Gaspé Bay; 2) the Laurentide Ice Sheet, deviated into the Laurentian Channel, passing through the north of the Gaspé peninsula; and 3) the Escuminac ice cap, located in the Gulf of St. Lawrence, north of Prince Edward Island. Ice flow indicators, geochemical analysis, petrographic and stratigraphic data collected in the Gaspé area were used to specify boundaries and ice flows chronology of these three ice masses. Combined to new AMS dates, the analyses attest their coalescence at the east of Gaspé Peninsula before 15.5 to 14.8 kyr cal. BP, when deglaciation started in the area.Glacier retreat occurred until 13.9 to 13.7 kyr cal. BP, and was followed by a marine transgression which reached its maximum elevation at 32 m. This high stand was followed by a rapid land emergence and seismic data indicate a low stand at 30 m below present sea-level, followed by a long period of submergence.

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Palaeoflood history recorded by the slackwater deposits of the Dong River, Korea

KIM S., TANAKA Y.
Kyung Hee Univ., SEOUL, SOUTH KOREA

Slackwater deposits are the flood sediments of river and the palaeostage indicator. These deposits have been used in many studies to estimate the magnitude and frequency of discrete flood events. Study area is located along the Dong-river in Gangwon province, the east of Seoul. Caves are formed along the both the Dong-river banks. Sites 1 and 2 are small cave that were located the cut bank of river. Site 3 is located in the margin of slip-off slope, and site 4 is located in the tributary mouth. Based on faces and colors, the sample of slackwater deposits in each site was classified. Grain-size of each special layer in sites was analyzed by using grain-analyzer. These results of slackwater deposits suggest that grain size (median, ø) of each layer changes according to flood events. For instance, the coarser layers indicate the occurrence of large magnitude flood events. The slackwater depsoits in this area are generally covered with sand layer associating with great flood event occurred by Typhoon Lusa of 2002. The age of slackwater deposits under Lusa deposits may be estimated more exactly based on relative age methods through the trash and the data of river water level and absolute age methods through the radioisotope ^{137}Cs and ^{14}C. Flood slackwater sediments indicate peak stage from which the discharge of a flood can be calculated using hydraulic reconstruction methods and the Manning equation. It is able to estimate the frequency and magnitude of palaeoflood using these results such as grain-size analysis, stratigraphical description and several dating methods.

Slackwater deposits indicating paleoflood of Kherlen river, Mongolia

TANAKA Y.(1), KIM S.H.(1), KASHIMA K.(2)
(1) Kyung Hee University, SEOUL, SOUTH KOREA ; (2) Kyushu University, FUKUOKA, JAPAN

Kherlen river flows through earstern Mongolia and enters into Hulun lake and upstream of Amur (Heilongjiang) river. Sampling site 1 is located at tributary mouth along the Kherlen river. Backflooding sediment with its depth of more than 2 m occurred at sampling site 1. Sapmling sites 2 and 3 are located in the margin of slip-off slopes along the Kherlen river. Based on charactreistics of sediment such as faces and colors, the sample of slackwater deposits in each site was classified. Grain-size of each special layer in the sites was analyzed by using grain size analyzer. The ^{14}C age of 175 cm depth layer was 1580±20yrBP. Coarser layers indicate the occurrence of large magnitude flood events, thus, grain size (median, Ø) of each layer changes largely associating with flood events. Based on the result of grain size analysis for site 1 sample, at least 6 times large changes occurred since 1580±20yrBP. This means that large magnitude floods occurred with the intervals of about 250 yr.

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Interaction between geochemical processes texture and PH in the podzolization of arenosols in the Espinhaço Moutain Range - Brazil

ROCHA L.(1), AUGUSTIN C.(2), FIGUEIREDO M.(3)
(1) Universidade Federal de Minas Gerais, SÃO JOÃO DEL-REI, BRAZIL ; (2) UNIVERSIDADE FEDERAL DE MINAS GERAIS, BELO HORIZONTE, BRAZIL ; (3) UNIVERSIDADE FEDERAL DE SÃO JOÃO del REI, SÃO JOÃO DEL REI, BRAZIL

This study aims to understand how geochemical processes, texture and pH influence the podzolization of sandy soils in Southern Espinhaço Range (SdEM) in the state of Minas Gerais, Brazil. This rocky mountain massif is characterized by the dominance of quartzite outcrops, with varying degrees of quartz composition. These outcrops are intercalated by relatively flat depressions whose size ranges from tens of meters to kilometers forming a quite distinct geomorphologic unit. These surfaces are covered by sandy material with depths ranging from 0.5 to 1.0m almost always articulated to a very shallow superficial flow of water. We sampled three soil and rock profiles that were submitted to physical and chemical analyses. Results indicate the occurrence of soils formed of material resulting from prolonged weathering processes with silica contents ranging from 92 to 96, aluminum from 2.6 to 5.11 and iron from 0.2 to 2.9 ppm. However, soils are apparently young, poor in clay, shallow, but presenting differentiation of horizons and accumulation of organic matter in the lower horizons suggesting podzolization. Results also indicate that the soil sandy texture that results from the original rocks which is low in clay content (psammitic rocks) promotes translocation of chemical elements and organic matter. This factor, coupled with the occurrence of a permanent humid environment due to the existence of small and slow concentrated and disperse flows, favors the action of the translocation process promoting the formation of spodosols and a generalized loss of much of all chemical elements measured including the most stable. The mass balance analysis indicates a loss of 20 to 57% of silica, 33 to 41% of aluminum and 7 to 17% of iron. These data suggest that the materials which form the depressions in the domain of the outcrops of quartzite rocks of Espinhaço Supergroup in the Southern Espinhaço Mountain Range have undergone a significant depletion of geochemical elements.

Exogenous processes and soil formation during MIS 2 and MIS 3 on geoarchaeological sites in the Angara region and Cisbaikalia

KOBYLKIN D., RYZHOV Y.V.
Institute of geography of the SB RAS, IRKUTSK, RUSSIAN FEDERATION

Exogenous processes and soil formation during MIS 2 and MIS 3 on geoarchaeological sites in the Angara region and Cisbaikalia

MIS 3 encompasses the time period from 24 to 57−58 kya and is characterized by interstadial warmings and stadial coolings. An early warming period of MIS 3 showed a stage of incision in river valleys and erosional forms. Subsequently, there was taking place largely the peneplanation of topographic features caused by the removal of deposits from divides and down the slopes to river valleys. Significant climatic fluctuations during that time interval are embodied in spores-pollen spectra of deposits, and in buried soil horizons.

The buried soils on geoarchaeological sites in the Angara region and Cisbaikalia were forming during the time intervals 24−30 ^{14}C, 33−37 ^{14}C and 44-46 ^{14}C kya. The activity of the slope processes during those time spans decreased by a factor of 2 to 5. The interstadials were exemplified by a decrease of the rates of exogenous processes, and the catchments developed interlayers and horizons of buried soils. The stadials were accompanied by an intensification of erosion-accumulation and cryogenic processes.

Over the course of MIS 2 (11.7−24 ^{14}C kya), defluxion processes dominated the cryohumid phase, while aeolian-deluvian and aeolian processes were dominant in cryoarid phase. During MIS 2, The soils that had formed in MIS 3 experienced active cryogenic deformations (cryoturbations). Loess-like carbonaceous loamy sands and loams were forming. Negative landforms were actively filled with eroded material. The end of MIS 2 (11−14 ^{14}C kya) showed a stage of incision in river valleys and erosional forms to a depth of 1−10 m, and an intensification of the soil formation process.

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Information decoded from the Late Holocene sedimentary records in the Outer Western Carpathians, Czech Republic

SMOLKOVA V., PANEK T., HRADECKY J.
Department of Physical Geography and Geoecology, Faculty of Science, University of Ostrava, OSTRAVA, CZECH REPUBLIC

Due to the lack of other suitable data in the mid-mountain region of the Outer Western Carpathians, the landslide-related deposits (landslide-dammed palaeolakes, intercolluvial and near-scarp peat bogs) are the key sources of the Late Holocene landscape development. Using standard sedimentological analyses combined with absolute dating, we studied tens of sedimentary cores and outcrops in the study area. The most important information we got about the Late Holocene environment is the evidence about local onset and character of human activity in the study area. We dated minerogenic peat bog deposits revealing accelerated sedimentation, starting in c. the 16–17th centuries and connected with the one of the latest European colonization of nearly pristine mountainous landscape. The Wallachian colonization of the Western Carpathians centuries caused major change of the ecology of mountain ridges and subsequent increased erosion of deforested and grazed slopes. Next important information, which we were able to trace by the sediments from the landslide-dammed reservoirs, is the frequent recurrence of the slope movement activity. Absolute dating of the events correlates with regional phases of increased climate humidity. Taking into account the mapped morphological evidence and recent catastrophic failures with preceding Holocene activity we assume, that majority of slope deformations in the study area are of a recurrent character. As on an average 10 % of the study area was previously believed to be fossil slope deformations, today we can consider them as potentially active, which is important for evaluation of landslide hazards in the study area.

Late pleistocene and holocene morphostratigraphic and allostratigraphic records in southeastern Brazil

MELLO C., PEIXOTO M.N.O., MOURA J.R.S.
UNIVERSIDADE FEDERAL DO RIO DE JANEIRO, RIO DE JANEIRO, BRAZIL

Geomorphologic and stratigraphic studies of Quaternary colluvial and alluvial deposits have been developed during last 30 years in the Southeastern Brazilian hilly domains. Based on identification of depositional surfaces and main stratigraphic discontinuities, these studies allowed the distinction of late Pleistocene and Holocene record in morphostratigraphic and allostratigraphic units. Radiocarbon and luminescence dates are avaiable for a chronostratigraphic order. Three main morphostratigraphic/allostratigraphic intervals were recognized, dated on late Pleistocene, early to middle Holocene, and modern times. Late Pleistocene colluvial and alluvial deposits are associated with discontinuos fluvial terrace that seems smooth low hills. These deposits are younger than 100,000 years BP and their upper limit is marked by a paleohorizon A dated on approximately 10,000 years BP. Pedostratigraphic and palinologic analysis suggest a sparse forest cover at the Pleistocene-Holocene boundary, under humid climatic conditions. A remarkable erosive episode occurred in early to middle Holocene and was responsible for a great sediment production and widespread valley filling up. This event suggests high intensity and concentrated rainfall over a landscape with sparse vegetation cover. Several geomorphologic and structural data document a very important influence of neotectonic mechanisms at this time. The early to middle Holocene record is associated with well preserved fluvial terraces. Modern colluvial and alluvial deposits are respectively associated with lower hillslope domain and lower fluvial terrace/floodplain. Modern colluvial deposits are dated on 150 years BP and related to human occupation of the studied area. The younger episode of fluvial sedimentation have started around 1,000 years BP and was intensified around 250 years BP. Thus, modern colluvial deposits and the upper interval of modern alluvial deposits document human inflluence on regional geomophic record.

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Sea urchin burrows in Rocky Shores as indicator of Holocene Sea-Levels at the Northern Coast of the State of São Paulo, Brazil

VILANO W.F.(1), SOUZA C.R.G.(2), CANTARELI C.V.C.(3), SILVA W.W.D.B.(4)
(1) Universidade de São Paulo-USP, SÃO PAULO, BRAZIL ; (2) Instituto Geológico-SMA, SÃO PAULO, BRAZIL ; (3) Instituto CAÁ-OBY, SANTOS, BRAZIL ; (4) Universidade Santa Cecilia, SANTOS, BRAZIL

Worldwide rocky shores are considered important testimonies of the Quaternary changes in sea level. The Holocene sea-level curve for the State of São Paulo indicates that: it was close to the current *ca*. 7000 yr BP; the maximum of the Holocene transgression occurred around 5100 yr BP (5600 cal yr BP) and reached *ca.* 4±0.5m; after that there is a recent debate on whether sea-level fell to the current position steadily, or whether there were oscillations and negative levels. For the Ubatuba County (Northern Littoral of the State of São Paulo, Brazil) some authors suggested a steady sea-level falling towards the current position after 3800 yr BP (few dated samples), but others pointed a negative sea-level after 2000 cal yr BP. This paper presents a study carried out on rocky shores at Ubatuba County, where three bands within palaeo-burrows of sea urchins, located above their present living level, seem to indicate three distinct steady phases of positive sea-level stabilization, probably intercalated by negative sea-level periods. Bands have around 1.10-1.20 m in width, and are separated by narrow (0.20-0.25 m in width) strips free from burrows; burrows diameter varies from 6 cm up to 16 cm (strongly weathered). It has been verified that the higher limit of the living sea urchins (*Equinometra lucunter*) coincides to the current ordinary spring low-tide level (OSL= -0,10-0,00 m), being the present mean sea-level around +0.66 m (Ubatuba's tide gauge). Based on these data we concluded that: the higher limit of the superior and older band positioned *ca.* 3.82 m above the OSL would indicate a maximum Holocene paleo-sea-level around 4.48-4.58 m above the present level; the 2.70 m above OSL for the intermediate band top would mean a positive paleo-sea-level around 3.36-3.46 m; and the inferior and younger band top at 1.40 m above OSL would suggest a sea-level *ca.* 2.06-2.16 m above the present.

Fluctuations of Lake Lisan level during Marine Isotope Stage 2: implications for palaeoclimatic changes of the Jordan Valley

ABU GHAZLEH S.(1), KEMPE S.(2)

(1) University, Department of Geography and Urban Planning United Arab Emirates, ABU DHABI, UNITED ARAB EMIRATES ; (2) University of Darmstadt, DARMSTADT, GERMANY

Lake Lisan was one of several lakes that occupied the Jordan Valley during the Last Glacial (70-14 ka BP*). It extended for ~ 300 km from Lake Tiberias in the north to > 60 km south of the current Dead Sea (DS). On the eastern coast of the DS rift, high-level terraces of Lake Lisan were identified and surveyed for the first time using DGPS. U/Th dating and geochemical analysis of the terrace stromatolites allowed resolving the lake level curve at a high resolution during MIS 2 (32-19 ka BP).

Terrace levels range between -130 m and -160 m, implying that the highest stand of Lake Lisan was at least 50 m higher than the previously reported. Comparison of several terrace profiles and correlation of their altitudes show no evidences of tectonic subsidence, demonstrating that the lake level drop was entirely climatic.

U/Th dating of stromatolites shows that Lake Lisan receded from its initial high level of -137 m at 31.99 ± 0.21 ka BP to -148 m at 30.55 ± 0.22 ka BP, consistent with the Heinrich event 3 and Dansgaard Oeschger Stadial 5, the coldest period in the North Greenland Ice Core record (NGRIP). Then, the lake dropped to -152 m at 27.38 ± 0.16 ka BP. The Lake continued to drop to -154 m at 23 ka BP and to -200 m at 22 ka BP, corresponding with Heinrich event 2 and the cold stadial 2C, the final phase of the Last Glacial Maximum (LGM).

By the End of the LGM (~19 ka BP), Lake Lisan recovered again to a high level of -160 m followed by a regression to -200 m during Younger Dryas at ~ 11 ka BP.

Superimposing our dates on the NGRIP curve shows that several drops of Lake Lisan occurred during the cold stadials and Heinrich events 3 and 2. This suggests cold and dry climatic conditions of the Jordan Valley during the N-Hemispheric cold periods.

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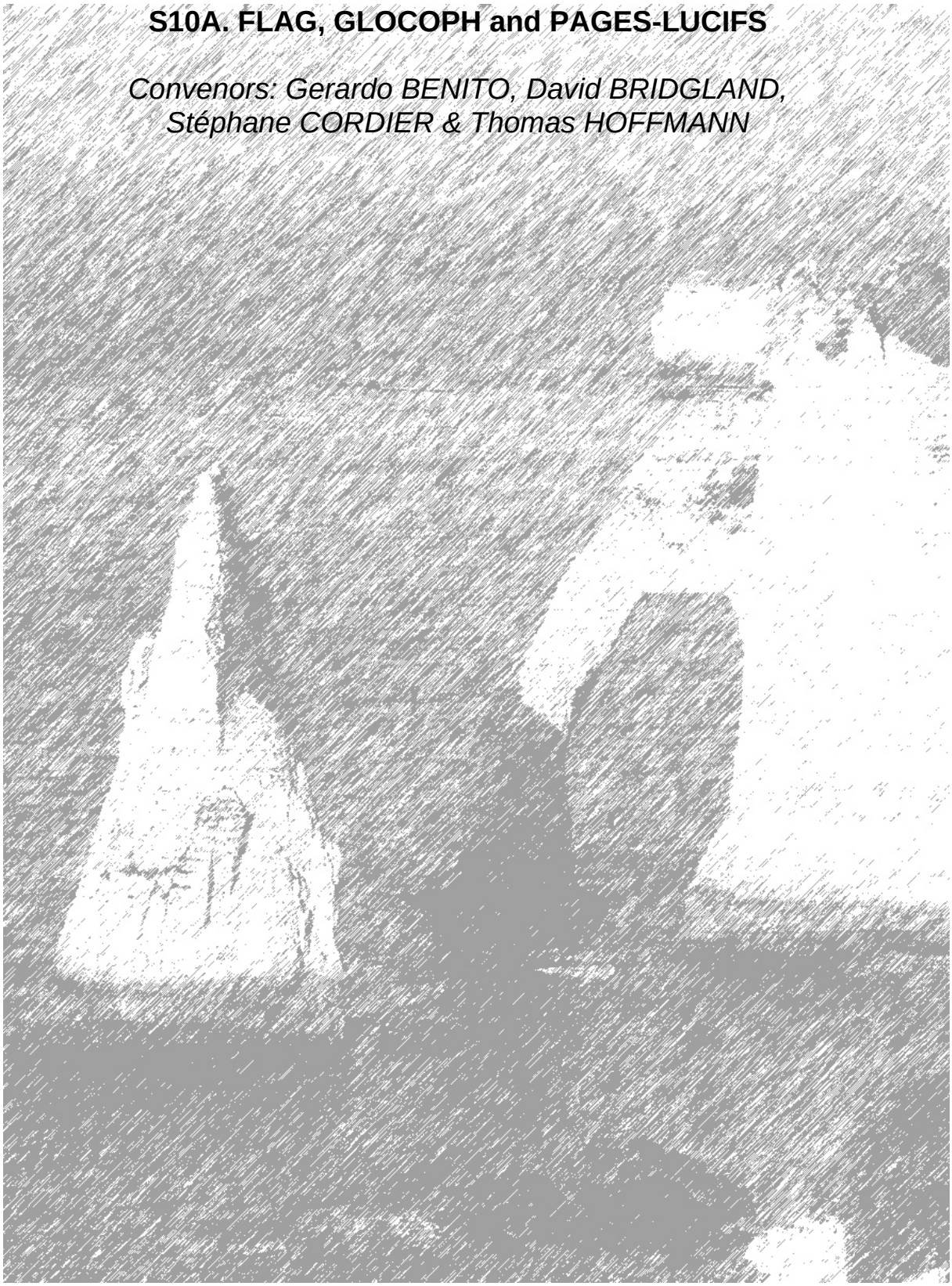
S10A. FLAG, GLOCOPH and PAGES-LUCIFS

Convenors: Gerardo BENITO, David BRIDGLAND, Stéphane CORDIER & Thomas HOFFMANN



Oral presentations:

Plioquaternary morphosedimentary evolution of the Allier valley (Massif Central, France). New contribution of K-Ar and 40Ar/39Ar datings

PASTRE J.F.(1), GUILLOU H.(2), NOMADE S.(2), DEGEAI J.P.(1)
(1) UMR 8591 LGP CNRS, MEUDON, FRANCE ; (2) LSCE, CEA, GIF-SUR-YVETTE, FRANCE

The Allier valley offers one of the longest fluvial record in Europe. From ca. 4 to 0.01 Ma numerous alluvial deposits follow the morphosedimentary evolution. Surrounding volcanism provides an unique chronological framework. New K-Ar datings on Devès basalts allow to precise the stage of evolution of the upper Allier valley during early and middle Pleistocene. New $^{40}Ar/^{39}Ar$ datings on the tephras of the Mont-Dore/Sancy strato-volcano upgrade the tephrochronological framework.

The three main areas followed by the Allier show very different morphosedimentary records.

- The upper Allier, incised in basement, was strongly affected by the basaltic volcanism of the Devès. At the end of the Pliocene, before the first lava flows ca. 3 Ma, its middle part was incised at a level close to the present one. The new K-Ar datings confirm the existence of two major volcanic episodes centered around 2 and 0.8 Ma. The slow evolution of the valley during all the Pleistocene can be attributed to interactions between volcanism, subsidence and cold climatic phases.
- The middle Allier valley in the Oligocene Limagne graben presents a long stepped record covering 200 m of incision since 4 Ma. The key-sequence of Perrier shows several alluvial stages dated by $^{40}Ar/^{39}Ar$ on Mont-Dore pumices between 3.09 ± 0.01 and 2.58 ± 0.01 Ma.

During lower Pleistocene incision predominates and only few terraces are observed. The climatic terraces system of the Grande Limagne begins after 1 Ma and shows several correlations with the Sancy tephras until 0.3 Ma. This evolution is mainly driven by an uplift of the area.

- The lower Allier valley evolution in the Bourbonnais is strongly different. A long multiphased aggradation takes place during the Pliocene – early lower Pleistocene. Four main phases can be recognized by their mineralogical content. The Pleistocene is mainly marked by a slow incision in regard with the low subsidence and/or stability of the area.

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Links between geomorphology and Quaternary geology: evidence from fluvial archives

BRIDGLAND D.
Durham University, DURHAM, UNITED KINGDOM

It should come as no surprise that there are clear linkages between geomorphology and Quaternary fluvial archives. The lynch pin for such linkage is the river terrace ‘staircase’, which, provided some form of age constraints are available, can allow progressive of valley incision to be dated, thereby enhancing understanding of landscape evolution. By these means erosional geomorphological features can also be constrained chronologically. Contrasting case-study examples will be presented, showing particularly important differences from inside and outside of Last Glacial ice limits.

Incision/aggradation events in river valleys of the Central Russian Plain in the Valdaian (Weichselian) ' Holocene climatic cycle

PANIN A.(1), ADAMIEC G.(2), BUYLAERT J.P.(3), MATLAKHOVA E.(1), MURRAY A.(3)
(1) Geography Faculty, Moscow State University, MOSCOW, RUSSIAN FEDERATION ; (2) Silesian University of Technology, Institute of Physics, GLIWICE, POLAND ; (3) The Nordic Laboratory for Luminescence Dating, Aarhus University, ROSKILDE, DENMARK

Series of >70 radiocarbon and OSL dates on terrace and floodplain sediments of the Seim and Khoper Rivers supplemented with archaeological data on Late Paleolithic settlements located within the range of recent floods were used to establish chronology and magnitude of river downcutting and aggradation stages:

(1) >77 – <50 ka: river aggradation, accumulation of 12-16-m Terrace 1 (T1) alluvium.

(2) <50 – >27 ka BP: river incision by >10 m, formation of alluvial basement of so called intermediate, or “zero” 5-7-m terrace (T0). Incision was most probably caused by considerable increase of water discharges, which is evident from widening of valley floor due to active channel migrations.

(3) >27 – ~17-18 ka BP: low runoff, river stability/aggradation, wide occurrence of aeolian sands interplaying with deluvial loams (climate aridity, scarce vegetation). Stationary human settlements existed on the T0 terrace, i.e. at low topographic positions which are subject to seasonal flooding now.

(4) ~17-18 – ~ 12-13 ka BP: river incision 5-7 m below the present-day channel, formation of large meanders with high wavelength. Seasonal inundation of the T0 terrace resumed, which broke terrace occupation by humans and provided overlaying of cultural layers by overbank alluvium.

(5) ~12-13 – ~10 ka BP: river aggradation to the preset-day levels as response to runoff decrease.

(6) >10 ka BP – present: relative stability (no incision, no aggradation).

Comparison with climate change shows that major erosion/sedimentation events occurred within the cold part of the last glacial/interglacial cycle, for which general correspondence of major temperature and runoff changes may be deduced: considerable runoff increase and corresponding river incision occurred within the relatively warm phases – late MIS 3, the Late Glacial time, while the coldest climatic phase (LGM) was characterized by lowest runoff and accretion of valley floor.

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Unraveling the Quaternary river incision in the Moselle and the Sarre valleys (Rhenish Massif, Germany): insights from cosmogenic nuclide dating (10Be/26Al) of fluvial terraces

CORDIER S.(1), RIXHON G.(2), HARMAND D.(3), BRÜCKNER H.(2), KELTERBAUM D.(2), DUNAI T.(4), BINNIE S.(4)
(1) Universit_ Paris Est Cr_teil, CRETEIL, FRANCE ; (2) Institute of Geography, University of Cologne, COLOGNE, GERMANY ; (3) Université de Lorraine, NANCY, FRANCE ; (4) Institute of Geology, University of Cologne, COLOGNE, GERMANY

During the last decade, the fluvial terraces of the Moselle River and its main tributary the Sarre have been largely investigated. The multi-proxy research made it possible to provide an initial reconstruction of the Middle and Upper Pleistocene valley evolution. In particular, eight “middle and lower” terraces have been recognized at less than 100 m relative height. These terraces were able to be correlated from the Vosges Massif to the Rhenish Massif on the basis of sedimentological evidences and, for the younger terraces, of OSL dating.

Located at higher elevations on the valley sides of the Rhenish Massif, the well-preserved “main terraces” are characterized by a constant absolute elevation in the 150 km-long reach between the Lower Sarre/Trier area and Cochem. While several hypotheses have been proposed to explain this horizontality (updoming, faulting...) all studies assumed an age of ca.800 ka for the younger main terrace, but without reliable chronological evidence.

Recent results obtained for the Meuse River and two of its main tributaries in the western Rhenish Massif demonstrated, on the basis of cosmogenic nuclide dating, that (i) the main terraces were younger than expected and (ii) their formation was diachronic. These results are consistent with the reconstruction proposed for the middle and lower terraces of the Moselle and the Sarre. Following on from this, cosmogenic nuclide dating was applied to the fluvial sediments of the Moselle and Sarre terraces, in order to provide a chronological framework for the main terrace complex and the older middle terraces. Two distinct sampling approaches were carried out: (i) a depth profile provided that the terrace (palaeo-)surface was well-preserved and (ii) an isochron technique where the sediments were thick enough.This presentation aims to expose the preliminary results and their significance to improve the knowledge of the Moselle and Sarre Pleistocene evolution.

Sediment storage and evacuation episodes during the Late Quaternary in the intermontane basin of Dehradun, NW India

SINHA S.(1), DENSMORE A.L.(2), SINHA R.(1)
(1) Indian Institute of Technology Kanpur, KANPUR, INDIA ; (2) University of Durham, DURHAM, UNITED KINGDOM

The intermontane basin in Dehradun region in NW India is bounded by the Ganga to the east and Yamuna to the west and is believed to have started to develop ~700 ka ago in response to the development of the Mohand anticline. The widespread trapping of sediments in the Dun has been mainly caused by growth and lateral propagation of the Himalayan frontal fault system and the Mohand anticline. This paper presents a GIS based approach for quantitative estimates of sediment volume accumulated and evacuated in the Dehradun intermontane basin during the deposition and incision phases respectively.Our study focuses on three major geomorphic surfaces namely, (1) proximal fan, (2) isolated hills (3) distal fan. The proximal fan has been interpreted as the oldest fan surface (41-30 ka) followed by isolated hills (23-14 ka) and distal fan surface (17-10 ka). The hypothetical surfaces representing the total volume accumulated in the area over a 50 ka time period were extracted using ASTER DEM with 30 m horizontal and 10 to 25 m vertical resolution. The total volume of sediments accumulated within the fan surfaces since ~50 ka works out to be 1.22-0.81x10^{11} m^3 and that eroded from the surfaces within the time span of 50 ka is estimated to be 6.4-4.7 X$10^9$$m^3$ and the average removal rate is computed to be 5.3-3.9 x 10^5 m^3/yr. Comparing this with the modern sediment load of the Yamuna River, this is equivalent to ~2-3 % of total annual sediment load of Yamuna River. A first orderestimate of the capacity of the Dehradun valley is 2.72 X$10^{11}$$m^3$and this suggests that the valley is only half-filled and can accommodate more sediments. We conclude that variations in storage or excavation on short time scales (50-100 ka to present) are mostly controlled by sediment supply from the catchments and climate-modulated changes and that the duns have acted as ‘filters’ for modulating the sediment supply into the plains.

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River system response to Pleistocene glaciation within a Mediterranean landsystem

ADAMSON K.(1), WOODWARD J.(2), HUGHES P.(2)
(1) Queen Mary, University of London, LONDON, UNITED KINGDOM ; (2) The University of Manchester, MANCHESTER, UNITED KINGDOM

The fluvial morphosedimentary records of Mount Orjen, western Montenegro have been used to investigate the response of Mediterranean river basins to Pleistocene glaciation. A range of meltwater pathways and depositional contexts at 12 sites have been analysed. These include terraced alluvial valley fills, poljes and alluvial fans, which are broadly representative of glaciated river basins across the Mediterranean. The nature and timing of fluvial activity has been determined using detailed sedimentological and stratigraphical analysis, 35 U-series dates, calcite micromorphology, and soil profile analysis. This study is one of the first attempts to directly correlate Pleistocene glacial and fluvial records within the context of a single landsystem.

The fluvial record is in good agreement with the Pleistocene glacial history of Mount Orjen. The most extensive phase of alluviation is correlated to MIS 12-8 (Kotorska-Sušica Member) when the large depocentres beyond the maximum ice margins became infilled. There is only limited evidence of fluvial activity during MIS 6 (Krivošije Member) despite extensive glaciation at this time. Fluvial morphosedimentary records from MIS 5d-2 have not yet been observed in the study area. Since MIS 12, meltwater and sediment supply to the fluvial system has declined in accord with the decreasing magnitude of glaciation. Subterranean karst flows have increasingly dominated over surface flows and the Pleistocene glacial and surface fluvial systems have become progressively decoupled. Importantly, neighbouring basins surrounding Mount Orjen often contain contrasting records of Pleistocene river dynamics and/or preservation of the fluvial archive. These findings have important implications for our understanding of Pleistocene river system dynamics within glaciated catchments in the Mediterranean and elsewhere.

Alluvial megafans along the Italian Southern Alps

MOZZI P.(1), FONTANA A.(2), MARCHETTI M.(3)
(1) Dipartimento di Geoscienze - Universit_ di Padova, PADOVA, ITALY ; (2) Dipartimento di Geoscienze - Università di Padova, PADOVA, ITALY ; (3) Dipartimento di Scienze della Terra - Università di Modena e Reggio Emilia, MODENA, ITALY

Large fan-shaped landforms represent most of the northern Po Plain (40,000 km^2) and its eastern continuation, the Venetian-Friulian Plain (10,000 km^2). Major Alpine rivers which feed this Alpine-Apennine foreland basin drain a total catchment of about 100,000 km^2 (70,000 km^2 Po R. tributaries, 25,600 km^2 Venetian-Friulian rivers).

The main depositional phase occurred during LGM (27-19 ka cal BP), when the glaciers hosted in the Alpine valleys reached the plain and fed the related glaciofluvial and fluvial systems. These latter experienced large and widespread aggradation as fan-shaped distributary systems, that have been described as alluvial megafans when their longitudinal axis is >30 km (i.e., Isonzo, Tagliamento, Piave, Brenta, Adige, Mincio, Chiese, Oglio, Adda, Olona river systems). These large landforms have an extent of 500-3000 km^2.

Pede-Alpine megafans are characterized by steep (1-0.4%) piedmont sectors consisting of amalgamated gravels down to 10-30 km from apex, while the distal sector is fine-dominated and channels are sandy braided. The thickness of LGM sediments in the plain is 30-10 m, thinning to <5 m on the Adriatic Sea shelf, where depositional bodies dating to LGM or previous low-stand units (i.e. MIS 3 and 4) still largely crop out.

Following ice decay at around 17 ka cal, an erosive phase occurred in the pede-Alpine sector during Lateglacial and early Holocene. This led to river downcutting for tens of meters. Alpine tributaries of the Po River still flow in entrenched valleys down to their junction. In the Venetian-Friulian sector, where distal tract of megafans are directly connected to the Adriatic Sea, incisions have depths of 15-30 m and widths up to 2 km. Post-LGM sedimentation in the valleys consisted of predominant gravels and sands down to the present coastal area. After 8.0 ka cal sea level rise triggered the formation of the coastal wedge, the infilling of incised valleys and the widespread aggradation in the interfluves.

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Fluvial responses to climate changes, eustatism, neotectonics and anthropogenic impacts during the last 50 000 years in the Northwestern Africa: Gharb plain, Oued Sebou watershed (Morocco)

CASTANET C.(1), DEGEAI J.P.(2), DESRUELLES S.(3), ROBERT V.(4)
(1) Université Paris 8, UMR CNRS 8591 Laboratoire de Géographie Physique, PARIS, FRANCE ; (2) UMR CNRS 5140 Archéologie des Sociétés Méditerranéennes, MONTPELLIER, FRANCE ; (3) Université de Picardie Jules Verne, UMR CNRS 8185 Espaces, Nature, Culture, AMIENS, FRANCE ; (4) UMR CNRS 8591 Laboratoire de Géographie Physique, PARIS, FRANCE

This research deals with fluvial responses to the external factors, allocyclic and autocyclic evolutions and lower alluvial plains construction. The potential of North Africa fluvial archives is strong but Holocene reconstitutions have to be refined and evolutions of the last glacial period are badly known. The study area is the Gharb Plain, which is alluvionated by Oued Sebou (basin: 40000 km²). The integrated approach appeals to the morpho-stratigraphy (10 thick series), sedimentology (granulometry, mag. susc., heavy minerals), geochemistry (elementary analysis, C, N, electric conductivity, IR analysis, S), geomatics (DGPS, DEM, spatial modeling, GIS, remote sensing), geochronology (40 AMS^{14}C datings), geomorphological cartography and archaeology. In the Gharb Plain, fluvial formations (Middle and Late Pleniglacial, Lateglacial, Holocene) are nested and vertically stacked. Their global architecture results from allocyclic evolutions of the fluvial system, due to i), the base level changes (erosive episode during the marine low-level of the Late Pleniglacial (OIS2), aggradation episode during the post-LGM sea level rise, Holocene transgression) ii), the climatic changes (sediment yield, Holocene organic facies and cyclic alluviation) and iii), the neotectonics (subsidence allows the storage of large formations). Autocyclic evolutions widely structured the internal architecture of formations, with fluvio-deltaïc and fluvio-estuarine processes. Palaeo -hydrographical, -hydrological and -environmental reconstructions reveal meandering fluvial patterns during the end of the Middle Pleniglacial (OIS3) and the Holocene. A model of regional fluvial activity of the Oued Sebou was established. It shows multicentennial scale variability in response to climate and environmental changes and anthropogenic impacts. Interregional comparisons within North Africa were done. The palaeoenvironmental reconstruction potential of the Pleniglacial and Lateglacial formations was revealed.

The Loir River fluvial dynamics during the Lateglacial and the Holocene (France): multi-scaled and multi-proxy approach

PIANA J.(1), CARCAUD N.(2), CYPRIEN-CHOUIN A.L.(3), GANDOUIN E.(4), LEROY D.(5), VISSET L.(3)
(1) L'UNAM -Université d'Angers UMR ESO 6590, ANGERS, FRANCE ; (2) Agrocampus Ouest, Département Paysage, ANGERS, FRANCE ; (3) Faculté des Sciences et des Techniques de Nantes.Laboratoire d'Ecologie et des Paléoenvironnements Atlantiques, NANTES, FRANCE ; (4) IMBE - UMR CNRS 7263 / IRD 237, AIX-EN-PROVENCE, FRANCE ; (5) Ministère de la Culture et de la Communication, Sous-direction de l'Archéologie, PARIS, FRANCE

A multidisciplinary research has been initiated in the Loir River valley where investigations (3 study areas from upstream to downstream), revealed high-potential fluvial records. Coring operations (3 main cross-sections, 100 boreholes) provide the opportunity to reconstruct fluvial responses to climate, environmental and societal changes during the last 16000 years, with a multi-scaled approach and several proxies: sedimentology, soil micromorphology, geochemistry, palaeoecology (pollen, chironomidae), archaeology, geochronology (37 AMS ^{14}C datings).

The post-LGM climate warming induces an early incision episode before 15095-16343 a. cal. BP (2σ), with the erosion of older Weichselian formations. During the Bolling-Allerod period, warmer and wetter conditions, reconstructed from bioindicators, cause organic sedimentation in the plain. Tenuous evidence of the Older Dryas (colder) is locally suggested from pollen and chironomidae. The Lateglacial-Holocene transition is marked by a change from a multichannel to a meandering fluvial pattern and a calcareous and clayey-peat infilling in the secondary channels. This infilling seems to run on till the Atlantic. At the beginning of the Atlantic, an incision episode probably erodes the older Holocene deposits. From the Subatlantic, the opening of the vegetal landscape and the cattle raising activities in the valley are known by archeological and palynological results. During the 2nd Iron Age and the Gallo-Roman periods, massive silty-clay contributions rush to the plain and attest the opening of the forest and the destabilization of slope soils. Besides, the increasing rates of aquatic plants and of the clayey-silty sedimentation in the plain indicate higher groundwater level and flood frequency. Aquatic plants disappear at the beginning of the Middle Ages (drainage). Demographic growth, agricultural activities and the LIA conditions lead to strong slope erosion and aggradation in the plain.

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Contrasting influences from land use changes and climatic variations on alluvial and colluvial deposition in Southern France

NOTEBAERT B.(1), BERGER J.F.(2), BROCHIER J.L.(3)
(1) KU Leuven, LEUVEN, BELGIUM ; (2) UMR 5600 EVS du CNRS, Université Lyon 2, LYON, FRANCE ; (3) Centre d'Archéologie Préhistorique du Rhône aux Alpes, VALENCE, FRANCE

This study aims at quantifying a temporal differentiated Holocene sediment budget for the Valdaine region (330 km²) in the Pre-Alps of S-France. This region has a long and intense history of human land use. Sediment budgeting is a tool which allow the objective and quantitative comparison of processes over different time and spatial scales, and within different regions. A growing amount of historical sediment budgets is available for C-Europe, but data from S-Europe are missing.

The sediment budget is constructed using field data and an extrapolation over geomorphologic units. Results indicate that there is ca 190 10^6 m³ (0.85 Mt/km²) colluvial deposition, which is high in comparison with catchments in C-Europe. About 125 10^6 m³ sediment is present in the alluvial plains, and ca 30 10^6 m^3 in the outlet's alluvial fan, which receive both also sediment from the upstream reaches outside the study area (total catchment area 600 km^2). Dating results show that colluvial deposits date mainly from the last 3000 a, with highest deposition during the last 1000 a. The floodplains have a complex cut and fill history, which complicates precise temporal quantifications. Pre-Medieval deposits are mainly fine, followed by an important cut and fill phase during the LIA, with deposition of a coarse gravel originating from channel and gully erosion in the upper mountainous reaches.

From the presented sediment budget it can be concluded that anthropogenic land use is responsible for major soil erosion and colluvial deposition during the last 3000 a in the lower and middle altitudes of the basin, without conclusive data on a climate related intensification during the LIA. Floodplain deposition is controlled by land-use from the Mid-Holocene to the early Medieval period. This changes however dramatically during the LIA, with deposition of a major gravel layer, which can be related to the combination of this particular climatic period with a major deforestations in the upper reaches.

Evidence for a continuous fluvial activity of the Tremithos River (South Central Cyprus) during the Early to Mid-Holocene

GHILARDI M.(1), CAROZZA J.M.(2), CORDIER S.(3), PSOMIADIS D.(1), ZOMENI Z.(4), DEMORY F.(1), SABATIER D.(1), VELLA M.A.(1), BONY G.(1), MORHANGE C.(1)

(1) CNRS CEREGE UMR 7330, AIX-EN-PROVENCE, FRANCE ; (2) Univeristy of Strasbourg, STRASBOURG, FRANCE ; (3) Univeristy of Créteil UPEC, CRÉTEIL, FRANCE ; (4) Cyprus Geological Survey, NICOSIA, CYPRUS

This article shows evidence of an important alluviation and a fast vertical accretion in Central-East Cyprus during the Late Neolithic/Early to Late Chalcolithic periods, implications for the settlement development is in parallel discussed. Cyprus has been little studied for palaeohydrological reconstruction and Holocene fluvial terrace formation. Based on the previous works undertaken on the southern (Vassilikos and Dhiarizzos Valleys) and eastern most parts of the island (Gialias drainage basin), recent paleoenvironmental investigations have been conducted within the Tremithos drainage basin (an area of ~ 170 km²). A stratigraphic profile of ca. 8 meters thick, situated 8.5 km west of the city of Larnaka, was studied for magnetic parameters, LASER grain size distribution and XRD measurements. In addition a chronostratigraphy sequence was obtained, based on the dating of 7 charcoal samples. Two additional stratigraphic profiles were investigated and help to better understand the Late Pleistocene to Early Holocene fluvial framework and comparisons have been established with previous studies led in the Island. For the first time, our study reveals an important and fast sediment accretion from ~ 5000 cal. BC to ~ 2800 cal. BC where mainly fine material (fine to medium well sorted sands) was deposited and a phase of high energy of deposition has been identified where pebbles mixed together with fine sands and was dated from the beginning of the third millennium BC. The results also highlight the presence of a palaeosoil dated 3342-3026 cal. BC (Mid to Late Chalcolithic periods), evident alteration of an open air site is observed due to flooding of the Tremithos River. Our works show first evidence for a continuous fluvial activity in Central East Cyprus during the Early to Mid Holocene and discussions are dealing with climate and anthropogenic (forest clearance) parameters which could be combined to explain the rapid terrace formation.

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Late to final Holocene fluvial system dynamics in the Yamé valley (Mali): climatic change or human impact ?

GARNIER A.(1), LESPEZ L.(1), BALLOUCHE A.(2), LE DREZEN Y.(3), RASSE M.(4), HUYSECOM E.(5), DELAHAYE D.(1)

(1) LETG Caen -Géophen. Université de Caen Basse-Normandie, CAEN, FRANCE ; (2) LETG Angers-LEESA Université d'Angers, ANGERS, FRANCE ; (3) PRODIG, UMR 8586 CNRS. Université Paris1 Panthéon Sorbonne,, PARIS, FRANCE ; (4) Laboratoire GEOSUDS, CNRS-UMR IDEES 6228, Université de Rouen, ROUEN, FRANCE ; (5) Laboratoire Archéologie et Peuplement, Département de Génétique et Evolution, Université de Genève, GENÈVE, SWITZERLAND

In West Africa, studies on fluvial system evolution are rare and were mainly conducted to underline the role of climatic change as single driver. This presentation aims to propose a synthesis of fluvial changes of the Yamé River (Mali) during the Late to Final Holocene (5000 years BP onwards). Because of its exceptional preservation including plants and archaeological remains, the Yamé valley deposits permit a high resolution of environmental and human dynamics reconstruction, especially for the Final Holocene period (2500 years BP onwards) which is, until now, not well documented in West Africa. This study focuses on the whole fluvial system from the upstream sandstone plateau to the downstream Inner Niger Delta. Outcrops profiles and cores, correlated to eight cross sections along the130 km of the Yamé valley and combined with sedimentological analyses on 250 sampleswere investigated to appreciate the general pattern of alluvial dynamics and the longitudinal complexity from upstream to downstream. The comparison of these results with regional and local archaeological and palaeoenvironmental data permits to identify the respective parts of the climatic and anthropogenic variables during the Holocene and within the catchment area.

The results highlight a contrasted response of the fluvial system to regional controls such as climatic oscillations and the general increasing impact of societies since the Neolithic. However, natural and human local variables were also identified. Then, the diversity of geological settings and geomorphological inheritance of the Yamé catchment are relevant in determining water discharge and sediment supply. Furthermore, from 3000 years, the increase of agricultural practices, the emergence of iron metallurgy and more recently the demographic pressure are relevant in determining Yamé fluvial system changes and colluvial development.

A 7300 year record of palaeohydrology in the Swiss Rhône River floodplain (Valais, Switzerland)

LAIGRE L.(1), ARNAUD-FASSETTA G.(2), REYNARD E.(3)
(1) Institute of Geography and Sustainability, University of Lausanne (Switzerland) - UMR 8591 Laboratoire de Géographie Physique, Meudon (France), LAUSANNE, SWITZERLAND ; (2) University of Paris Diderot (Paris 7) - UMR 8591 Laboratoire de Géographie Physique, Meudon, PARIS, FRANCE ; (3) Institute of Geography and Sustainability - University of Lausanne, LAUSANNE, SWITZERLAND

Unlike the French part of the Rhône River catchment, the fluvial history of the Swiss Rhône River (Upper Rhône) is relatively unknown. In this paper, we establish the record of floodplain filling in the Upper Rhône since 7000 cal. y BP. A multimethod approach based on historical mapping, geophysical measurements, coring and C14/OSL dating allowed identification of several major hydrodynamic phases. Geophysical measurements provided information on the sedimentary architecture, location and dimensions of most of the younger buried palaeochannels, illustrating the nature of river broading in the period before embankment. They also revealed the significant influence of tributaries on the Upper Rhône system. Four phases of major fluvial activity have been identified: (i) Prior to 7300 cal BP, coarse sedimentary facies predominated in the south of the valley and was linked to the position of the active channel; (ii) After a period of low activity, from 7270 cal. BP a multiple channel pattern with flows on the entire surface of the floodplain is observed; (iii) After a new short period of low hydrological activity, a migration of the main Rhône River from the north to the south of the valley is associated with the Early Atlantic period. Indeed, in the southern floodplain the vertical sequencing of layers suggest the functioning of an unstable channel that was probably braided. Furthermore a core drilled in the base of a tributary alluvial fan suggests an increase in tributary sediment delivery during the same period. This contributed to the migration of the channel towards the south. (iv) The last major hydrodynamic period recorded by sediments corresponds to the Little Ice Age and is characterised by the domination of pebbles and gravels. During this period, the main braided channel was back to the north of the valley with single secondary channels connected to the Rhône River still flowing in the south, as geophysical and historical mappings emphasised.

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Late Quaternary floodplain evolution in the low tableland of Transylvanian Depression, Romania

PERŞOIU I.(1), FEURDEAN A.(2)
(1) Ştefan cel Mare University, SUCEAVA, ROMANIA ; (2) Senckenberg Research Institute and Natural History Museum and Biodiversity and Climate Research Centre (BiK-F), FRANKFURT AM MAIN, GERMANY

Here we present the evolution of a river-lake system (Pârtoț River and Ştiucilor Lake), tributary of Someşu Mic River in NW Romania, over the past ~15.000 years. Lithological, mineral magnetic proprieties, organic content and grain size observations on three cores (drilled both in the lake – C1, and in the floodplain perimeter – C2, C3) enabled us to reconstruct the evolution of the lake and fluvial system over the past ~15.000 years.

In core C1 (in the present lake), bottom sands (glacial) are followed by clay gyttia and detritus gyttia of late-glacial origine . At the bottom of core C2 (1 km upstream from the present edge of the lake), coarse sands and pebbles of alluvial origin are followed by medium to fine sands, deposited in a typical lake environment. In core C3 (~4 km upstream from the present day edge of the lake), clays and sandy clays were deposited during the Bolling-Allerod, followed by fine - medium sands during the Younger Dryas. In all three cores, the beginning of the Holocene is marked by the development of *Phragmites* peat with low minerogenic flux.

These results suggest that during the Late Glacial (LG), a larger than present lake extended at least 1 km upstream from the present day lake edge, fed by coarse materials (sands) from low tree-cover slopes. This lake continued upstream (for ca. 3 km) with, a low energetic humid area, covering the entire floodplain. During the YD and the early Holocene, the lake dramatically reduced its surface, and dried our between 11,000 and 6000 cal yr BP. A second lacustrine phase started ~6000 years ago lasting until present. Biotic and abiotic proxy data from Ştiucilor Lake indicate that the lake level show greatly fluctuating water table.

The model of fluvial evolution and the sedimentary records offered by this floodplain has a regional relevance in a poorly studied area from SE Europe, with high potential in investigating the fluvial system changes related to climate and human activities.

Late Quaternary weathering, sediment production, erosion, and alluvial fan deposition in hyperarid Nahal Yael, Israel

ENZEL Y.(1), AMIT R.(2), GRODEK T.(1), AYALON A.(2), LEKACH J.(1), PORAT N.(2), BIERMAN P.(3), BLUM J.(4), EREL Y.(1)
(1) The Hebrew University of Jerusalem, JERUSALEM, ISRAEL ; (2) Geological Survey of Israe, JERUSALEM, ISRAEL ; (3) University of Vermont, BURLINGTON, UNITED STATES ; (4) University of Michigan, ANN ARBOR, UNITED STATES

A conceptual model for geomorphic response to Pleistocene-Holocene climate change (Bull and Schick, 1979) was applied to the hyperarid (<30 mm yr^{-1}) Nahal Yael. It included an event chain following this change: reduced vegetation cover, increased sediment yield from slopes, aggrading terraces and forming an alluvial fan. The model is revaluated here with data acquired in Nahal Yael over the 30 years since the original model was proposed. Recent studies indicate hyperarid late Pleistocene climate; the transition from semiarid late Pleistocene to hyperarid Holocene did not occur. The revised chronology reveals a 35-20 ka episode (probably already beginning at ~50 ka with lower rates) of accelerated weathering and sediment production and distinct talus accretion on slopes. Coeval with accretion on slopes, sediments were also transported and aggraded in terraces and alluvial fans, without noticeable lag time or a chain of discernable events. This intensified sediment production and delivery phase is unrelated to the Pleistocene-Holocene transition. The depositional landforms were rapidly incised (20-18 ka); since this ~LGM incision, sediment yield is from storage in these depositional landforms and is not produced from bedrock in significant quantities. We propose that in hyperarid environment, the main operators are individual extreme storms; here specifically, an episode of frequent storms/floods is the driver of change regardless the mean climatic conditions. It created a pulse of intense weathering due to numerous cycles of wetting and drying on slopes and sediment transport to fluvial terraces and alluvial fans; its impact continues all the way to the present. We suggest that even if aspects of the original conceptual model of Bull and Schick (1979) are correct, it has been applied too frequently, too generally, across very diverse arid climates and settings, and for too long in lieu of collecting new data at a full basin scale and testing the model

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Extending flood records in Irish and Welsh river catchments using high-resolution geochemical analysis of floodplain sediment sequences

JONES A.F.(1), TURNER J.N.(1), DALY J.S.(1), EDWARDS R.J.(2), FRANCUS P.(3), GOODHUE R.(2), REID I.(1)
(1) University College Dublin, DUBLIN, IRELAND ; (2) Trinity College Dublin, DUBLIN, IRELAND ; (3) Institut National de la Recherche Scientifique, QUEBEC CITY, CANADA

Extended records of riverine flooding are required to constrain the magnitude-frequency relations of high-magnitude flood events in order to produce accurate assessments of present and future flood hazard. Analysis of vertically-accreted floodplain sediment sequences provides a means of obtaining records of major flood events through the late Holocene. We report on an investigation using high-resolution geochemical analysis to identify the deposits of major flood events within floodplain sediment sequences from catchments in Ireland and the UK. Itrax XRF core scanning is used to obtain profiles of variation in the abundance of a range of chemical elements in cores from palaeochannels and stable mid-channel islands. The effects of variation in XRF scan settings and count times on the precision of the resulting element profiles are tested. Lithogenic element ratios are employed as proxies for sediment grain size which acts as an indicator of varying flood magnitude. The suitability of the lithogenic element ratios for application as grain size proxies at each site, and the accuracy and precision of the reconstructed variability in sediment grain size are assessed through the comparison of the geochemical results with independent grain size data from laser granulometry and SEM image analysis. Instrumental and historical flood data from the study catchments provide a means of assessing the accuracy of the records of flooding derived from floodplain geochemistry. The project reports on spatial and temporal variations in flood magnitudes and frequencies during the late Holocene and historical periods.

Obstacle marks as palaeohydrologic indicator

HERGET J.(1), EULER T.(2)
(1) Dept. of Geography, Bonn University, BONN, GERMANY ; (2) Hydrotec Ingenieurgesellschaft, AACHEN, GERMANY

Fluvial obstacle marks can be observed frequently in recent channels and along the pathways of previous floods, including Pleistocene megafloods. They are formed by the current of the flow around submerged obstacle like stones or features like trees, bridge piers and even hills reaching above the water level. Depending on thresholds of the flow velocity and steepness of the obstacle's front, they typically consist of a frontal scour hole and a sedimentary ridge in the back, where the reworked sediments are deposited. Initiated by the description of large scale obstacle marks generated by Pleistocene megafloods like those from glacial Lake Missoula (e.g. Baker 2009) or similar events in the Siberian Altai Mountains, first attempts for quantitative palaeohydrological interpretation were less successful (e.g. Herget 2005). Thus, flume and field data of classical obstacle marks are analysed to estimate flow velocities from obstacle mark geometry, especially scour depths, length, width and ridge width. These data reveal a consistency of correlations between obstacle mark morphometries across a wide spatial scale and therefore can be transferred from flume experiments via recent features back to Pleistocene large scale structures. Analytical models, basically integrating obstacle size, flow velocity as well as sediment size and grading, are transformed so that the magnitude of individual geometric parameters can be used as variables for the estimation of mean and tip flow velocities. A universally applicable practical outline is developed for palaeohydraulic reconstruction. The reliability and scale-invariance of these reconstructions is confirmed by similar results of velocity estimations by other independent approaches at the same locations.

References:

Baker, V.R. 2009 – Annu. Rev. Earth Planet. Sci. 37, 393–411.

Herget, J. 2005 – GSA Spec. Pap. 386.

Herget, J. et al. (in print): Hydrology Research.

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Late Holocene periodicities of Alpine floods inferred from multi-proxy data

SCHULTE L.(1), PEñA J.C.(2), CARVALHO F.(1), BURJACHS F.(3), JULIÀ R.(4), LLORCA J.(1), RUBIO P.(1), VEIT H.(5)
(1) Department for Physical and Regional Geography, University of Barcelona, BARCELONA, SPAIN ; (2) Area of Climatology, Meteorological Service of Catalonia (SMC), BARCELONA, SPAIN ; (3) IPHES - Catalan Institute of Paleoecology, Human and Social Evolution, TARRAGONA, SPAIN ; (4) Institute of Earth Sciences Jaume Almera, BARCELONA, SPAIN ; (5) Institute of Geography, University of Berne, BERN, SWITZERLAND

Densely populated mountain river basins such as the deeply carved glacier valleys in the Bernese Alps are prone to hydrological hazards (437 floods since 1800 AD). The multidisciplinary approach provides data from natural, historical, and instrumental time series, to the study of magnitude-frequency of extreme events and their forcings over pluri-millennium time scales, thus covering several Holocene climate cycles. For the reconstruction of delta plain aggradation pulses and flood processes, high-resolution sediments from interdistributary basins were examined by XRF-core scanning, LOI, grain-size and palynology techniques, performing proxy-records outside the known range of extreme events.

Spectral analysis of the geochemical and pollen time series (4800 to 1800 cal. yr BP) from mid-size catchments and other climate proxies (e.g. ^{14}C anomalies, $\delta^{18}O$ from Greenland ice and NAO Index) evidence similar periodicities of 60, 85, 105 and 210 yrs. Thus, the mechanisms of the aggradation pulses and flood processes were strongly influenced by the North Atlantic dynamics and solar activity. With regard to the last two centuries a summer flood index of Switzerland (INUi) based on damages recorded from 1800 to 2008 AD was performed. Spectral analysis of the INU index identify the 105-yr cycle recorded in the delta plain sediments and the 11-year solar cycle (Schwalbe-cycle).

Furthermore, the chemical composition of delta plain sediments (e.g. Ca/Ti, TOC and aluminum silicate content) and mesic pollen data shows high correlation with the GISP 2 record, providing evidences that cooler climate pulses were an important external driving force of floods. Detailed information was obtained with regard the last 200 years. Correlation of the INUi with, the composite annual temperature record Berne-Vienna since 1800 AD, the $\delta^{18}O$ GISP 2 record and the summer NAO indicate that mayor flood activity occurred during short warm climate pulses during cold low-frequency periods.

Floods, droughts and people: historical palaeohydrology and landscape resilience of a Mediterranean rambla (Castellón, NE Spain)

BENITO G.(1), MACHADO M.J.(1), RICO M.T.(2), SÁNCHEZ-MOYA Y.(3), SOPEñA A.(3)
(1) Spanish Natural Science Museum-CSIC, MADRID, SPAIN ; (2) Instituto Pirenaico de Ecología-CSIC, ZARAGOZA, SPAIN ; (3) Instituto de Geociencias (CSIC-Universidad Complutense), MADRID, SPAIN

Rambla de la Viuda (drainage area of 1500 km^2) is a Mediterranean ephemeral river with a hydrological regime characterised by large floods. The region has a long history of anthropogenic land-use changes, which contributed to temporal phases of increased rates of sediment yield and changes in flood hydrology. Valley sides revealed important accumulations of slackwater flood deposits. These slackwater flood deposits emplaced by high stage floodwaters show a complete stratigraphy from which we can reconstruct long-term records of floods and environmental changes. Interbeded with these flood units, colluvial units can be observed, and several edaphic horizons developed on colluvial and fluvial deposits were identified.

The alluvial and colluvial chronostratigraphical, sedimentological and palaeobotanical (phytoliths) analysis of these units, together with the hydraulic flood modelling approach, made possible to determine: a) the way in which hydrological extreme events may be changing both in frequency and intensity as a result of climate variability, b) the weight of human influence (land-use) on soil hydrology, c) geomorphic channel changes, and c) the grade of resilience of landcover during this temporal scale (last 500 yrs).

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Progress on the estimation of past flood discharge from dendromechanical analyses of tilted trees

BALLESTEROS CANOVAS J.(1), BODOQUE J.M.(2), EGUIBAR M.A.(3), RUIZ-VILLANUEVA V.(1), DÍEZ-HERRERO A.(1), STOFFEL M.(4), SÁNCHEZ-SILVA M.(5)
(1) IGME, MADRID, SPAIN ; (2) University of Castilla-La Mancha, TOLEDO, SPAIN ; (3) Technical University of Valencia, VALENCIA, SPAIN ; (4) University of Berne, BERNE, SWITZERLAND ; (5) Universidad de Los Andes, BOGOTA, COLOMBIA

Tilted trees, due to the unidirectional flow pressure, constitute a common dendrogeomorphic evidence on the river floodplain of past flood events. This evidence have been widely used in dendrogeomorphology to reconstruct flood frequency by mean of the identification of reaction wood, but their usefulness for flood discharge estimation never have been investigated. We present a mechanical tree deformation-flood depth model in order to reconstruct the flood peak discharge based on the rotational stem deformation. In this model, theories from dendrogeomorphology, dendrometric, mechanical structures and hydraulic sciences are combined. Input data required are: stand forest characteristic, deformation of the stem base, root-plate characteristic and soils characteristic. The objective of this study is to validate results derived of this model with observed data derived from tilted trees located close to river gauge stations.

We have sampled and analyzed tilted trees from three gauged reach river. Dendrogeomorphological methods have been carried out to date flood events by mean reaction wood, while gauge station record were consulted in order to assign their peak discharge. On the other hand, 3D-Georadar has been also carried out in order to define a root-plate model to each tree species. We also used 1D/2D-dimensional hydraulic model in order to reproduce hydraulic conditions during flood events. Other input data like soil and wood density, drag coefficient, Strickler parameter were finally tabulated. Results indicate that there is a correspondence between deformation and flood depth although variability is also implicitly. Possible controls on these variability is being studied and could be related with the age of the tree when was titled as well as the signal-noise in deformation due to subsequent events. However we discuss the usefulness of output of this model as censored data in order to reconstruct the flood frequency in ungauged or poorly gauged catchment.

Poster presentations:

Tectonic signals in fluvial archives Jarama River in central Spain

FAUST D., WOLF D.
TU Dresden, DRESDEN, GERMANY

The aim of this project was to examine Spanish River systems concerning their suitability to serve as archives to reconstruct Late Pleistocene and Holocene environmental conditions in Spain. The sediment sequences of the Jarama River in central Spain proved to be an outstanding archive as we were able to identify stages of floodplain development covering a timeframe of 44 ka before present. About 14 outcrops were studied with profile exposures up to 600m long. Sedimentological and pedogenetic findings were supported by 32 radiocarbon ages.

It appeared that the fluvial architecture is very complex and inconsistent along specific river courses. Between 5 ka and 3 ka cal BP we find loamy floodplain sediments accumulated in one section and coarse gravels deposited in another section, both extending over nearly the entire floodplain. By all appearances, basic preconditions regarding such river dynamics are closely linked to tectonic movements within the river valleythat are related to the surrounding gypsum marls. As a result of tectonic movements during the Pleistocene as well as the Holocene the longitudinal profile of the Jarama Valley shows sections of high river gradient and sections of low river gradient. Such a juxtaposition of different river gradients caused different sedimentation and erosion patterns within adjacent river sections even under the same palaeoenvironmental conditions. Beside the precondition of a tectonic movement, specific climate conditions with high discharge variability and discharge peaks are considered to be the cause of the highly dynamic sedimentation patterns in the lowermost river section. The deposition of several meters of coarse gravels in a kind of braided river sedimentation pattern during Mid-Holocene times has not been described before in the Mediterranean. The interaction of tectonics and an accentuated Mediterranean climate offers a possible explanation to these exceptional sedimentation patterns in mid- to late Holocene times.

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A palaeo-sebkha sequence near Kasserine (Central Tunisia): palaeohydrology and palaeoenvironment at the Upper Pleistocene- Holocene transition

BKHAIRI A.
Laboratoire de Cartographie Géomorphologique des Milieux, des Environnements et des Dynamiques, Faculté des Sciences Humaines et Sociales, Université de Tunis, CHRAYAA- SBEITLA, TUNISIA

Located in the Central Tunisia, the basin of kasserine was filled up by recent quaternary sediments. Fieldwork in the floodplain of Kasserine near wadi Hatab, highlights successive sedimentological phases with argillaceous silts and gypsum characterizing a palaeo-sebkha. A multi-proxy study based on sedimentological, palaeo-ecological and geo-chronological analysis carried out to reconstruct the bio-sedimentary evolution and palaeoclimatic fluctuations of the palaeo-sebkha at the Upper Pleistocene- Holocene transition.

Fifty-three samples were collected along the palaeo-sebkha sequences. Grain- size indexes, chemical and mineralogical data, micromorphological observations and magnetic susceptibility describe the morpho-sedimentary dynamics and the palaeolimnology reponse to hydrology and climate changes occurring in the basin of Kasserine between 20 and 10 ka cal. BP. Five episodes of sedimentation are recorded. During the two first episodes, the sedimentation in the palaeo-sebkha alternated between clayey-silty micro-sequences and sandy-gypsums laminated lentils. Within the third episodes, an alluvial sedimentation with clayey silts attests to climate and limnologic changes with increasing moisture. The 4^{th} episode is a period of increasing aridity, and the aeolian sand with gypsum at the top of sequence is associated to maximum extended of this arid environment.

Keys-words: sebkha, Kasserine, micromorphology, morpho-sedimentary dynamics, aridification, Upper Pleistocene-Holocene transition.

Contribution of OSL signals for reconstructing the debris flow activity for two tributaries of the Swiss Rhône River: the Fully and Charrat torrents (Valais, Switzerland)

LAIGRE L.(1), BÄTZ N.(2), LANE S.(2)
(1) Institute of Geography and Sustainability, University of Lausanne (Switzerland) - UMR 8591 Laboratoire de Géographie Physique, Meudon (France), LAUSANNE, SWITZERLAND ; (2) Institute of Geography and Sustainability - University of Lausanne, LAUSANNE, SWITZERLAND

In the Alps, tributary debris flow and alluvial fan systems can have a major influence on the fluvial patterns of the river into which they flow. Because of both the rapid onset of debris flow activity and the commonly abundant nature of sediment supply, they can have a dramatic effect on river and valley floodplain fill downstream, especially where the events are driven by tributary localised rainfall and the main river has insufficient capacity to transport the sediment supplied to it. The result can also be both river migration and in extreme cases avulsion. Debris flow deposits from two tributaries, the Fully and the Charrat torrents, have been identified in sediment cores in the River Rhône floodplain and these allow us to quantify and to explain the influence of tributaries on the main river. Here, we use data obtained from an OSL portable reader where the luminescence signal (total photon counts) measured in buried deposits is used to deduce the nature of transport and depositional processes. A series of debris flow events have been identified, one of which was sufficient to impact upon the main Rhône River by increasing the slope of the alluvial fan surface and forcing the channel to migrate towards the south. Subsequently, with hydrological activity in the tributaries, the Rhône, whilst remaining braided, migrated back to the north of the valley and eroded the base of the alluvial fan. This resulted in fluvial material being interspersed with fan deposits and shows how even for a large river system like the Rhône River, certain debris flow events can have a significant impact upon its dynamics.

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Using tree-ring oxygen stable isotopes for studying the origin of past flood events: first results from the Iberian Peninsula

DIEZ-HERRERO A.(1), FERRIO J.P.(2), BALLESTEROS J.A.(1), VOLTAS J.(2), BODOQUE J.M.(3), AGUILERA M.(2), RUIZ-VILLANUEVA V.(1), TARRES D.(2)
(1) Geological Survey of Spain (IGME), MADRID, SPAIN ; (2) Dep. Crop and Forest Sciences, ETSEA, University of Lleida, LLEIDA, SPAIN ; (3) Mining and Geological Engineering Department, University of Castilla-La Mancha, TOLEDO, SPAIN

For over forty years, tree-ring studies have been used to date and quantify past flood events. On the other hand, stable C and O isotopes in tree-rings have been extensively applied for reconstructing past environmental conditions and their changes over time. So far, both approaches have not been combined and integrated. In this study we explore whether the meteorological origin of precipitation causing past flood events might be assessed through the investigation of oxygen stable isotopes in tree rings. It is well known that floods may have different origins, e.g. heavy convective rainstorms, frontal precipitations, snow melting, etc. Each of these floodwater sources bears a particular isotopic fingerprint.
This communication presents the first results of this methodology applied to recent flash flood events occurred in Central Spain. To this end, a well-known heavy-rain convective event was chosen from the recent flood record. In the forested area affected by this event, 6 cores from each one of 4 species selected (*Pinus sylvestris, P. pinaster, Quercus pyrenaica* and *Alnus glutinosa*), were sampled using a Pressler incremental borer. The wood cores were dated and the tree-ring corresponding to the event year, along with the precedent and the subsequent rings, were identified and isolated for isotope analysis. After α-cellulose extraction, the oxygen isotope composition ($\delta^{18}O$) was analyzed and compared with the values of other recent convective precipitations from the Spanish Network for Isotopes in Precipitation. These preliminary results are interpreted in terms of the screening ability of the oxygen isotope signature in tree rings for identifying contrasting storm events, underlining the limitations and specific requirements of the methodology, but also its potential applications. Future, more in-depth analyses will be aimed at recognizing specific precipitation sources and separating different populations of past floods according to their cause.

The use of microscopic study of quartz grains for establishing the origin of the Late Pleistocene river terrace deposits in the Central Russian Plain

MATLAKHOVA E.(1), DUBIS L.(2), PANIN A.(1)
(1) Geography Faculty, Moscow State University, MOSCOW, RUSSIAN FEDERATION ; (2) Kiev National University, KIEV, UKRAINE

Late Pleistocene river terraces in the Central Russian Plain were subject to complex reworking after the alluvial sedimentation had finished. Terraces may therefore contain sediments of different origin and terrace levels may vary according to the post-alluvial reworking. To establish terrace sedimentation mechanisms we supplemented lithological data collected in the field with quartz grains morphoscopy technique – microscopic study of texture of sediment particles. The results exhibit wide participation of aeolian and slope wash sediments in terrace deposits, deep aeolian reworking of terrace alluvium during LGM that could be possible due to deep pre-LGM incision of rivers. The main difficulty in interpretation of morphoscopic results is that aeolian signals are sometimes not clear due to short duration of wind action over alluvial sands.

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Hydrological EXtreme Events in Changing Climate: The HEX Events project

BENITO G.(1), MACKLIN M.M.(2), COHEN K.M.(3), HERGET J.(4)
(1) CSIC-Museo Nacional de Ciencias Naturales, MADRID, SPAIN ; (2) Institute of Geography and Earth Sciences, Aberystwyth University, CEREDIGION, UNITED KINGDOM ; (3) Faculty of Geosciences, Utrecht University, UTRECHT, NETHERLANDS ; (4) Department of Geography, University of Bonn, BONN, GERMANY

Fluvial records in various ways contain evidence of past hydrological events, which can be linked to Earth's climate variability. Chronological control of fluvial archives has much improved in the last decades particularly for the Holocene and Late Pleistocene records, and this is renewing their use to improve palaeoflood sequences of rivers worldwide. The INQUA funded HEX Events project aims to combine extended regional records of hydrological events (above average stream flow and discrete flood events) from multiple proxies and to establish in-phase and out-of-phase periods of hydrological activity in response to climate and atmospheric circulation variability. The project approach is based on combined meta-analysis of large sets of dates (radiocarbon, OSL, IRSL) of diverse fluvial contexts, allowing series of fluvial activity periods to be more objectively defined, better facilitating their characterization in terms of forcing hydrological conditions, once overprint effects due to 'preservation' and 'radiocarbon plateaus' are corrected. This approach is applied to records of fluvial activity in different clusters of catchments, larger river drainage basins, and countries. The approach facilitates comparison with other climate and human impact proxy records, time series and other indicators, demonstrating the value of creating aggregate fluvial-palaeohydrological databases, to explain the past and predict the future of floods and droughts in our rivers. The HEX project has established the bases for addressing this standardised methodology on five target zones: (1) Mediterranean region; (2) Central Europe and Russian Plain; (3) North America (4) South America, (5) North Africa and (6) Australia.

Fluvial response to Holocene climate and environmental changes in NW Romania

PERŞOIU A., PERŞOIU I.
Ştefan cel Mare University, SUCEAVA, ROMANIA

Here we discuss the response of Someşu Mic river (NW Romania) to climatic and environmental changes during the Holocene.

Our analysis is based on morphological, sedimentological and chronological informations obtained from valley bottom peat bogs in the upper reach of the river, and openings scattered through the floodplain in the medium and lower reach.

The palaeoenvironental background for the fluvial dynamics is given by decadal scale stable isotope records from Scărişoara Ice Cave (summer temperature) and pollen data (vegetation dynamics) from peat bogs in the region.

The results of our study can be summarized as follows:

(1) The adjustment of the Someşu Mic River's channel (*i.e.*, metamorphosis from braided/wandering to narrow, incised, meandering channel) to the Holocene temperate conditions was delayed by ~1500 years occurring after the massive expansion of *Querqus* dominated forests (~10.3 kyrs BP), being probably triggered by the abrupt climatic event at 10.2 kyrs BP.

(2) At ca. 4.7 kyrs BP occurred the second important change in fluvial behavior, with increasing liquid and solid discharge, preceded by a rapid shift to colder climatic conditions and large scale development of *Fagus* forests at mid altitudes (starting with ca. 4.8 kyrs BP).

(3) The abrupt climatic events at 9.6, 8.2 and 4.2 kyrs BP and the periods of longer climatic deterioration (*e.g.*, Dark Ages Cold Period, Little Ice Age), had a lower impact on Someşu Mic River behavior.

(4) Human impact (forest clearance over the past 3000 years, changes in vegetation types), and hydrotechnical interventions in the last decades, has a reduced impact, subordinated to climate and other controls (*e.g.*, tectonics).

These findings highlight the conservative character of this river, with delayed or no reactions to external forcing (most probbaly induced by local geologic an tectonics conditions), as well as the role of vegetation on modulating the impact of climate on the fluvial system.

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The geoarchaeology of the Middle Garonne valley: first results

CAROZZA J.M.(1), VALETTE P.(2), CAROZZA L.(2), LLUBES M.(3), FERDINAND L.(2), SEVEGNES L.(4), DANU M.(5), GALOP D.(2), PY V.(2)
(1) University of Strasbourg, GEODE UMR 5602 CNRS, TOULOUSE, FRANCE ; (2) GEODE UMR 5602 CNRS - University of Toulouse, TOULOUSE, FRANCE ; (3) GET UMR 5563 CNRS, TOULOUSE, FRANCE ; (4) French National Heritage, Ministery of Culture, TOULOUSE, FRANCE ; (5) University Alexandru Ioan Cuza, IASI, ROMANIA

Despite its historical importance as a major communication exis between the Mediterranean and the Atlantic areas, very few is known about the Middle Garonne evolution during Late Glacial / Holocene time. Sedimentary architecture and chronology of the floodplain building remains poorly documented by previous works. Pluridisciplinary approach coupling geomorphology, archaeology and geophysic were carried out during the last three years in order to refine landscape evolution in relation with human settlements from Middle Neolithic to Roman periode.Between Toulouse and the Tarn confluence, the Middle Garonne is caracterized by an widening of its floodplain, witch riched more than 4 km wide. Two test zones were investigate in the south (Castelnau-d'Estrétefonds) and in the north (Bourret) of this area of interest. They allows to highlight two main stages of sedimentation separeted by a major phase of incision. The first alluvial phase associated with high sediments supply, *i.e.* the « yellow silt » occured between 16-8.9 ky BP. This episode remains poorly constrained by radiocarbon data. Downcutting and erosion partially removed the « yellow silt » level during the 8.9 to 5.0-4.5 ky BP interval. Biostabilisation by riparian forest (mixed oak forest) documented by palynological evidences and decrease in paraglacial sedimentary supply, seems the keys factor of controle of this stage of evolution.

The second alluvial phase starts arround 4.4 ky BP. These levels show high charcoal concentration that reflect first human impact on the riparian forest. The first archaeological evidence of settlement in the Garonne valley during Middle Neolithic are synchronous. During Bronze Age to Early Roman periode, slow aggradation occure. Late Roman periode, i.e. 2de c. AD is caracterized by increase in sedimentation rate, as well as the Middle Medieval periode.

Geoarchaeological approach of river-societies interactions: new developments in fluvial dynamics and embankments of the Loire River during the last 2000 years (Val d'Orléans, France)

CASTANET C.(1), CARCAUD N.(2)
(1) Université Paris 8, UMR CNRS 8591 Laboratoire de Géographie Physique, PARIS, FRANCE ; (2) Agrocampus Ouest, Département Paysage, ANGERS, FRANCE

This research deals with the study of fluvial systems, heavily and precociously transformed by societies (fluvial anthroposystems). It aims to characterize i), fluvial responses to climate, environmental and anthropogenic changes ii), history of hydraulical constructions relative to rivers iii), history of fluvial origin risks and their management - (Program: AGES *Ancient Geomorphological EvolutionS of the Loire Basin hydrosystem*). The Middle Loire River valley was strongly and precociously occupied, particularly during historical periods. Hydrosedimentary flows are there irregular. The river dykes were built during the Middle Ages (dykes named *turcies*) and the Modern Period, but ages and localizations of the oldest dykes were not precisely known. A systemic and multi-scaled approach aimed to characterize i), palaeo-hydrographical, -hydrological and -hydraulical evolutions of the Loire River, fluvial risks (palaeo-hazards and -vulnerabilities) and their management. It is based on an integrated approach, in and out archaeological sites: morpho-stratigraphy, sedimentology, geophysics, geochemistry, geomatics, geochronology, archaeology. Spatio-temporal variability of fluvial hazards is characterized. A model of the Loire River fluvial activity is developed: multicentennial scale variability, with higher fluvial activity episodes during the Gallo-Roman period, IX-XIth centuries and LIA. Fluvial patterns changes are indentified. Settlement dynamics and hydraulical constructions of the valley are specified. We establish the ages and localizations of the oldest discovered dikes of the Middle Loire River: after the Late Antiquity and before the end of the Early Middle Ages (2 dated dykes), between *Bou* and *Orléans* cities. During historical periods, we suggest 2 main thresholds concerning socio-environmental interactions: the first one during the Early Middle Ages (*turcies*: small scattered dykes), the second during the Modern Period (levees: high quasi-continuous dykes).

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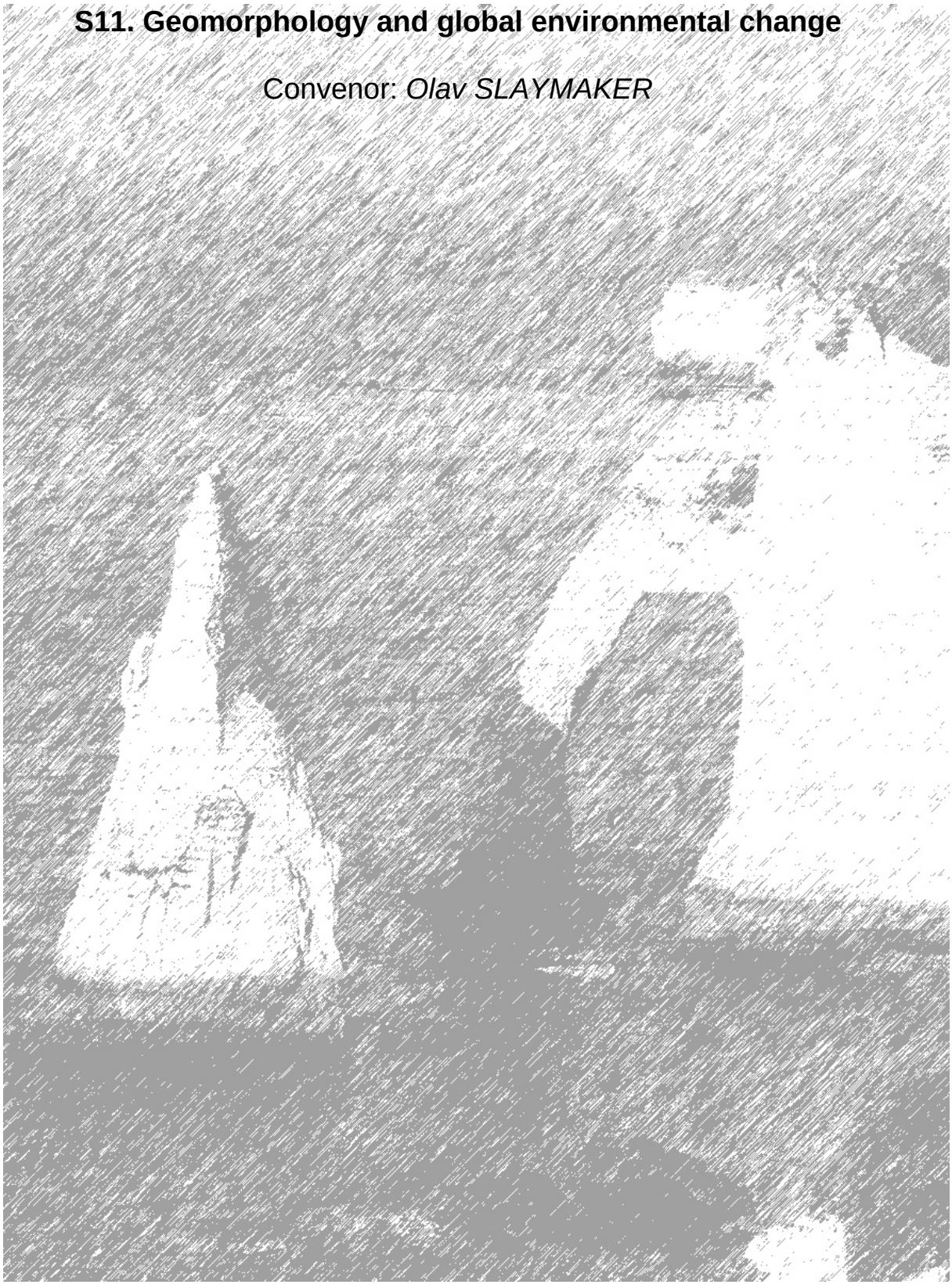
Understanding Quaternary landscape development using numerical modelling: issues associated with making models and data 'meet in the middle'

BRIANT R.(1), WAINWRIGHT J.(2), MOTTRAM G.(1)
(1) Birkbeck, University of London, LONDON, UNITED KINGDOM ; (2) University of Durham, DURHAM, UNITED KINGDOM

Understanding landscape processes over long timescales is increasingly important for climate change adaptation planning. Whilst most planners plan for the near-term (c. 50 years), there is an increasing desire to embrace planning solutions that do not close off options for the future. Since even before 2100 we may see up to 6°C temperature rise it is essential to look at Quaternary scale changes. Past analogues are not close enough to future possibilities, therefore numerical modelling is an important way of creating long-term projections. However, most landscape models are designed to work over a narrow range of climate conditions. There has also traditionally been a gulf between the timescales investigated for understanding landscape processes and those relating to sediment sequences. Thus, monitoring of sediment transport occurs at scales of minutes to days, with 'long-term' monitoring programmes up to a few tens of years only. In contrast, sedimentary sequences span hundreds to tens of thousands of years. Working out how small-scale processes 'sum' to produce the sedimentary sequences that are observed is potentially a very effective use of numerical modelling but most numerical models are applied over shorter timescales. Many models are also applied to abstract landscapes. It is therefore important to apply numerical models over a longer timespan and larger climatic fluctuations, evaluating it against geological data. In this case the development of a river catchment over the last glacial / interglacial cycle (c. 135,000 years) is modelled. Through this pilot study the challenges of addressing this time-scale gap are explored. The geological sequences are from a low-lying river catchment in the northern Fenland, eastern England and contain both fossil material providing evidence of local climate change and sedimentological evidence of system change. They are dated using both OSL and radiocarbon. The modelling was undertaken using a spatially distributed reduced-complexity cellular model.

S11. Geomorphology and global environmental change

Convenor: *Olav SLAYMAKER*



Oral presentations:

The role of geomorphology in global environmental change

SLAYMAKER O.
Department of Geography, University of B.C., Vancouver, CANADA

Huge resources have been channeled into research on atmospheric and oceanic system changes. But we happen to be located on the terrestrial surface and our civilization depends heavily on the top few metres of regolith and on the ecosystem it nurtures. Both biogeochemical and social systems are built on the back of soils. Fifteen percent of global soils have been removed and an unknown but significant percentage has been degraded. Remediating degraded soils may take hundreds of years, but reconstructing soils requires thousands of years. The changing terrestrial environment, which is at the core of geomorphological research, should receive greater attention within the global environmental change community. The key geomorphological issues revolve around the changing amount and forms of energy expenditure as well as the changing amount and forms of mass fluxes at and close to the terrestrial surface. The general question that arises is "what critical, geomorphically relevant measures or indices adequately reveal conditions or trends in the terrestrial environment?"

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A Protocol to develop an environmental fragility map: a case study from angra dos reis and paraty municipalities, Rio De Janeiro State, Brazil

GUERRA A.(1), BEZERRA J.(2), FULLEN M.(3), JORGE M.(1)
(1) Federal University of Rio de Janeiro, RIO DE JANEIRO, BRAZIL ; (2) State University Maranhao, SAO LUIS, BRAZIL ; (3) University of Wolverhampton, WOLVERHAMPTON, UNITED KINGDOM

A protocol to make an environmental fragility map is presented, based on a case study in Angra dos Reis and Paraty Municipalities, Rio de Janeiro State. Four types of data are considered: soils, land use, total annual rainfall and slope angle. The main characteristics include the *Sierra do Mar* mountain range, with steep slopes and shallow soils, fringed by a narrow coastal plain. Total annual rainfall ranges between 1,427-2,343 mm. The main soil types are Entisols, Inceptisols and Oxisols.Slope angles vary between 0-5 degrees on the coast and fluvial plains, to >45 degrees in the mountains. The main land uses are: urban, cattle rangeland, tropical forest and mangrove swamps. The used data were abstracted from the SRTM (2004), and the Brazilian Geographic Institute (air photos taken in 2005, at 1:25,000 scale). Using these data and ArcGis 9.3, four maps have been made, to assess environmental fragility. Using the function Raster Calculator of the Spatial Analyst tool, weights have been attributed to each variable: land use (0.3), soils (0.3), rainfall (0.2) and slope angle (0.2). Based on these weights an Environmental Fragility map has been made, with five classes: very low (38.13% cover), low (25.98%), medium (27.65%), high (3.83%) and very high (4.41%). The data show the dominant role of tropical forest, which covers ~90% of the area, protecting the environment against degradation. Therefore, >90% of the area corresponds to very low, low and medium fragility. Despite some steep mountain slopes, the forest protects these slopes from land degradation; and these environments are either in the low or very low fragility classes. The results show that high and very high classes correspond to high rainfall amounts (>2,000 mm), Entisols andInceptisols, slope angle between 6-15 degrees and the land uses cattle rangeland and urban areas. Environmental fragility mapping has the potential of being a valuable tool to analytically target priority areas for soil conservation.

Self-organising change? Considerations on causality

V. ELVERFELDT K.(1), EMBLETON-HAMANN C.(2), EGNER H.(1)
(1) Department of Geography and Regional Studies, KLAGENFURT, AUSTRIA ; (2) Department of Geography and Regional Studies, VIENNA, AUSTRIA

Commonly, global environmental change is understood as a matter of cause and effect: There are several external natural as well as human-induced causes which drive the processes of change within a system. This cause-and-effect-relationship is also used for the interpretation of geo-archives: An erosion event of high magnitude is assumed to be caused by external drivers like extreme rainfall events. These relationships require linear relation between driver and response. From the perspective of self-organising systems, the situation can be interpreted in a different way: Self-organisation, understood as a complex of internal processes which lead to a specific spatial structure (or pattern) of a system, can result in a similar situation of erosional deposits. Changing framework conditions may drive a system towards an instability threshold, the so-called bifurcation point. At this point, probabilistic theories fail as the system is driven “by chance”: Processes can come into action without any (evident) cause. As a result, a single – and especially a single external – cause for a certain system reaction cannot be determined anymore. For example, many studies indicate that sediment transport fluctuates strongly despite steady boundary conditions. This is crucial for environmental change studies for two reasons: (1) Interpretations of geoarchives have to consider that they may have been formed without any changes of external conditions and without a distinctive (internal or) external cause. (2) Current changes of system dynamics may be the result of self-organisation. Hence, geomorphological studies on environmental change should also lay a strong focus on internal system dynamics instead of primarily focusing on external drivers. It has to be acknowledged that self-organising systems are adapted to, but by no means determined by their environment.

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Can treeline dynamics in the afro-alpine north Ethiopian highlands be used as proxy to study climate change?

JACOB M.(1), FRANKL A.(1), BEECKMAN H.(2), GUYASSA E.(3), MELES K.(3), NYSSEN J.(1)
(1) Department of Geography, Ghent University, GHENT, BELGIUM ; (2) Royal Museum for Central Africa, Laboratory for Wood Biology and Xylarium, TERVUREN, BELGIUM ; (3) Institute of Geo-information and Earth Observation Sciences, Mekelle University, MEKELLE, ETHIOPIA

Worldwide average temperatures have risen during the past century, a change that is most prominent and rapid at high altitudes and latitudes. The composition and extension of the temperature sensitive treelines within these zones are potentially responsive to climate warming. In contrast to dynamics at higher northern latitudes, treeline dynamics in the tropics are scarcely investigated. The purpose of this paper is to reconstruct the extent of the upper *Erica Arborea* limit since the 1960s in the semi-arid to subhumid mountain climate zone of the north Ethiopian highlands: Leb Amba of the Abune Yosef Mt. range (12°04’N, 39°22’E, 3952 m a.s.l.) and the Ferrah Amba Mt. (12°52’N, 39°30’E, 3939 m a.s.l.). The present upper and physiognomic treeline limits were recorded in the field (February, 2012) and compared to previous treeline elevations studied from aerial photographs (1970s-1990s) and Landsat images (1980s-present). Photogrammetric restitution of the aerial photographs resulted in DEM models and orthophotographs that enable comparison between historical and present treelines. For the Landsat imagery, an NDVI ratio based on ground truthed Landsat images is used to detect treeline dynamics as well as changes in forest density. To detect these NDVI values of treeline forests are compared to a stable reference forest. Preliminary results indicate that the elevation of the *Erica* treeline increased, which has to be understood against important land use changes on the mountains and regional temperature rise.

Key words: Treeline dynamics, Climate Change, DEM, NDVI ratio, North Ethiopian Highlands

Increasing frequency of geomorphic disasters: climate change or geomorphic change?

BRUSCHI V.(1), FORTE L.M.(2), HURTADO M.(2), BONACHEA J.(1), DANTAS-FERREIRA M.(3), RIVAS V.(1), GÓMEZ-AROZAMENA J.E.(1), REMONDO J.(1), CENDRERO A.(1)

(1) Universidad de Cantabria, SANTANDER, SPAIN ; (2) Universidad Nacional de La Plata, Argentina, BUENOS AIRES, ARGENTINA ; (3) Universidade Federal de São Carlos, SAO PAULO, BRAZIL

Different types of data obtained by the authors in the last 20 years have led to the formulation of some concepts and a hypothesis related to the present evolution of geomorphic processes. Data gathered included landslide frequency, sedimentation rates, river discharge, rainfall and different indicators of human influence on land surface. Results obtained indicate that there is an important and growing *human geomorphic footprint*, which is causing a *global geomorphic change* reflected by the intensification of geomorphic processes. Geomorphic processes' intensification appears to be a characteristic of the Anthropocene, and is particularly marked since mid-20thcentury, coinciding with the great demographic and economic post World War II expansion. This "great geomorphic acceleration" does not seem to respond to climate change, but to human modification of land surface. A hypothesis, based on the driving force-pressure-state-impact-response conceptual model, was formulated to explain the results indicated.

If the hypothesis were correct, human influence and global geomorphic change should be reflected differently in the different types of natural hazards and risks. The number of all types of natural disasters registered in databases should be expected to increase with time, due to both growing human exposure and better data-gathering. Seismic and volcanic disasters should increase least. Climatic disasters, affected by the greater frequency of extreme events related to climate change, should increase more. Finally, geomorphic disasters, affected by both climate and geomorphic change, should increase most. Global data on the frequency of those disasters are presented and compared with data on potential natural and human drivers. The results obtained are to a very great extent coherent with the hypothesis and reinforce the idea that mitigation of geomorphic disasters should not focus mainly on climate, but rather on land-use issues.

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La méthode du transect fixe pour la détermination du bilan sédimentaire et la caractérisation de sa variation spatio-temporelle : application dans une région aride du Sud tunisien

OUERCHEFANI d.(1), CALLOT Y.(2), DELAITRE E.(3), ABDELJAOUED S.(4)

(1) institut des regions arides, MEDENINE, TUNISIA ; (2) Faculté de Géographie, Histoire, Histoire de l'Art, Tourisme, Université Lumière, Lyon2, LYON, FRANCE ; (3) Institut de Recherches pour le Développement, MONTPELLIER, FRANCE ; (4) Faculté des Sciences de Tunis, TUNIS, TUNISIA

Les travaux sur l'hétérogénéité spatio-temporelle de la surface en relation avec l'érosion éolienne sont peu nombreux. Ce sont des mesures ponctuelles et instantanées des paramètres physiques, prenant peu en compte les formes éoliennes comme marqueurs de dynamique et de changement du milieu. Ceci constitue un handicap dans l'analyse de ces espaces, et notamment de leur fonctionnement. La conception de méthodes pour la compréhension de l'organisation spatiale spécifique des paysages éolisés et leur suivi spatio-temporel est donc essentielle. Cela pour pouvoir quantifier des bilans sédimentaires annuels et saisonniers sur des sites peu instrumentés ne bénéficiant pas d'enregistrements automatiques de variables météorologiques.

Dans ce travail, nous proposons une méthode pour la quantification multi-temporelle du bilan sédimentaire à l'échelle d'un transect. Elle a l'avantage de lier la quantité de sable déposé/érodé avec le changement des états de surface. Elle consiste à délimiter puis confronter les zones d'accumulation et de déflation du matériel sableux avec celles à bilan sédimentaire positif et négatif. Pour ce faire, les techniques d'analyse linéaire de point quadrat et de nivellement par cheminement ont été appliqué sur un transect de 500 m de longueur pendant 2 années.

Les résultats montrent que le bilan global est positif avec toutefois des fluctuations saisonnières. Les zones d'accumulation peuvent être réellement des zones de déflation, malgré la présence d'indicateurs qui témoignent du contraire. Inversement les zones de déflation peuvent être réellement des zones d'accumulation. Ce travail est un apport pour la quantification des budgets sédimentaires à l'échelle stationnelle. Il permet, dans le cadre d'observatoire, d'harmoniser les méthodes de collecte/analyse des données pour produire régulièrement une synthèse de la situation de l'environnement local dans un format qui permet de faire des comparaisons aux échelles aussi bien temporelles que spatiales.

Response of morphoclimatic system dynamics to global changes and related geomorphological hazards: outline and perspectives of a national Italian research project

BARONI C.(1), ANZIDEI M.(2), DALLA FONTANA G.(3), DEL MONTE M.(4), FREPPAZ M.(5), MASTRONUZZI G.A.(6), SMIRAGLIA C.(7), SOLDATI M.(8)

(1) Dipartimento di Scienze della Terra, University of Pisa, PISA, ITALY ; (2) Istituto Nazionale di Geofisica, Centro Nazionale Terremoti, ROMA, ITALY ; (3) TESAF - Dipartimento Territorio e Sistemi Agro-forestali, University of Padua, PADUA, ITALY ; (4) Dipartimento di Scienze della Terra, University of Roma La Sapienza, ROMA, ITALY ; (5) Dipartimento di Scienze Agrarie Forestali e Alimentari, University of Turin, TURIN, ITALY ; (6) Dipartimento di Scienze della Terra e Geoambientali, University of Bari Aldo Moro, BARI, ITALY ; (7) Dipartimento di Scienze della Terra, University of Milan, MILAN, ITALY ; (8) Dipartimento di Scienze Chimiche e Geologiche, University of Modena e Reggio Emilia, MODENA, ITALY

Global landscape change and trends of future change are unfilled niches in global change research. We know fairly well how climate has changed in the past with sufficient time resolution, but we do not know how various geomorphological systems in Italy replied or will respond due to their complex dynamics and resilience. Global changes have a strong influence on cryosphere dynamics, on slope evolution, on shoreline variations and, more and more frequently, provoke extreme pluviometric events, floods, sea storms and geomorphological instability.

The main themes of this research project are: i) understanding the effects that global changes have on the sensitive and wide-ranging morphoclimatic systems typical of the Italian peninsula, ii) the ability to assess the effects of these changes on the environmental system through the elaboration of hazard and geomorphological risk scenarios. The most important objectives of the project are: a) the definition of the effects of climate change on the cryosphere in the Italian Alps, b) the characterization of the instability caused by global changes in different morphoclimatic contexts, c) the collection and comparison of series of climate and environmental data sets, and d) the prediction of future scenarios of instability induced by global changes. The systematic collection of environmental data in different morphoclimatic contexts, both through direct monitoring system, and through indirect techniques of investigation, will allow us to reconstruct the historical sequence of key events that have characterized the interactions between natural environment and global changes in Italy. The variety of the morphoclimatic contexts analyzed in this project will provide a significant contribution to the knowledge of the geomorphological setting of the Italian territory in different geographic and climatic regions and of the state of activity of the morphogenetic agents that have guided and will guide landscape modelling.

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Humans have impacted atmospheric C-exchange since the introduction of agriculture by changing the geomorphic cascade

VERSTRAETEN G.(1), VAN OOST K.(2), BROOTHAERTS N.(1), NOTEBAERT B.(1), DOETTERL S.(2), WIAUX F.(2), SIX J.(3)

(1) KU Leuven, LEUVEN, BELGIUM ; (2) Université Catholique de Louvain, LOUVAIN-LA-NEUVE, BELGIUM ; (3) UC Davis, DAVIS, UNITED STATES

Early human impact on the global C cycle through deforestation has been demonstrated and it is estimated that between 50 and 357 Pg C have been released from vegetation and soils to the atmosphere in the pre-Industrial era. However, the contribution of erosion and sediment storage on C exchange between terrestrial ecosystems and the atmosphere has not been accounted for, although long-term sediment budget studies show that large volumes of soil material have been mobilized since the introduction of agriculture. Furthermore, through human impact also the geomorphic setting itself has changed thus altering ecosystems such that the C exchange with the atmosphere changed as well. For the 780 km² Dijle River catchment in the western European loess belt, the impact of human induced soil erosion on C exchange with the atmosphere was quantified by combining a sediment budget with detailed inventories of C in soils and sediments. For the period 4000 BC to AD 2000 it was estimated that anthropogenic erosion induced a net C sink, offsetting 39% of the C emissions due to land cover change since the advent of agriculture. However, this sink is limited by a significant loss of buried C in colluvial settings lagging the burial: ca. half of the original C buried in the colluvial stores remains after 500 years. Contrary to colluvial settings, C burial in alluvial settings appears to be more conservative, which is most probably related to higher autochthonous production and preservation rates in wet floodplain soils. Data from the floodplain sediments also indicate that human induced high rates of minerogenic sedimentation since the Middle Ages were able to capture more C in the floodplain than the Mid-Holocene natural wetlands through peat formation. The result for the Dijle River catchment, with a long history of human impact, can be used to estimate the longer term impact of the major agricultural expansion of the 19th and 20th century worldwide on global C budgets.

Pre-Columbian Anthropogeomorphic Impacts in North America

JAMES A.
University of South Carolina, COLUMBIA, UNITED STATES

The geomorphic effectiveness of humans is linked to rates of change and the resiliency of environmental systems. Concepts of Pre-Columbian anthropogenic change in the New World have been revised recently. The 'Pristine Myth' of benign land use has been challenged by recognizing large populations that substantially altered environments. Such revisions assess early anthropic changes to ecological and climate systems, but conflict with many geomorphic studies that show slight or negligible pre-European anthropic erosion or sedimentation. Numerous studies in North America and Australia, for example, document well-developed floodplain soils abruptly overlain by deep historical alluvia. Many geomorphologists have inferred relatively stable geomorphic conditions prior to European land-use changes from these alluvial records. Stream restoration projects often assume pristine geomorphic conditions by describing reference reaches as natural or undisturbed. Recognition of legacy sediment may also belie this assumption.

Studies of floodplain and lacustrine sediment in North America are summarized to compare rates of sedimentation before and after European arrival. The focus on sediment separates geomorphic from ecological impacts. Evidence of early sedimentation in North American is mapped and compared to maps of pre-Columbian agriculture. Spatial patterns of pre-Columbian anthropogeomorphic effectiveness are non-uniform. Sedimentation was substantial in some areas, e.g.population centers in Meso-America, but negligible in others. Subsequently, European deforestation, agriculture, milling, wetland drainage, and mining increased sedimentation rates by an order of magnitude in some basins but had little effect in others. Assumptions that all environmental change had geomorphic responses over-simplify and exaggerate anthropogeomorphic change, which was less than ecologic change and often far less than geomorphic changes induced later by some European settlements.

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Quaternary Marine Terraces on Cyprus: Constraints on Uplift and Pedogenesis, and the Geoarchaeology of Palaipafos

ZOMENI Z.(1), NOLLER J.-. .S.(2), IACOVOU M.(3)
(1) Cyprus Geological Survey, LEFKOSIA, CYPRUS ; (2) Oregon State University, CORVALLIS, UNITED STATES ; (3) University of Cyprus, LEFKOSIA, CYPRUS

This work focuses on the coastal environment of Cyprus and investigates coastal uplift, geomorphology, pedology and landscape change. It will address the island–wide issue of Quaternary uplift, the rates of pedogenesis in southwestern Cyprus and the landscape response to human occupation for the last 4000 years in the area of Kouklia–Palaipafos. Uplift of Cyprus during the Quaternary was estimated with dated marine terraces and varies along the coast in response to deformation on different geological structures. Rates of pedogenesis were studied and estimated using soils on these dated surfaces. Uplifted marine terraces present the opportunity to get a good estimate for the time factor in the soil-forming function because the time of subaerial exposure for these surfaces is well known. A soil-development index (PDI) served as a proxy for age. Prior soil surveys note rubification and calcium carbonate accumulation as two distinct characteristics of the area's soils and thus proved again to be strong PDI indicators The southwestern part of Cyprus was chosen for this part of the study due to the availability of soil and new geological data and, most importantly, because the uplift evident in this area suggests numerous marine terraces well-separated in time for developing a reliable soil-age relationship (chronofunction). The last part focuses on a small part of southwestern Cyprus, the ancient polity of Palaipafos. Established in the second millennium BC, at the beginning of the of the Late Bronze Age, most probably prospered from the production and trade of copper and later became known for its temple to the goddess of Aphrodite. The diversity of the geomorphological units on the landscape of Palaipafos is evidence for the tectonic and climatic dynamics of its environment contributing to a shifting ancient harbour. Field investigations have benefited ongoing archaeological excavations by identifying new promising sites of previously unexcavated monuments.

Sea Level Variability, Shoreline Response and Global Environmental Change: Observations from Eastern England

BROOKS S.(1), SPENCER T.(2)
(1) Birkbeck, University of London, LONDON, UNITED KINGDOM ; (2) University of Cambridge, CAMBRIDGE, UNITED KINGDOM

It is well known that global environmental change will drive sea level rise and it is commonly assumed that sea level rise will lead to enhanced shoreline retreat and coastal land loss. However, moving from global-scale inference to regional and local consequences continues to be problematic for several reasons. Firstly, sea-level rise can be measured on an annual timescale but its influence on coastal landforms can only be demonstrable at timescales of decades to centuries. Secondly, even the longest historical datasets on shoreline response generally do not reveal linear trends that might be associated with secular sea level rise, because signals from decadal-scale variability in other driving factors generally overwhelm any such trend. Given that coastal change is event-driven, near-future changes in the direction and intensity of wave climates, and magnitude-frequency characteristics of storms are potentially of greater significance to shoreline response. This assertion is contested (are 'superstorms' really the 'new normal'?) as well as being poorly-specified in atmosphere – ocean models. Thirdly, in addition to sea level variability, waves and storms, coastal retreat is driven by other natural factors – particularly sediment supply - which only weakly (if at all) relate to the main drivers of global change. Anthropogenic activity can intensify these controls on coastal change. Finally, the net impact of this suite of process controls ultimately depends upon accommodation space, the ability of coastal landforms to migrate to new locations in the near-coastal zone. This paper uses the rapidly-retreating soft rock cliffs of East Anglia, UK, to consider these complex challenges. The cliffs are considered in their response to sea level rise; the dynamic of a major atmospheric perturbation, the North Atlantic Oscillation; and in their changing contribution to regional sediment budgets as retreat interacts with a changing coastline topography.

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The implications of last decades sea level variations for coastal erosion: a review

LE COZANNET G.(1), GARCIN M.(2), CAZENAVE A.(3), THOMAS Y.F.(4), LAVIGNE F.(4)
(1) BRGM / Univ Paris 1 / LGP, FRANCE, FRANCE ; (2) BRGM, ORLEANS, FRANCE ; (3) LEGOS, TOULOUSE, FRANCE ; (4) LGP, PARIS, FRANCE

Shoreline erosion is a consequence of the coupled effects of waves and currents on coastal sediments, either available locally or provided by adjacent coastal sedimentary units. In the future, sea level rise due to anthropogenic climate change is expected to exacerbate coastal erosion, but the actual role of this ongoing process in present day's shoreline mobility is still debated.

Starting from a review of papers previously published, we identified two barriers to a better understanding of the actual consequences of contemporary sea level rise in coastal erosion. First, actual sea levels along the coast are generally only known for a few areas where tide gauges are available, whereas subsidence or uplift is a common feature of many coastal areas. Secondly, there is a lack of well-established method for attributing shoreline mobility to a specific factor or to a combination of causes. At present, such methods range from field expertise, analysis of data to schematic or physical modeling. However, no model is presently able to represent accurately all processes accounting for coastal hydro-sedimentary processes.

In spite of these limitations, this review highlights that sea level rise rates in the order of a few millimeters per year are generally not considered as a dominant cause for shoreline erosion. On the contrary, most studies attribute it to the effects of waves, storms, variations in sediment supply and human activities.

Rise and Fall of Palaeolake Megachad

BRISTOW C.(1), ARMITAGE S.(2), DRAKE N.(3)
(1) Birkbeck University of London, LONDON, UNITED KINGDOM ; (2) Royal Holloway University of London, LONDON, UNITED KINGDOM ; (3) King's College University of London, LONDON, UNITED KINGDOM

Palaeolake Megachad lies within central North Africa, at its peak it covered an area in excess of 350,000 km^2 and extended from latitude of 11° to 18° N, an area that currently spans climatic belts from hyperarid Sahara through the Sahel to humid tropical latitudes. At present the Lake Chad is reduced to less than 1% of its maximum extent and the northern sub-basin the Bodélé Depression is completely dry. During the last glacial maximum both basins dried completely. The lake record of climate change is important because it is located within the middle of the African continent far from any marine cores, and due to the extent of its catchment it is more representative of regional moisture balance than small lakes. In addition, most of the lake is shallow and thus sensitive to changes in hydrology.

In this paper we document the rise and fall of palaeolake megachad through the latest Pleistocene interglacial-glacial and the Holocene. In order to determine the timing of lake high-stands and low-stands we have obtained 31 OSL ages from lake shoreline beach ridges as well as dunes that have been flooded when the lake levels rose.

We identify last interglacial (MIS5) high-stand shorelines along the southern margins of palaeolake Megachad. This humid period was followed by a basin wide regression during the last glacial Maximum (LGM) accompanied by aridity with desert conditions prevailing. The Sahara expanded south and sand dunes driven by northeasterly winds migrated right across the basin floor. A return to more humid conditions at the end of the LGM resulted in a rise in the lake levels with lacustrine transgressions flooding over the dunes. Beach ridges provide evidence for early to mid-Holocene highstands. Falling lake levels from the mid-Holocene onwards are documented by lower elevation shorelines and a delta at the where waters overflowed from the southern Chad basin into the northern Bodélé Depression.

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Aggradation/erosion stages of tufa dams during Holocene: a palaeoclimatic comparison between northern Ethiopia and central Italy

DRAMIS F., FUBELLI G.
Department of Geological Sciences, Roma Tre University, ROME, ITALY

The ^{14}C dating of buried soils and peat layers from tufa dammed swampy-lacustrine sequences allows outlining the aggradation/degradation phases of Holocene tufa dams in Central Mediterranean and East Africa. In northern Ethiopia the aggradation of tufa dams started before 9510±100 ^{14}C yr BP. From 4780±70to 2380±50 ^{14}Cyr BP, alternating stages of dam erosion/aggradation occurred, eventually followed by dam incision down to the present valley floors. *In the first stages, the deposition rates of tufa were likely higher, enough to allow the formation of a relatively deep lacustrine basin upstream. In Central Italy the ^{14}C dating of organic-rich layers from the backfill sequences of Holocene tufa dams indicates that the deposition of tufa first occurred prior to* 8240±75*^{14}C yr BP.Since 3760±60 ^{14}C yr BP a sequence of alternating periods of erosion and aggradation occurred. After* 2825**±**60*^{14}C yr BP fluvial incisioncut the dam down to the present valley bottom. Also in this case, the first stages of dam aggradation were characterized by deposition rates high enough to form a lacustrine basin upstream.* The occurrence of comparabletrends of tufa dam aggradation/erosion in both Mediterranean Europe and East Africa seems to indicate that climatic fluctuations have been responsible for significant environmental changes at a supra-regional scale. T*he high rates of tufa deposition in the lower Holocene and their decline in the mid-late Holocene, followed by the complete incision of the dam, seem to provide some support to the ground/surface thermal disequilibrium model of tufa aggradation/erosion (Dramis et al.,*Physics and Chemistry of the Earth, Part-A, 24/10, *1999). Consideration should be also given to the incidence of wet/dry climate changesand the middle-late Holocene aridification trend in both regions. In this context,* the short-lived *cycles of erosion/aggradation recorded in both areas could be explained by the occurrence of high frequency dry/wet climate fluctuations.*

Infilling constraints of the Estuary of River Alcabrichel since Middle Holocene

RAMOS-PEREIRA A.(1), RAMOS C.(1), TRINDADE J.(1), DANIELSEN R.(2), MONGE-SOARES A.(3), PORTELA P.(3), MARTINS J.(4)

(1) Centre of Geographical Studies, Institute Geography Spatial Planning, Univ.Lisbon, LISBON, PORTUGAL ; (2) Laboratorio de Arqueociências, LARC/CIBIO/InBIO, DGPC, LISBON, PORTUGAL ; (3) Laboratório Radiocarbono, IST/ITN,Univ. Técnica Lisboa, LISBON, PORTUGAL ; (4) Laboratório Radiocarbono, IST/ITN,Univ. Técnica Lisboa; Univ. Algarve, LISBON, PORTUGAL

The mouth of the River Alcabrichel (Portuguese Estremadura) is a complex estuary conditioned by a diapiric tectonic (Caldas da Rainha fault). The estuary has two alluvial plains separated by a limestone gorge, and was selected to evaluate the balance between fluvial and marine influences, the responses to climatic fluctuations and the impact of human activities in the drainage basin, during the last 5000yrs.

Several hand-operated mechanicalcores were extracted in sediments of the two alluvial plain estuary, of whichtwo are discussed here reaching respectively depths of 7.70m and 5.03m.

A multidisciplinary approach was performed based on a detailed sedimentological analysis of 1cm core samples in orderto identify: (i) sediment textural changes includingtheir origin (marine or fluvial), helping to establish the sequence of wet and dry periods during the middle and upper Holocene; (ii) pollen and npp that provide information about the climatic and environmental changes natural or human induced ; iii) ratios of stable isotopes in fine sediments, to define the sources of organic matter (marine or continental); and (iv) their absolute chronology using radiocarbon dating.

The results show that geomorphologic conditions constitute a strong control on the generation of new meso featuresand, consequently,on the estuary evolution. An old estuary exists inland the gorge, remaining active until *c.* 2000 BP. The genesis of the distal section occurred since then, where the 1755 tsunami play an important role. The balance between sea level change, climatic change and anthropogenic influences on landscape evolution will be discussed.

Acknowledgements

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Sediment fluxes on steep LIA moraine slopes in the Central Austrian Alps

BECHT M., HILGER L., DUSIK J.M., NEUGIRG F., HECKMANN T., HAAS F.
Department of Physiscal Geography, EICHSTATT, GERMANY

Melting glaciers and degrading permafrost lead to a weakening of moraine wall stability and as a consequence to an ever increasing availability of sediment for geomorphic processes in high mountain areas. In combination with the predicted change in frequency-magnitude relationships of summer precipitation events, this forms the basis for highly intense fluvial reworking of sediment and debris flow activity.

The work presented here is part of the joint project PROSA (High-resolution measurements of morphodynamics in rapidly changing PROglacial Systems of the Alps) which deals with the generation of the sediment budget for an alpine catchment in the Austrian Alps.

Multitemporal airborne and terrestrial LiDAR data were used for the detection of volume changes on lateral moraine slope sections within the proglacial zone of the Gepatschferner, Kaunertal, Ötztal Alps. Six test sites along a chronosequence of deglaciation on the LIA lateral moraine were selected and monitored repeatedly using a terrestrial laser scanner to acquire digital terrain models of high spatial and temporal resolution.

Sediment budgets for each time interval and lateral moraine subsection were calculated, and different glacial stages digitized from historical maps and multi-temporal orthophotos were used to estimate the respective time passed since deglaciation. This space-for-time substitution approach made it possible to calculate section specific erosion rates, to calibrate a sediment exhaustion curve for the Gepatschferner lateral moraine and to monitor the development of morphometric parameters of the gullies dissecting the lateral moraines.

Physical Geography, Geomorphology and Global Environmental Change: Perspectives from the Developed and Developing World

MEADOWS M.E.(1), SLAYMAKER O.(2), MOREIRA-MUNOZ A.(3), BRIERLEY G.(4), CLIFFORD N.(5), ALCANTARA-AYALA I.(6)

(1) University of Cape Town, CAPE TOWN, SOUTH AFRICA ; (2) University of British Columbia, VANCOUVER, CANADA ; (3) Pontificia Universidad Catolica de Chile, SANTIAGO, CHILE ; (4) University of Auckland, AUCKLAND, NEW ZEALAND ; (5) King's College, University of London, LONDON, UNITED KINGDOM ; (6) National Autonomous University of Mexico, MEXICO CITY, MEXICO

In science there is a tension between the need for detailed, highly focused work on specialised components of the physical environment (as in geomorphology) and more generalised, integrative approaches that attempt to resolve complex multi-dimensional and trans-disciplinary problems (as in physical geography). The tension is further amplified by the requirement and, in certain situations, imperative to conduct research that is applied and addresses particular societal, governmental or corporate needs. Applied research is, however, prone to conditions set by funders and may not always encourage the pursuit of fundamental scientific problems that are essential to the advance of the discipline as a whole. The socio-economic and political context may also influence the degree to which – and type of - physical geography research that is feasible in a particular country. This paper explores the status of physical geography and geomorphology in several developing and developing world settings with a view to comparing the challenges of pursuing the science across a variety of national contexts. A number of examples of the status of the discipline in diverse contexts are provided and the trajectory of physical geography is contemplated in each of these circumstances. Physical geographers and geomorphologists clearly need to engage with issues around the wider problems of global environmental change and the ICSU/ISSC 'Future Earth' framework and this, along with other approaches, may represent an opportunity to improve the level of funding for physical geography and geomorphology and to attract higher student enrolments without slavishly bending to the obligations inherent in institutional or government contract research.

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Poster presentations:

Seven years of rockfall monitoring in the Mont Blanc massif to validate the relationship between permafrost degradation and rockfall

DELINE P., RAVANEL L.

EDYTEM Lab, Université de Savoie, CNRS, LE BOURGET-DU-LAC, FRANCE

Rockfall is a major natural hazard in high mountain regions and its frequency is growing, especially since two decades. Given the lack of systematic data on rockfalls, the relationship between permafrost degradation and rockfall has however remained difficult to assess.

Data on rockfall were acquired for 2003 and the period 2007-2012 thanks to a satellite image of the Mont Blanc massif and a network of observers (mountain guides, hut keepers and mountaineers) in its central part (57 % of massif area), respectively. To ensure a higher completeness of the inventory, fieldwork is conducted every fall, whereas Summer 2003 rockfalls in the whole massif were identified from their supraglacial deposits. Rockfall parameters were calculated in a GIS.

182 and more than 330 rockfalls (maximal volume: 43 000 m^3) occurred during the Summer 2003 heatwave and the period 2007-2012 respectively.

Most of the rockfalls occur during the hottest months of the year. Modellingsuggests the presence of permafrost in nearly all of the affected rockwalls, and massive ice was observed in at least 45 scars during the period 2007-2012. The very high frequency of the Summer 2003 rockfalls can only be explained by permafrost degradation. Several other elements support permafrost degradation as main triggering factor of rockfall: mean elevation of 2003 and 2007-2012 scars (3335 m a.s.l.) is much higher than the mean rockwall elevation (2880 m a.s.l.) while very few detachments occur below 3000 m a.s.l., which suggests that the main triggering factor is not ubiquitous; most affected altitudinal belt is 3200-3600 m a.s.l., with modeled warm permafrost (> -2°C); the hotter the summer, the higher the scar elevation; sharp contrast in scar elevation between north and south faces; rockfall especially affects topography prone to permafrost degradation such as pillars, spurs and ridges.These results suggest that the permafrost warming is the major rockfall triggering factor at high elevation.

Role of wind activity in the forest opening in Québec's southern portion of the spruce lichen woodland, Québec, Canada

ROBITAILLE A.
Universite Laval, QUEBEC, CANADA

This study presents the impacts of wind activity following forest fires over several thousand square kilometres in the southern portion of the spruce lichens woodlands in the provinceof Québec. This phenomenon had not been studied, and compared to other regions of the Canadian boreal zone wind activity in this area it is unique in its intensity and progression.

Effects of wind, sand dunes and blowouts, occur in many areas between the 51st and 53rd degree of northern latitude, corresponding to the transition between the spruce-moss forest and spruce-lichen woodlands. The study uncovered huge areas composed of water-deficient sandy soils. There are indications that increased wind activity triggered by forest fires led to the development of aeolian erosion and sand dunes in this region. This phenomenon leads to the loss and degradation of forest soil and most likely contributes to opening up forest cover over a long period of time, notably by a return to a primary stage of soil development. According to our observations, wind effects increase following forest fires in this region.In addition, a hypothesis was derived that the effect of the wind in winter can damage the forest regeneration and maintains low density forests.

For the area under study as well as areas located further north, climate change scenarios predict that the 800 growing degree-day isotherm could shift northward. In theory, this would favour the northward expansion of black spruce forests. In this context of climate change, we describe the extent of wind activity to provide an overview of the situation and to understand its evolution over time, in connection with climate. For the coming decades, this extent of wind activity and the abundance of very dry soil could limit the northward expansion of black spruce forests and reduce the area of productive forest land.

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Responses of Pinus tabulaeformis tree-ring to climatic metrics in Hasi Mountain, China

LU R., JIA F., SHANG Y., GAO S., CHEN Y.
Key laboratory of environmental change and natural disaster, MOE, Beijing Normal University, BEIJING, CHINA

The transition zone between the Mu Us desert, the Tengger Desert and the Loess Plateau is sensitive to climatic changes. Former dendroclimatic researches have found that precipitation and temperature(especially that of the warm season) both played important roles to tree growth in this area.Therefore, it is necessary to select a suitable climatic metric as predictor of tree-ring width or to be reconstructed using tree-ring growth.

In this research, we collected *Pinus tabulaeformis* tree-ring cores from Hasi Mountain of China and analyzed responses of *Pinus tabulaeformis* tree-ring to different climatic metrics.

Correlations of tree-rings widths withprecipitation and temperature suggested that most monthlyprecipitation had positive correlation with tree growth while temperature was negatively correlated, which indicated that precipitation and temperature both restrict the tree growth in Hasi Mountain. However precipitation or temperature alone could not well reveal the relationships between tree-growth and climate, therefore we try to look for a comprehensive index to reveal the response of tree-growth to moisture. Three indicesincluding Walter index, de Martonne aridity index as well as PDSI were selected to further analysis.

The consistent results are found in correlations between tree-ring width and Walter index and de Martonne aridity index, but the correlations are low in single month which hardly pass the test, the correlations are stronger in combined month than in single months. Compared with these two moisture indices, the PDSI has the strongest correlation with tree-rings width during the whole period (from September of the previous year to September of the current year), all correlation coefficients were significant at the 0.01 levels, and the strongest correlation occurred in June-July. The upper analyses indicated that the PDSI was an appropriate index as predictor of tree-ring width and could be reconstructed in our study area.

Aeolian activities during Holocene in the Qinghai-Tibet Plateau, China

WU Y.(1), ZHENG Y.(2), TAN L.(3)
(1) MOE Engineering Center of Desertification and Blown-sand Control at Beijing Normal University, BEIJING, CHINA ; (2) College of Real Estate, Beijing Normal University, ZHUHAI, CHINA ; (3) School of Geography, Beijing Normal University, BEIJING, CHINA

With the in-depth research of global change, the study of aeolian activities has become an important aspect of global change research. The aeolian depositon is widely distributed in the Tibetan Plateau, and it is significant to understand the characteristics of aeolian activities and increase the paleoclimatic data of the Tibetan Plateau with the study of aeolian activity process in Holocene. This work selected the middle reaches of Yarlung Zangbo River in southern Tibetan Plateau, and Gonghe Basin in north-eastern Qinghai-Tibet as study areas. By analyses of sedimentary facies, grain size, magnetic susceptibility, $CaCO_3$and organic matter contents, dating with ^{14}C(including AMS ^{14}C) and OSL methods, the process of aeolian activities During Holocene was reconstructed. The results show that, 1) There are three cold events in 8.5-8.0 ka B.P., 4.3-4.2 ka B.P. and 3.5-2.6 ka B.P. in the Middle Reaches of Yarlung Zangbo River, there are four cold events in 5.5-5.0 ka B.P., 4.4-4.2 ka B.P., 3.0-2.1 ka B.P., 0.5 ka B.P. in Gonghe Basin. 2) Century-scale climatic events are similar in occurrence times both in southern and north-eastern Qinghai-Tibet Plateau, but both the start and end of the stable warm stage are earlier in southern part of the Plateau than those in east-northern part. The cold events are characterized by strong aeolian activities and sand dune activation. The stable warm stage in the warm mid-Holocene period is characterized by dune fixation and soil development.

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Tree-ring based PDSI reconstruction from AD 1804 for the Hasi Mountain, northwestern China

GAO S., JIA F., LU R., SHANG Y., CHEN Y.
Key Laboratory of Environmental Change and Natural Disaster, Ministry of Education of China, Beijing Normal University, BEIJING, CHINA

A 206-year chronology was developed using *Pinus tabulaeformis*tree-ring data fromHasi Mountain in northwestern China. Based on the correlation analysis between tree-ring width and climate data, a June-July PDSI series from AD 1804-2009 was reconstructed. The PDSI reconstruction showed that periods of wet years occurred in AD1804-1805, 1868-1867, 1887-1895 and 1948-1952, whereas dry periods occurred in AD 1926-1932, 1990-1992 and 2005-2006. The years AD 1926-1932 are the driest period in the reconstruction, coinciding with records from documents, missing rings and other reconstructions. Four significant cycles (2.3 yr, 2.6 yr, 3.4 yr and 68 yr) were found by spectrum analysis in the reconstruction,and the high frequency cycles of 2.3 yr, 2.6 yr and 3.4 yr are consistent with QBO and ENSO.

Assesing lacustrine sediment for environmental changes, Red Lake(Romania)

HALIUC A.(1), HUTCHINSON S.(2), FRANTIUC A.(1), MINDRESCU M.(1), ROMANESCU G.(3)
(1) Stefan cel Mare University, SUCEAVA, ROMANIA ; (2) University of Salford, MANCHESTER, UNITED KINGDOM ; (3) Al.I.Cuza University, IASI, ROMANIA

Located in the north east of Romanian Carpathians, Red Lake is a unique valley lake formed by a landslide. The landslide occurred in the Hăşmaş Massif in the Central Group of Eastern Carpathians blocking the Bicaz Brook at its confluence with the Suhard Brook. Red Lake is a significant and interesting natural barrage lake because of its origins and its multiple uses and consequently needs to be subjected to efficient environmental management.

The aim of this study is to examine the proprieties of the recently taken lacustrine sediments in order to achieve a perspective on the environmental changes.

The sediments were taken in the summer of 2011 using an inflatable boat, a hand GPS and a gravity corer. Each core was sectioned at 2 cm interval, dried at 37 C, subjected to multiple analyses using: pXRF analysis (Niton XL3t 900)for elemental composition, Bartington Instruments Ltd MS2 and C sensor, Molspin Ltd Pulse Magnetiser and Minispin Fluxgate Magnetometerfor magnetic characteristics, LOI (loss on ignition) to estimate the total organic matter and carbonate content, Horiba Particle LA-950V2 for particle size measurements.

The geochemical, mineral magnetic, organic and particle size characteristics of the samples reflect changes in the surrounding environment due to anthropogenic actions and natural events. The surface, basal sediments as well as cores taken near the main limbs have different characteristics. This indicates the different sources of the sediments as well as differential deposition. The longest core appears to cover a considerable part of the history of the lake confirming the high rate of infilling as well as other important environmental episodes. Even though, this well-known water body is declared a protected area this study provides an insight for the necessity of environmental management for its longevity and sustainability.

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Vegetation changes and associated climate variations during the past ~40,000 years reconstructed from the Shaamar eolian-paleosol section in northern Mongolia

MA Y.(1), MENG H.(1), LIU K.B.(2), TAO M.(3)
(1) Key Laboratory of Environmental Change and Natural Disaster, Ministry of Education of China, Beijing Normal University, BEIJING, CHINA ; (2) Department of Oceanography and Coastal Sciences, School of the Coast and Environment,Louisiana State University, BATON ROUGE, UNITED STATES ; (3) College of Resources Science and Technologh, Beijing Normal University, BEIJING, CHINA

This study presents the vegetation changes and associated climate variations at the Shaamar eolian-paleosol section in the northern Mongolian Plateau. The semi-quantitative reconstructions of paleovegetation types and temperature and moisture indices show that the vegetation in the Shaamar area was a taiga forest between ~40,000 and ~30,000 cal. yr BP when the reconstructed moisture level was the highest of the past ~40,000 years. The vegetation during the ensuing period from ~30,000 to ~22,000 cal. yr BP was mainly a steppe under low temperature and low moisture conditions. The vegetation during the period from ~22,000 to 11,000 cal. yr BP varied from a taiga forest, through steppe and forest steppe, to a desert steppe. The climate was cold and dry in the early phase (~22,000 to ~20,000 cal. yr BP), and warmer and somewhat drier in the later phase (~18,500 to ~ 11,000 cal. yr BP). The vegetation has been primarily dominated by forest-steppe during the past ~11,000 years with more taiga-like vegetation during ~ 11,000– ~ 9,300 and ~ 3200 – ~ 400 cal. yr BP. The reconstructed temperature was rising from ~11,000 to ~6000 cal. yr BP and falling since ~6000 cal. yr BP. The reconstructed moisture was low from ~10,000 to ~3200 cal. yr BP and then dramatically increased during the past ~3200 years. Comparison of our pollen record from the Shaamar section with other paleoclimatic records from China and Greenland suggests that the climate changes in the northern Mongolian Plateau have been controlled or modulated by ocean-atmospheric coupling dynamics in the North Atlantic region.

The grain size component of winter sand and summer sand of the red sand dunes in the coast of southern China and its paleoclimatic significances

YU M.
School of Geographical Sciences, Fujian Normal University, FUZHOU, CHINA

The “Old Red Sand” mainly distributed in the coastal zone of Fujian, Guangdong, Taiwan and other places of the southern China is Quaternary red sand dunes. Previous studies suggest that the Old Red Sand were coastal beach sediment, later uplift to the coastal zone. However, later studies have found that the Old Red Sand is constituted by fine sand, the monotonous material; excluding marine micro-organisms debris. Comprehensive analysis from the particle size, geochemical elements, magnetic susceptibility indicate that the Old Red Sand was the coastal sand deposition. The sources of sand is believed from the low sea level beach sand during the last glacial.

The Old Red Sand recorded monsoon changes. The sequence Old Red Sand samples from Qinfeng section in island of Pintang in Fujian province were collected. Both the winter sand and summer sand samples in the gulf near Qinfeng were also collected. Particle size for the Old Red Sand, winter sand and summer sand have been measured and shown different granularity peaks, respectively locate in 300μm ±, 400μm ± and 260μm ±. Winter sand and summer sand were mixed in different proportions to simulate the particle size distribution of the Old Red Sand. It shows the ratio of 7:3 of summer sand to winter sand determine deposition Old Red Sand, that indicate the duration or intensity of the summer monsoon are stronger during Old Red Sand deposition than that in the postglacial. Moreover, Old Red Sand is in reddish range between brown-red (2.5YR4 / 8), light brown and red (2.5YR5 / 8), which is reddening than modern sand. The four dating samples for the optically stimulated luminescence show that the Old Red Sand formed at 123-62KaBP, the last interglacial. We therefore can reconstruct the East Asian monsoon changes since the last interglacial by proxy of 400μm particle size content from Old Red Sand of the indicators of winter monsoon and 260μm content of summer monsoon.

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Landslide inventory bimodality in volcanised tertiary basin of Puy-en-Velay (France): a geoindicator of climate change

POIRAUD A.
GEOLAB - UMR CNRS 6042, CLERMONT-FERRAND, FRANCE

The inventory of more than 200 landslides in the volcanised tertiary basin of Puy-en-Velay (France) reveals a clear bimodality of their distribution. The surface magnitude/frequency curve of all the landslides determines 2 power-law adjustments i) the first one with a b = -1.54, corresponding to the ancient landslides and palaeolandslides and ii) the second one with a b = -0.51 corresponding to the historical and present-day landslides. The C14 dating of 4 landslides of the first group allows us to determine that Subboreal period was significant for activation or reactivation of high mass movements. Thus, we conclude that these 2 populations of landslide are the expression of different climatic patterns characterised by different level of geomorphic activity. This geomorphic activity is expressed by the synthetic term b of the statistical adjustments. Finally, the landslides, in the study area, seem to be a geoindicator of this climatic temporal diversity.

Sandy Desertification and its Control in Qinghai Plateau, China

ZHANG D., TIAN L., WU W.
Beijing Normal University, BEIJING, CHINA

The Qinghai Plateau is a fragile arctic-alpine area which is one of the places seriously suffered from sandy desertification that threaten people's living condition and impact social sustainable development in China.

Compared with other areas, the main characteristics of the sandy desertified land in Qinghai Plateau are high altitude, lower temperature, less accumulative temperature and shorter frost-free seasons. The Qinghai Plateau has the harshest natural environment in the sandy land of China. Based on field investigation, observation, experiments, and previous studies, this paper used method of multi-subjects synthetic analyses to study sandy desertification and its control in Qinghai Plateau from both macroscopic and microcosmic aspects. The sandy desertification control in Qinghai plateau must be focused on protecting the current vegetation, integrity of protection and harness, and combination of the implement of various important projects for environmental protection.

The engineering measures for sandy desertification control include setting clay sand barrier, *Salix cheilophila* sand barrier, *Tamarix* sand barrier, *Artemisia* sand barrier and straw-checker sand-barriers to fix shifting dunes; and the biological measures include closure for natural vegetation recovery, direct seeding forestation, transplanting seedlings, and so on. New plants such as *Salix cheilophila* and *Tamarix*, which are available in study area, can change from dead sand barrier to live one set in an appropriate season, changing engineering measure to biological ones directly accelerate the progress of forestation and dunes fixation. In addition, we developed new techniques of deep planting *Salix cheilophila* and *Tamarix* with their long stem, which can effectively resist drought; meanwhile it had lower cost and higher live rate. It has resolved the key problem of control sand flow speed and low efficiency, sand burying and wind erosion and low conservation rate for forestation in the sandy area.

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Preliminary results of a national Italian research project: Response of morphoclimatic system dynamics to global changes and related geomorphological hazards

BARONI C.(1), ANZIDEI M.(2), DALLA FONTANA G.(3), DEL MONTE M.(4), FREPPAZ M.(5), MASTRONUZZI G.A.(6), SMIRAGLIA C.(7), SOLDATI M.(8)
(1) Dipartimento di Scienze della Terra, University of Pisa, PISA, ITALY ; (2) Istituto Nazionale di Geofisica, Centro Nazionale Terremoti, ROMA, ITALY ; (3) TESAF - Dipartimento Territorio e Sistemi Agro-forestali, University of Padua, PADUA, ITALY ; (4) Dipartimento di Scienze della Terra, University of Roma La Sapienza, ROMA, ITALY ; (5) Dipartimento di Scienze Agrarie Forestali e Alimentari, University of Turin, TURIN, ITALY ; (6) Dipartimento di Scienze della Terra e Geoambientali, University of Bari, BARI, ITALY ; (7) Dipartimento di Scienze della Terra, University of Milan, MILAN, ITALY ; (8) Dipartimento di Scienze Chimiche e Geologiche, University of Modena and Reggio Emilia, MODENA, ITALY

The knowledge of the relationship between the phenomena of instability and the climate changes is essential for an effective approach to the management of geomorphological hazards and risks in those regions, such as Italy, that are subjected to extremely dynamic and fast environmental changes. Preliminary results on the impacts of climate changes obtained within this project point out an environmental degradation which results in more frequent geomorphological hazard occurred frequently during recent years along the whole Italian territory.

The use of modern survey and measurement techniques and of innovative methods of investigation applied to the modelling and prediction of geological hazards in a broad sense, provides a powerful new tool to face consciously the consequences of the current global changes and of those that can be expected in the future in very different geographical and climatic systems, from the Mediterranean to the Alps. The morphoclimatic environments that we are investigating can be considered true natural laboratories for studying the effects of global changes, ranging from the glacial to the coastal environments. The integrated use of different monitoring techniques and prediction models provides new results extremely useful in the environmental context. The new data on sea-level changes, on phenomena of accelerated erosion and adaptation of the catchments, on changes in the cryosphere, on the ongoing instability in the territory will contribute to the advancement both of basic and applied research. Thus, new data are coming at hand for refining and/or build from the scratch spatial prediction models of geomorphological instability in several environmental contexts.

If complemented with efficient politics for mitigating the environmental risks and with aware actions for territorial management and planning, the topics addressed by this research project will help to improve the safety and sustainability of the communities potentially at risk.

A synthesis of landscape the Pantanal of Mato Grosso from theoretical and methodological sketch of G. Bertrand

FONSECA G.
USP, SAO PAULO, BRAZIL

The concern in prioritizing and classifying the natural environment is based clearly systemic approach. The two principles have converged geosystems: homogeneity and differentiation, are considered a homogeneous structure containing differentiated structures, which indicates the need to take into account the scale of analysis, since the more general scale, fewer differences will be found. In order to classify the landscape of the Pantanal respecting an order scalar, ie, placing the units of this landscape according to time and space. We sought to identify the factors, conditions and the general mechanisms of the landscape with a scale greater detail as well as the linkage between the different units from different levels: geosystem and geofacies. Focusing on this case, as the Pantanal wilderness area in general, the geosystem the sub-region of the Pantanal Poconé-MT, is located in the State of Mato Grosso, in Central-West Brazil, adopting the classification of sub-regions of the Pantanal performed by Abdon and Silva (1998) and as geofacies units contained in that sub-region. The partitioning of the landscape from the theoretical and methodological outline proposed by Bertrand (1971) was a way to analyze and understand the dynamics between the different components of the same and even to identify their specific characteristics. The definition of the type of landscape found in geosystem was performed taking as elements anchors vegetation, morphological features and materials that compose them.

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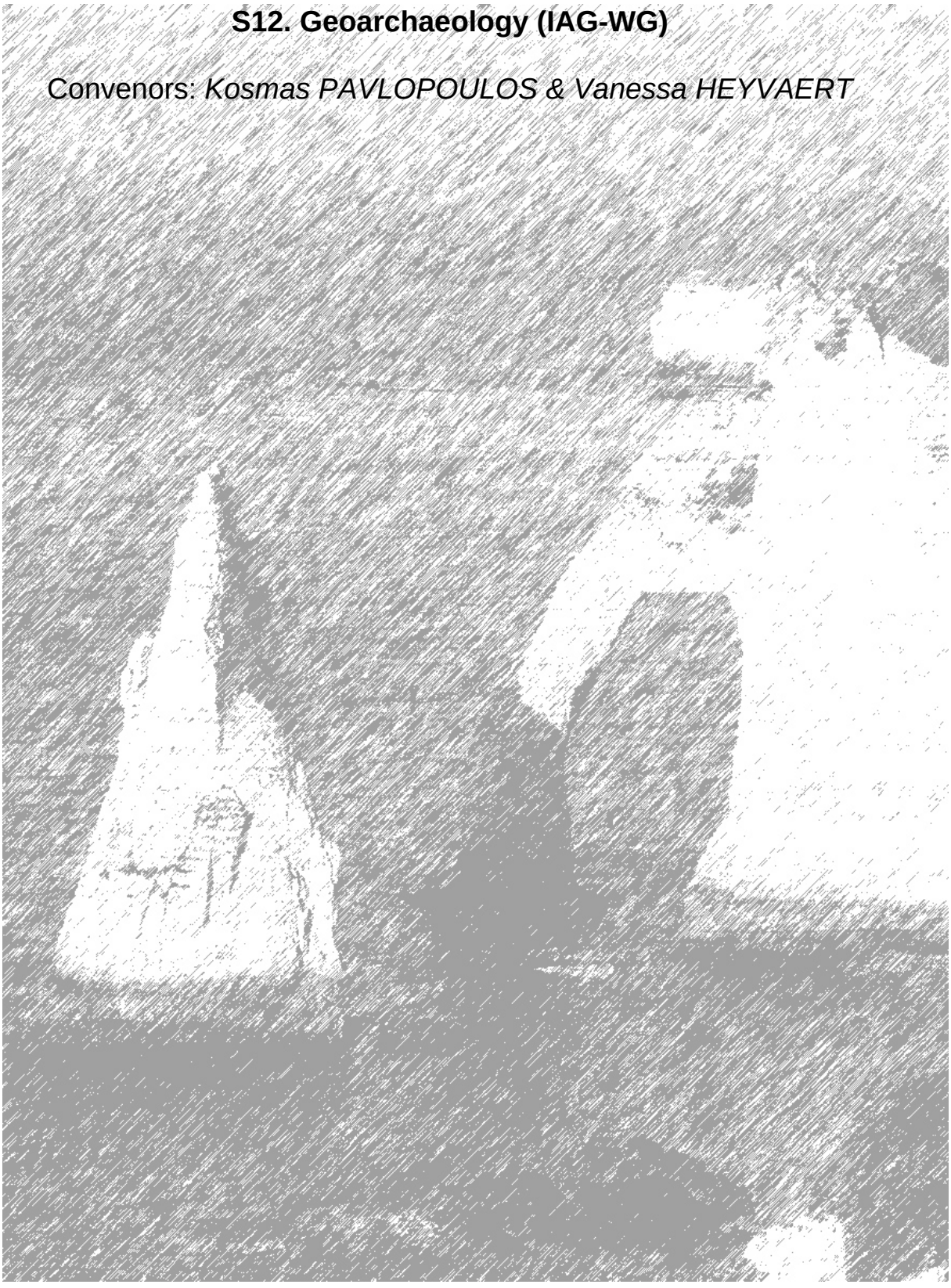
S12. Geoarchaeology (IAG-WG)

Convenors: *Kosmas PAVLOPOULOS & Vanessa HEYVAERT*



Oral presentations:

Relative sea level changes during Roman times in the NW Mediterranean, a geoarchaeological approach

MORHANGE C.
Institut Universitaire de France, AMU, CEREGE, AIX-EN-PROVENCE, FRANCE

Fish tanks become fashionable throughout the Mediterranean area between the 1st century BC and the 1st century AD. Because of this narrow chronological window, and their link to former sea level, they constitute precious archives to investigate RSL since the Roman period, especially when combined with fossilized marine benthos found attached to the walls. Here, we present new results from an integrated analysis of a fish tank located in the Roman colony of Fréjus, southeastern France. The well-preserved biological remains on the fish-tank wall enable us to estimate a RSL rise of 40 ± 10 cm at Fréjus since 2000 years. By contrast, the findings contradict the ~150 cm of RSL change since Roman times reported for the NW Mediterranean by some authors (eg. Lambeck et al., 2004). This contrasts with the 50 cm reported by Pirazzoli (1976). We suggest that the discrepancies between data from the southern coast of France and Italy are essentially due to methodology. Evelpidou et al. (2012) demonstrated that the sluice channels' sliding grooves are not a reliable archaeological indicator of former sea level because they can be located at any depth in the basin.

Our RSL data are in good correspondence with Evelpidou et al. (2012). This range is considerably lower than that proposed by Lambeck et al. (2004) a discrepancy that we attribute to a different interpretation of the hydraulic position of fish tank structures relative to former sea level.

In conclusion, our new data confirm: (1) that no Holocene sea level occurs above the present along the Provence coast, except in the direct vicinity of the maritime Alps near Nice; and (2) that RSL changes since Roman times have been very modest (of the order of a few decimetres). In Provence, the role of sea level in shaping coastal changes is therefore relatively minor in comparison to sediment inputs. (3) The most precise RSL results are achieved by marrying archaeological structures with biological zonation.

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Hellenistic landscapes of the sacred harbour of Delos (Cyclades, Greece): new reconstruction based on sedimentological and geophysical data

DESRUELLES S.(1), PAVLOPOULOS K.(2), APOSTOLOPOULOS G.(3), FOUACHE E.(4), ETIENNE R.(5), HASENOHR C.(6), COSTA L.(5), TRIANTAPHYLLOU M.(7)
(1) UFR d'histoire-géographie, Université de Picardie Jules Verne, Amiens, France et UMR 8185 ENeC (Espaces, Nature et Culture), Université Paris-Sorbonne/CNRS, AMIENS, FRANCE ; (2) Department of Geography, Harokopion University, ATHENS, GREECE ; (3) School of Mining and Metallurgical Engineering, National Technical University of Athens, ATHENS, GREECE ; (4) UMR 8185 ENeC (Espaces, Nature et Culture), Université Paris-Sorbonne/CNRS, PARIS, FRANCE ; (5) UMR 7041 ArScan, CNRS/Paris 1 Panthéon-Sorbonne/Paris Ouest Nanterre La Défense, NANTERRE, FRANCE ; (6) UMR 5607 Ausonius, Université Bordeaux 3/CNRS, BORDEAUX, FRANCE ; (7) University of Athens, Faculty of Geology and Geoenvironment, Department of Historical Geology - Paleontology, ATHENS, FRANCE

During the Hellenistic period, the sacred island of Delos (Cyclades, Greece) was one of the major commercial centres of the ancient Greek world. This centre was linked to the "sacred harbour" which was mainly developed at the 2rdcentury BC in a sandy bay rather little protected from the swell. The reconstruction of the shoreline and landscapes of the main port of the island constitutes an important issue for the knowledge of the development and the economic activities of the ancient city of Delos.

The strong evolution of the port's landscapes, primarily caused by deposit of excavated material at the end of the 19thcentury and the beginning of the 20thcenturydoes not facilitate the reconstruction of the Hellenistic landscapes.

Most studies on the "sacred harbour" of Delos are based on archaeological studies carried out at the beginning of the 20thcentury, whose results are opposing. According to the cross-comparing between data obtained on the relative sea-level changes and data resulting from the investigations carried out between 1995 and 2007 (archaeological surveys, geophysical prospecting and boreholes realized with the financial support of the French School of Athens), we propose a new reconstruction of the landscapes of ancient port of Delos. The obtained reconstruction asks questions about the accessibility of this port for the deep draught boats.

The evolution of the Bay of Elaia and the fate of the former harbour of ancient Pergamum (Western Turkey)

SEELIGER M.(1), BARTZ M.(1), FEUSER S.(2), PIRSON F.(3), KELTERBAUM D.(1), VOETT A.(4), BRUECKNER H.(1)

(1) Institute for Geography, University of Cologne, Albertus-Magnus-Platz, 50923 COLOGNE, GERMANY ; (2) Heinrich Schliemann-Institut für Altertumswissenschaften, University Rostock, 18051 ROSTOCK, GERMANY ; (3) German Archaeological Institute, ?nönü Caddesi 10, 34437 ISTANBUL, TURKEY ; (4) Institute for Geography, Johannes Gutenberg-University Mainz, Johann-Joachim-Becher-Weg 21., 55099 MAINZ, GERMANY

It was the aim of this geoarchaeological research to reconstruct the landscape history around Elaia, the harbour of ancient Pergamum, based on sedimentological evidence of 75 terrestrial and 11 semi-aquatic corings. The focus was on the history of the Hellenistic harbour basin until its total siltation.

The construction of the prominent jetty in Hellenistic times as well as the siltation process of the harbour could be verified by sedimentological criteria and ^{14}C age estimates as dating from the Hellenistic period. The first pollen diagram of the area covers the period of 800 BC to 600 AD, reflecting the human impact on the ecosystem.The quasi natural vegetation degraded due to grazing and lumbering to a maquis-type vegetation already in Hellenistic times. Along with the decreasing importance of Elaia in Late Roman times the vegetation recovered, and around 600 AD a pine forest was established.

Six coring transects helped to identify the maximum marine transgression and thereby the extend of the embayment. In the north it dates to ~2000 BC, in the west to ~1600 BC.

Wallstructures in the western part of the embayment, lying only 0.5-1 m below present sea level, were ^{14}C-dated to the Late Roman period (3^{rd} - 4^{th} century AD) The comparison with similar structures from other periods and places of the Mediterranean makes their use as salt works the most likely interpretation. In order to refine the chronostratigraphy, the sediments immediately below the walls are currently OSL-dated.

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Relative sea-level change in the Central Adriatic during the last 2 ka years - a pluridisciplinary approach

FAIVRE S.(1), BAKRAN-PETRICIOLI T.(2), HORVATINCIC N.(3)

(1) University of Zagreb, Faculty of science, Department of geography, ZAGREB, CROATIA ; (2) Faculty of Science, University of Zagreb, Department of Biology, ZAGREB, CROATIA ; (3) Institute Rudjer Boskovic, ZAGREB, CROATIA

The study of sea-level variations today is more and more pluridisciplinarily approached. Geomorphological, sedimentological, archaeological and biological indicators are used and combined. In studying the 2 ka of relative sea-level change along the Croatian Adriatic coast, different markers have been used. One of the first markers used were the submerged archaeological remains which were later combined with geomorphological markers. In order to approach the problem pluridisciplinary we started to work on the biological markers combining them systematically to the all other available data.

The morphology of well-developed *Lithophyllum* rims combined with ^{14}C dating revealed four phases of relative sea-level changes during the last 1.5 ka. Large algal rims grew during near-stable sea-level conditions that occurred during two relatively colder periods: the Dark Ages Cold Period and the Little Ice Age. This stabilisation has at the same time its morphological reflection in the formation of the tidal notches in the studied area. During the Medieval Climate Anomaly and the Current Warm Period the sea-level rise at a much higher rate.

Our study concludes on a rise of a relative sea-level of about 60±10 cm since 1500 years ago in the Central Adriatic. Thus our results cast new light on the sea-level of Vis Island during Antiquity, which was higher than previously reconstructed on existing submerged archaeological remains. Consequently, this means that the most of the upper level blocks of the submerged Issa quays are missing. On the other side, the perforated *dolia* found *in situ* now perfectly fit in the new biologically defined sea-level (-110±25 cm) for the 1900 ± 100 yr BP period.

Our results clearly demonstrate the relationship between biological, geomorphological and archaeological sea-level markers and also environmental conditions on the studied area in the past and the clear need of such multidisciplinary approach in the study of the relative sea level changes.

Geomorphic hazards and ancient human occupation: the Russian Altai case study

BARYSHNIKOV G.
Altai State University, BARNAUL, RUSSIAN FEDERATION

Modern Altaian culture has deep historical roots evidenced by numerous archaeological finds ranked as the most ancient in Siberia. At last historical phases the major driver of human dispersal was competition between different nations, their mutual ousting, blending or assimilation. As to early modern humans, no single factor governing expanding or contraction of their occupation areas might have existed, but natural environmental control was probably prevailing. The author's geological and geomorphological studies at archaeological monuments of the Russian Altai gave evidences of multiple natural hazards in the last 20-30 ka that influenced greatly on ancient human occupation and preservation of archaeological sites. Degradation of glaciation in the end of the Late Pleistocene caused multiple outbursts of glacial dammed lakes. Catastrophic flood in the Katun River about 25 ka BP changed considerably the whole geomorphic structure of the valley and destroyed all previously existed features of valley morphology together with potential archaeological sites within them. Similar event occurred in the Biya River around 20 ka BP. Mudflows and debris flows occurred in small valleys during the Holocene thermal optimum at 6-8 ka BP. They were promoted by climate warming and increase of precipitation. Given the wide occurrence of such events not only in Altai but also in a wide range of regions, they may probably be regarded as a possible source for what was preserved as "the Deluge" in human's collective memory.

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Geomorphological development and early human settlement pattern of Ruhnu Island in the Gulf of Riga eastern Baltic Sea

MURU M.(1), ROSENTAU A.(2), AUNAP R.(1)
(1) University of Tartu, Department of Geography, TARTU, ESTONIA ; (2) University of Tartu, Department of Geology, TARTU, ESTONIA

In the low relief Baltic Sea region the sea level and shoreline changes have influenced human populations since the Stone Age. The geomorphology of Ruhnu Island in the Gulf of Riga eastern Baltic Sea was studied to understand the pattern of early human settlement and the development of the landscape in connection with the sea level changes and the post-glacial rebound.

The island emerged from the sea c. 12 000 years before present and has an area of c. 12 km² today. The oldest part of the island is surrounded by large well-developed coastal foredune systems reaching mainly 5–15 m a.s.l. The earliest human habitation on the island is dated c. 7300 years before present (Kriiska & Lõugas 2005).

Geomorphometric analysis based on high resolution airborne LiDAR data and ground-penetrating radar studies were carried out, geological profile of the Holocene deposits of the island was studied and sediment samples of the major foredune ridges for luminescence dating were taken. Combination of different methods enabled to clarify the geomorphological development of Ruhnu Island. Digital terrain model, the new data and water level change data from previous studies (Rosentau et al. 2011) were used to reconstruct the palaeogeography of the area by GIS approach, which in turn enabled better comprehension of early human settlement pattern and migration routes in the whole Gulf of Riga region.

References:

Kriiska, A. & Lõugas, L. 2005. Formation of Ruhnu Island and its early settlement history. *Estonia Maritima 7*, 119–132.

Rosentau, A., Veski, S., Kriiska, A., Aunap, R., Vassiljev, J., Saarse, L., Hang, T., Heinsalu, A. & Oja, T. 2011. Palaeogeographic model for the SW Estonian coastal zone of the Baltic Sea. In Harff, J., Björck, S. & Hoth, P. (eds.): *The Baltic Sea Basin*, 165–188. Springer-Verlag, Berlin.

From the hillsides to the port : evolution and management of agrarian and maritime landscapes in the territory of Frejus since the Antiquity (Var, France)

PORTALIER N.(1), PURDUE L.(2)

(1) Service du Patrimoine, Ville de Frejus, FREJUS, FRANCE ; (2) CEPAM-UMR 7264 / Service du Patrimoine, Ville de fréjus, NICE, FRANCE

Built in *Gallia Narbonenis* on the southern Mediterranean coast between 49 and 43 B.C., *Forum Julii* has had to deal constantly with the control of its coastal line in order to protect its port from silting up with sediments from the Argens River, as a result of long-shore drift.

Previous research has focussed on the coastal progradation of the Argens Ria, particularly intense during the Antiquity, and its link with inland landscape change. However, no studies have aimed to explain the sediments origin and the reason for their strong availability. Recent rescue archaeology projects along two tributaries of the Argens River (Caïs and rue Vadon) have enabled us to further discuss this issue and apprehend human occupation and land use in upstream rural areas.

At Caïs, in the rural territory of Fréjus, we conducted archaeological and geomorphic studies combined with paleobotanical and micromorphological analysis, chronologically framed by radiocarbon and ceramic dating. At rue Vadon, closer to the sea, the multiproxy analysis of a 20 m core included stratigraphic description, paleoecological studies and magnetic susceptibility.

These project have allowed us to describe and better grasp the influence and impact of lateral hydrosedimentary dynamics and sediment transport in the Argens valley (coastal line evolution with lagoons and swamps), soil management during the roman period (drainage and irrigation practices), and measure the influence of climatic fluctuations and/or human occupation on soil erosion. The importance of these results and their integration into relevant problematics related to long-term human-environment interactions in southern France highlight the fact that more systematic geomorphic and paleoenvironmental studies should be prescribed in upstream watersheds, in the framework of rescue archaeology.

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Study of a coastal sedimentary sequence containing the remains of a Roman salt-mine in NW Spain

TALLÓN-ARMADA R.(1), COSTA-CASAIS M.(2), LÓPEZ-MERINO L.(3), BLANCO CHAO R.(4), MARTÍNEZ CORTIZAS A.(1)

(1) Department of Soil Science and Agricultural Chemistry, Faculty of Biology, University of Santiago de Compostela (USC), SANTIAGO DE COMPOSTELA, A CORUñA, SPAIN ; (2) Institute of Heritage Sciences (Incipit). Spanish National Research Council (CSIC), SANTIAGO DE COMPOSTELA, A CORUñA, SPAIN ; (3) Institute for the Environment, Brunel University, UXBRIDGE, LONDON, UNITED KINGDOM ; (4) Department of Geography, Faculty of geography and history, University of Santiago de Compostela (USC), SANTIAGO DE COMPOSTELA, A CORUñA, SPAIN

We present a multi-proxy characterization (geomorphological, physicochemical, mineralogical, geochemical, and palynological data), supported by radiocarbon dating, of a sediment sequence which contains the remains of a Roman salt-mine, located in the Ria de Vigo (NW Spain). The aim was to obtain information on the environmental conditions, and the role of climate and human activities in the evolution of this coastal environment, before and after the use of the salt-mine.

Our results indicate a restructuring of the coastline in the sampled area, with a progressive evolution from a marine environment to a more continentalized one. The reconstructed pre-Roman beach formations were buried by the development of a first marsh phase (with presence of Chrysophyceae and Hystrichoesphaeridae cysts indicative of brackish-marine conditions), where the Roman salt-mine was built. The exploitation of salt occurred between II BC/ III-V centuries AD. The collapse of the salt-mine structures was accompanied by a second, less saline, marsh phase (with presence of *Typha latifolia* type and Cyperaceae). A progradation of dune formations is detected during Medieval times, some of which showed a certain degree of pedogenetical evolution, thus stabilization. Additionally, a dramatic decrease in the mesophilous forest cover was also observed in this period, with a large increase in Poaceae abundance. The main changes in the pedo-sedimentary sequence and in the pollen record were synchronous with the already known Late Holocene climatic changes, although human activities may have also played a role on forest evolution (presence of cereal pollen was found in roman period and from the VIth century AD onwards). Results also enabled to propose a reconstruction of the morphodynamic changes in the coast and to discuss on the occurrence of a sea-level higher than today during Roman times, the period of exploitation of the salt-mine.

The submerged chalcolithic lanscape of Taraschina: a key data to understand early Danube delta evolution

CAROZZA J.(1), CAROZZA L.(2), MICU C.(3), BURENS A.(2), DANU M.(4), MESSAGER E.(5), RADU V.(6), LEVÊQUE F.(7), OPREANU G.(8), BALASESCU A.(9)

(1) University of Strasbourg - GEODE UMR 5602, STRASBOURG, FRANCE ; (2) GEODE - UMR 5602, TOULOUSE, FRANCE ; (3) Eco-Museal Research Institute, TULCEA, ROMANIA ; (4) ?Alexandru Ioan Cuza? University, IASI, ROMANIA ; (5) CEPAM - UMR 7264, NICE, FRANCE ; (6) National Romanian History Museum, BUCAREST, ROMANIA ; (7) UMR 7266, LA ROCHELLE, FRANCE ; (8) National Institute of Marine Geology and Geoecology, BUCAREST, ROMANIA ; (9) National Museum of Natural History, PARIS, FRANCE

Until recent works, the Danube delta was supposed to be void of any human occupation as late as late Iron Age. The discovery of a Chalcolithic (Gumelnita A1) occupation in Taraschina in the heart of the upper delta provides a better constraint on palaeogeographic evolution and formation process of the older phase of the delta, related to final sea-level rise in Black Sea.

Data collected in and around the chalcolithic settlement allows us to document the last evolution stage of the blocked delta and its transition to open delta phase. After the Black Sea reconnected to global ocean, the upper Danube delta prograde on fresh water lagoon. Between the reconnection phase ~ 8.4 ky BP to 6.0 ky BP, aggradation has domined the delta evolution, in response to rapid sea level rise. From 6.0 ky BP, decrease in sea level rise rate initiated a stage of rapid progradation of the delta and the beginning of St George lobe formation. This phase is well documented by a series of coring around the site of Taraschina and have huge influence on human settlement occupation. During 6.5-6.0 ky BP rapid aggradation occurred in the lagoon and stops abruptly. This period corresponds to the end of the occupation of Taraschina settlement now wildly silted. During this period, the whole surrounding landscape of the settlement was progressively fossilised under fluvio-lagoonal deposits.

We proposed palaeogeographical reconstitution of the settlement and surrounding area during 6.0 to 4.0 ky BP. The site was builted at the edge of a loessic terrace recognized in core and correlated with other Pleistocene deposits within the delta. This terrace probably constitute the southern extend of the Bugeac plateau. During 6.5-5.9 ky BP interval high variability in fluvial regime is observed. Synchronicity between hydrological regime and settlement occupation is point out, implying rapid adaptation of chalcolithic societies to environmental changes.

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Geoarchaeology of the ancient harbour of Ostia at the river mouth of the Tiber: chronology, stratigraphy and palaeoenvironmental reconstruction

GOIRAN J.P.(1), SALOMON F.(2), MAZZINI I.(3), BRAVARD J.P.(2), PLEUGER E.(1), VITTORI-VILLETTE C.(1), BOETTO G.(4), ARNAUD P.(5), PELLEGRINO A.(6)

(1) CNRS - UMR 5133 - MOM, LYON, FRANCE ; (2) UMR 5600 - Université de Lyon, LYON, FRANCE ; (3) IGAG CNR - Università Roma TRE, ROMA, ITALY ; (4) CNRS - Centre Camille Jullian, AIX-MARSEILLE, FRANCE ; (5) UMR 5189 - Université de Lyon, LYON, FRANCE ; (6) Soprintendenza archeologica di Roma, ROMA, ITALY

Since the Renaissance, many attempts to locate the river mouth harbour of Ostia were undertaken. It was not until the 19th and 20th centuries that Italian archaeologists define an area in the north of the city, near the Imperial Palace. At the turn of the century, a team of German archaeologists confirmed the probable location of the northern basin by using geomagnetic surveys.

We wanted to validate this hypothesis by extracting cores to obtain deep stratigraphy of this area, which is difficult to excavate due to groundwater.

The obtained stratigraphy shows three main units. The basal unit, called pre-harbour unit, is composed of marine sediments dating from the early 1st millennium BC. A middle unit, termed harbour unit, has a grey silty-clay facies recording alternation of marine and river influences. Finally, the uppermost unit, termed post-harbour unit, sign abandonment by generalized silting at the Roman imperial period.

For the first time, a multidisciplinary research combining French-Italian archaeologists, historians, geographers, sedimentologists, geomorphologists and biologists allows to validate the hypothesis of the location of the river mouth harbour basin of Ostia, in the north of the city and in the west of the Palazzo Imperiale. This discovery will advance our understanding of the relationship between Ostia, his river mouth harbour, and subsequently the creation of the Portus in the 1st and 2nd centuries AD.

Human occupation and geomorphological evolution of the Corfu strait (NW Greece) during the Holocene: submarine seismic profiles and sedimentological proxies

CHABROL A.(1), KAPSIMALIS V.(2), FOUACHE E.(3), LECOEUR C.(4)
(1) Ecole francaise d'Athenes, UMR CNRS 8591, Université Paris 1 Panthéon-Sorbonne, ATHENS, GREECE ; (2) Hellenic Center for Marine Research, ATHENS, GREECE ; (3) Université Sorbonne Abou Dhabi, Paris IV, Institut Universitaire de France, ABOU DHABI, UNITED ARAB EMIRATES ; (4) Université Paris 1 panthéon-Sorbonne, UMR CNRS 8591, PARIS, FRANCE

Across the Mediterranean Basin, the glacial-interglacial transition is the transition from hunter-gatherer societies of the Upper Paleolithic and Mesolithic Final companies to Neolithic farmers. In Epirus (northwestern Greece), the lack of archaeological sites is obvious for this period: only two cave sites have yielded Upper Paleolithic occupations and one open air site was dated to the Mesolithic. During the Lateglacial and the Holocene, climate fluctuations have caused major palaeogeographic changes on the coastline evolution and the river dynamics. The prehistoric remains in a continental environment cannot be easily found: they were either destroyed by marine erosion during the post-glacial rebound/fast sea level rise, or they were buried by sediment accumulation.

Our geoarchaeological study focuses on two specific areas: the delta formed by the Kalamas river, and the inlet between the island of Corfu and the mainland.

Thedelta formed by the river Kalamas Kalamas is the smallest of Epirus (64km²). It was occupied on a continuous basis since the Bronze Age. To provide a wide study of the whole Holocene and not just the last 6000 years (global age of formation of the mediterranean deltas), a submarine geophysical surveys was conducted. The profiles obtained by seismic reflection (boomer) helped to highlight paleolandforms submerged by the post-glacial sea-level rise.

Absolute dates associated with the crossing of sedimentological data obtained by drilling (grain-size analysis, magnetic susceptibility, forams and ostracods, fire signal) with those obtained during the geophysical submarine survey, synthesized in a common GIS, permitted to reconstruct the Holocene different paleogeographies in this area. Environmental data are supplemented by intensive archaeological surveys in the Kalamas valley. The intersection of these archaeological data and the paleogeographic reconstructions thus obtained provide a methodological basis for a predictive archaeology.

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The geoarchaeology of the Talgar River alluvial fan and Iron Age history in the Semirech'ye region, Kazakhstan

PANYUSHKINA I.(1), MACKLIN M.(2), TOONEN W.(3), CHANG C.(4)
(1) University of Arizona, TUCSON, UNITED STATES ; (2) Aberystwyth University, ABERYSTWYTH, UNITED KINGDOM ; (3) Utrecht University, UTRECHT, NETHERLANDS ; (4) Sweet Briar College, SWEET BRIAR, UNITED STATES

The Talgar River is one of the western tributaries of the Ili River that shaped the cultural landscape of the Semirech'ye- a principal region of the "nomadic world" in Central Asia for the last 5000 years. We hypothesize that population dynamics in this area were significantly influenced by multi-centennial periods of high and low river flow that impacted on floodwater farming, located on alluvial fans. River flooding and alluvial fan development are related to climate change and glaciation in the NW Tian Shan Mountains. The Iron Age chronology of Semirech'ye, which includes new radiocarbon dating of excavated archaeological sites and surveys, shows discrete short-term phases of occupation of the Talgar fluvial fan by Saka farmers and herders between 800 BC and 200 BC. Our geoarchaeological studies and refined OSL chronology indicate that the Talgar fluvial record has correlations with the contraction and expansion of Iron Age populations. The dry centennial-scale phases could be associated with the dispersal of prehistoric populations and out-migration, whereas the wet phases (e.g. ca. 600 BC and then between 300 BC and 200 BC) attracted people to the area, and might have led to increased social complexity, the emergence of local 'nomadic' elites, and increased alliances among both settled and nomadic groups. We discuss how multi-proxy records can be employed to model population-size variability (concentration and dispersal) for various Saka groups in the Semirech'ye region, which includes both nomadic and sedentary populations exploiting diverse economic and land-use strategies.

Luminescence dating and sedimentological investigations of alluvial archives in the Mediterranean: A case study of a prehistoric site in Morocco, Ifri n'Ammar

BARTZ M.(1), EIWANGER J.(2), HILGERS A.(1), MIKDAD A.(3), BRUECKNER H.(1)
(1) Institute of Geography; Universtiy Cologne; Germany, COLOGNE, GERMANY ; (2) Kommission für Archäologie Außereuropaeischer Kulturen (KAAK) Bonn, Duerenstr. 35-37, 53173 BONN, GERMANY ; (3) Institut National des Sciences de l'Archéologie et du Patrimoine, 1, rue Ghandi, RABAT, MOROCCO

The area of investigation is situated southwest of Nador in the eastern part of the Rif mountains. The prehistoric site of Ifri n'Ammar, an abris dating back to epipalaeolithical times and characterized by periodic colonization, shows human activity since 170 ka. The primary aim of this study is to determine morphodynamic active (e.g. flooding) and morphodynamic stable (e.g. pedogenesis) phases of the fluvial system. The wadi sediments provide direct information for the reconstruction of local palaeoenvironmental changes; they may also serve as an indicator for the regional climate. In order to determine the morphodynamic changes a detailed chronology of the fluvial sedimentation record is being established. First OSL data from wadi deposits in direct connection with Ifri n'Ammar with ages of 94.0 ±7.7 ka and 60.7 ±5.4 ka (potassium feldspar, postIR IRSL protocol, fine grain) demonstrate that the archive covers at least the last 100 ka. This will be supplemented by luminescence-dating four additional wadi profiles. The application of different OSL dating techniques (single-aliquot and single-grain on quartz and potassium feldspar) is used to improve the chronological classification. Furthermore, sedimentological and geochemical analyses are carried out to characterize the runoff dynamics within the fluvial system. To investigate the morphodynamically stable phases of pedogenesis, the palaeosols shall be studied with the tools of XRD (clay mineralogy) and micromorphology. Grain-size analyses and geochemistry (e.g. X-ray fluorescence of major and trace elements) are performed to document the morphodynamically active phases.

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Alluvial geoarchaeology of the palaeomeander of Ostia, Tiber delta, Italy

SALOMON F.(1), BRAVARD J.P.(1), GOIRAN J.P.(2), ROSA C.(3), PANNUZI S.(4), KEAY S.(5)
(1) Universite Lumiere Lyon 2 - UMR-5600, EVS, LYON, FRANCE ; (2) Maison de l'Orient et de la Méditerranée - CNRS-UMR-5133 Archéorient, LYON, FRANCE ; (3) Fondazione Ing. C. M. Lerici - Politecnico di Milano, ROMA, ITALY ; (4) Soprintendenza Speciale per i Beni Archeologici di Roma, ROMA, ITALY ; (5) University of Southampton, SOUTHAMPTON, UNITED KINGDOM

At its peak, Imperial Rome was blessed with a great power that stretched all around the Mediterranean Sea. The link between Rome and the Mediterranean was enabled by the Tiber River and two harbour cities located on the shores of the Tiber delta: *Ostia* and *Portus*. Each city had its own genesis. *Ostia* developed gradually from a fortress (*castrum*) built in the IV c.-III c. BC at the mouth of the Tiber River. *Portus* was planned in the mid-first century AD on the left bank of the Tiber River. There are many hypotheses to justify the creation *ex nihilo* of this city. In this presentation, we will try to understand the origins of *Portus* in the light of fluvial dynamics near *Ostia*:

Is it possible that the Tiber dynamics hindered the development of the Roman *Ostia*? To what extent the harbour city of *Portus* was built to address problems met in *Ostia*?

To answer these questions,we will focus on the dynamics of the *Ostia* palaeomeander presently called *Fiume Morto*. Based on an interdisciplinary approach (archaeology and geoarchaeology) and on the analysis of sediment cores extracted from the paleomeander, the results reconstruct the main stages of its evolution. We will consider how the migration of the river partly conditioned the urban planning of *Ostia* and obstructed its road system in the first centuries BC and AD.

In this presentation we will address the specificities of an anthropized meander, and consider its dynamics through the combination of natural processes and human activities. We will clearly identify internal control factors, at the scale of the palaeomeander (autocyclicity ...), and external control factors, at the scale of the watershed (land use, paleoclimate ...).

Dynamic changes in Loire, Saône and Doubs rivers in Burgundy (France) forced by the Little Ice Age: impact on archaeological site record

STEINMANN R., GARCIA J.P., DUMONT A.
UMR 6298, Universite de Bourgogne, DIJON, FRANCE

Three underwater archaeological sites have recently been studied in the Loire, Doubs and Saône rivers. Mostly consisting of accurately dated oak piles, they are interpreted as roman bridges remains and exactly point the channel position in Romain times. However these bridges were not meant to stand in the *active* channels, depending on the considered rivers dynamics.

Geoarchaeological studies have been achieved on the alluvial valleys surrounding the sites, crossing data from various natural and human records. Very soon, it appeared that the last important change in fluvial style and deposits occurred during Little Ice Age (LIA) on the three rivers. But each system reacted differently, depending on its dynamics.

- Upstream Loire river migrated far from its antique position and came back to it, leading to its discovery under water. Trenches also revealed a buried medieval path, settled on the bank of an abandoned channel filled with coarse crevasse deposits during LIA.
- Upstream Saône did not migrate as Loire during LIA, but kept its main channel the same while reactivating anastomosis that evolved into short meanders until the middle of 19th century.
- Doubs river was a multichannelled river surrounded by a swamp that disappeared, probably due to LIA, in favour of a dynamic straight system that migrated very few but leaded to thick levee deposits, burying archaeological remains over banks.

To conclude, late Holocene dynamics changes had an important impact on the archaeological record of these three different alluvial systems. Loire erased its own floodplain archaeological remains, and that could mean a lack of discovery. Saône did not migrate, leading to an accumulation of sites at the same places through time. Doubs little eroded its banks but mainly buried archaeological remains under flood deposits.

Such different response to climate change have to be taken in consideration while trying to find new archaeological sites in alluvial context.

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Mid-Holocene inundation of the Lower Danube Valley - Lake sediments reflecting changing environmental conditions and human impact

NOWACKI D., WUNDERLICH J.
Institute of Physical Geography, Goethe-University, FRANKFURT/MAIN, GERMANY

Geoarchaeological research has been conducted in the valley of the Lower Danube between Giurgiu and Oltenita to reconstruct changing environmental conditions and human impact during the Holocene with special focus on the Copper Age (5th mill. BC). Numerous settlement mounds indicate that settlements existed along the Lower Danube during this period, one of the most important being Tell Pietrele, located in the study area. Our palaeoecological research concentrates on floodplain sediments covering the valley bottom, which is about 8 km wide. More than 160 sediment cores were taken and complemented by geoelectric measurements. A multi-proxy approach consisting of sedimentological and geochemical analyses as well as analysis of microfauna (ostracodes), pollen and macro remains has been applied. The chronological frame is based on AMS-^{14}C and OSL-dating. The results indicate that after the deposition of sands and gravels by a braided river system, lake sediments accumulated covering nearly the whole valley bottom. While the sands were dated to LGM and Late Glacial the deposition of lake sediments occurred from mid to late Holocene. The inundation of the Lower Danube valley was possibly caused by the transgression of the Black Sea. Within the lake sediments several black layers, each with a characteristic geochemical composition, appear. Those marker layers indicate changing conditions or events during lake evolution. The lowermost dark layer can be attributed to the Copper Age settlement period. It can be presumed that the development of the distinctive layer was caused by an increase of eroded soil material and/or of nutrients originating from settlements and agriculture that were washed into the lake. The upper part of the sediment record indicates that branches of the Danube prograded into the lake, starting not earlier than 2000 years ago. An anabranching river system established. Only remnants of the vast palaeolake prevailed until they were drained in the 1960ies.

Lithostratigraphic evidence of the paleogeographic evolution of the Athenian basin during Holocene (6.000 YBP)

VANDARAKIS D.(1), PAVLOPOULOS K.(1), VOUVALIDIS K.(2), FOUACHE E.(3)
(1) Harokopio University Athens, KALLITHEA, GREECE ; (2) Aristotele University of Thessaloniki, THESSALONIKI, GREECE ; (3) Université de Paris Sorbonne (Paris 4), PARIS, FRANCE

The Athenian basin is a very interesting area from archaeological point of view, since a large number of important archeological sites are situated. It is inhabited from Neolithic time. The human impact on the landscape is shown by the ancient constructions such as the Long Walls and the canalization of the rivers in the area of the Athenian Basin and Piraeus. In this basin the sediments are fluvial, alluvial, anthropogenic, lagoonal and coastal in origin.

The available obtained information of the depositional environments in the Athenian basin, has been received by previous studies, 217 geotechnical boreholes were collected from literature review (National Center of Documentation), 10 sampling boreholes from the area of Piraeus and 14 geotechnical boreholes from the New Opera of Athens. In addition topographic and geological maps were collected.

A GIS database established to manipulate and analyse the collected data. A DEM created through the ArcGis v. 9.3 platform, to represent the recent topography of the study area.

After the interpretation of the boreholes, six lithostratigraphic units were defined (*Anthropogenic sediments*: *Unit A*, *Holocene sediments*: *Units B1, B2*, *Pleistocene sediments*: *Unit C*, *Neogene sediments*: *Unit D*, *Substratum of the Athenian basin*: *Unit E*). The lithostratigraphy of the boreholes is represented through the Rockworks v. 14 software. Maps cross sections and 3d models of the lithostratigraphic units were drawn to correlate them. From the observation of these cross sections and 3d models, the Holocene evolution of the Athenian basin and the human impact on the paleo-landscape were detected.

Paleogeographic maps were created in order to represent the landscape for each lithostratigraphic unit of the Athenian basin, and extract results for the temporal and spatial changes of the paleo-landscape and the involvement of the human impact on the depositional process in the Athenian basin during Holocene.

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Mid-Holocene Environmental History of a Central Mediterranean Island

GAMBIN B.(1), MEDAIL F.(1), ANDRIEU-PONEL V.(1), DJAMALI M.(1), MARRINER N.(2), MORHANGE C.(2), GAMBIN T.(3)
(1) IMBE UMR 7263 CNRS et IRD 237, Aix-Marseille Université (AMU) Europôle Méditerranéen de l'Arbois, AIX-EN-PROVENCE, FRANCE ; (2) CEREGE UMR 7330 CNRS et IRD 161, Aix-Marseille Université (AMU) Europôle Europôle Méditerranéen de l'Arbois, AIX-EN-PROVENCE, FRANCE ; (3) University of Malta, Department of Classics and Archaeology, MSIDA, MALTA

Through the PaleoMed project a number of cores have been taken from key locations on the Maltese Islands with the aim of establishing various aspects related to the archipelago's historical environment. A multi-disciplinary team have been investigating a number of bodies of evidence including sediments, charcoal and shells.I will present the results from pollen samples extracted from a section of one of the cores. The core, taken from Burmarrad, has a section that has been carbon dated to 7200-3200BP. Preliminary results from this site, one of the largest flood plains on Malta, will provide an indication of the local vegetation during this chronological window.

Pollen was extracted from sediment deposits following the classical treatment method (eg Moore et al., 1990). Furthermore, identification was undertaken through the use of pollen atlases of Europe and North Africa (Reille, 1992, 1995, 1998) and Beug (2004) along with IMBE's international pollen reference collection. Pollen percentages were calculated in TILIA and the pollen percentage diagram constructed using TGView software (Grimm 2004, 2005).

Current results indicate that prior to 7000BP there was a high percentage of aquatic plants, while tree and shrub counts were low. At 6900BP a large increase in Pistacia pollen is recorded, with moderate increase in Plantago (especially lanceolata), Asphodelus, Dinaflagelates and Mirco Foraminifera. At this time there is also a reduction in Cichorioideae & Charcoal in the section. A similar increase in Pistacia at around this time has also been recorded from another core in Burmarrad (Djamali et al., 2012) and in southern Sicily (Tinner et al., 2009). The date of this increase corresponds to the first recorded settlement on the Maltese Islands (circa 5500BC) as well as the climatic optimum of forest cover in the Mediterranean region (Noti et al., 2009).

Arsenic Exposure in Pre-Columbian Populations of Caleta Vitor, Northern Chile

CUPPER M.(1), SWIFT J.(2), GREIG A.(1), CARTER C.(2), WESTAWAY M.(3), JACOBSEN G.(4), WOOD R.(5), SANTORO C.(6)

(1) School of Earth Sciences, The University of Melbourne, MELBOURNE VICTORIA 3010, AUSTRALIA ; (2) School of Archaeology and Anthropology, The Australian National University, CANBERRA AUSTRALIAN CAPITAL TERRITORY 2600, AUSTRALIA ; (3) Queensland Museum, SOUTH BRISBANE QUEENSLAND 4101, AUSTRALIA ; (4) Australian Nuclear Science and Technology Organisation, LUCAS HEIGHTS NEW SOUTH WALES 2234, AUSTRALIA ; (5) Research School of Earth Sciences, The Australian National University, CANBERRA AUSTRALIAN CAPITAL TERRITORY 2600, AUSTRALIA ; (6) Universidad de Tarapacá de Arica, ARICA 1000000, CHILE

Elevated arsenic levels among the pre-Columbian inhabitants of Caleta Vitor, northern Chile, may be an indication of changing environmental exposure and behaviour related to palaeoclimate, the adoption of agriculture and metallurgy.

Caleta Vitor, located on the Pacific coast some 30 km south of the border city of Arica, comprises seven hunter-fisher-gatherer habitation and burial areas. The site's location in the Atacama, the world's driest desert, leads to excellent preservation of human soft tissue. An estimated several hundred burials at the site range from simple interments of skeletal remains to bundled mummies containing grave goods. Similar settings at Arica and Caleta Camarones to the south preserve the world's oldest artificially mummified human remains, the Chinchorro mummies, which date up to 8000 radiocarbon years.

Public health consequences relating to arsenic exposure have previously be recognised in both modern and ancient populations from northern Chile, but this issue has not previously been explored in the pre-Columbian populations of Caleta Vitor.

ICPMS trace element analysis of 20 human bone samples coupled with new radiocarbon ages has established a temporal correlation for biogenic arsenic concentration in some individuals. Increased exposure to arsenic may relate to environmental variability influencing sources of drinking water, mining activities or dietary changes associated with agriculture.

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A geoarchaeological approach for assessing the archaeological potential in the city of Pisa (NW Italy)

BINI M.(1), ANICHINI F.(2), BINI D.(3), DUBBINI N.(3), FABIANI F.(2), GATTIGLIA G.(2), GIACOMELLI S.(3), GUALANDI L.(2), NOTI V.(1), PAPPALARDO M.(1), ROSSI V.(4), SARTI G.(1), STEFFÈ S.(3)

(1) Dipartimento di Scienze della Terra - Università di Pisa, PISA, ITALY ; (2) Dipartimento di Civiltà e forme del sapere - Università di Pisa, PISA, ITALY ; (3) Dipartimento di Matematica - Università di Pisa, PISA, ITALY ; (4) Università di Bologna, BOLOGNA, ITALY

Pisa’s subsurface conceals walls, floors, tombs and roads: the traces of life that the city has left behind in almost 3000 years of history. These remains – for the greater part unknown – must coexist with the life needs of modern inhabited areas. MAPPA is a project in the framework of which archaeologists, geologists and mathematicians combine their expertise to study predictive calculation instruments applied to the archaeological potential of the city of Pisa. The archaeological potential of an area is a parameter that quantifies the possibility that a more or less significant archaeological stratification is preserved in an unexplored area. In the urban and periurban area of Pisa a geomorphological survey mainly based on evidence from remote sensing analyses was carried out. It was complemented by subsurface data from 18 cores ranging in depth between 7 and 15 m, analyzed through an interdisciplinary approach. Depositional facies were reconstructed through integration of sedimentological, micropalaeontological, palinological and geochemical data, and chronologically constrained by extensive radiocarbon dating. Geophysical prospecting supported the reconstruction of palaeo-drainage network. The acquired data improved our knowledge about the palaeoenvironmental and human settlement evolution of Pisa area over the past 6000 years, highlighting the mutual interaction between landscape and human activities.

The MAPPA web-GIS is the digital mapping instrument used for the free publication of archaeological, geological and geomorphological data, obtained in the framework of MAPPA activities, on the web. On the basis of predefined parameters and a specific mathematic calculation, the map of archaeological information has been developed in order to evaluate possible remains buried in areas for which there is no existing information today.

Open cast mines in South Brandenburg (Germany) - Archives for Late Holocene anthropogenic landscape development

RAAB T.(1), RAAB A.(2), NICOLAY A.(2), TAKLA M.(2), BÖNISCH E.(3), RÖSLER H.(3)
(1) Brandenburg University of Technology , COTTBUS, GERMANY ; (2) Brandenburg University of Technology, COTTBUS, GERMANY ; (3) Brandenburgisches Landesamt für Denkmalpflege und Archäologisches Landesmuseum, COTTBUS, GERMANY

Since 2010 the Brandenburg University of Technology (BTU) Cottbus and the Brandenburgische Landesamt für Denkmalpflege und Archäologisches Landesmuseum (BLDAM) collaborate to study the environmental impact of past human land use. Our study area is the opencast mine Jänschwalde, one out of four active lignite mines in South Brandenburg, Germany. Different approaches are combined for a comprehensive landscape reconstruction. Outcrops provide a view into the soil stratigraphy and are used for archaeological studies. In addition, chronological information is obtained by different methods of relative and absolute (14C, OSL, dendrochronological) age determination. To build up a model for the landscape development, data (topographical maps, historical maps, physiogeographical information, etc.) is gathered and processed. Charcoal burning is a main factor of landscape development in the last centuries. Production of charcoal was carried out from the c. 17th to the 19th century and is very well documented by about 800 excavated ground plans of circular upright kilns and more kilns are prospected. It is assumed that charcoal was produced for the smelter at Peitz nearby, where bog iron ore was processed since 1567. There is sedimentological proof of the relationship of logging and the formation of wind-blown deposits. In addition, pedological studies on test trenches show that buried plough horizons are widespread. First results of radiocarbon dating of charcoal fragments from buried topsoil horizons date to the Slavic middle ages (600-1200 AD). It is assumed that the eolian activity was triggered by deforestation and extending agricultural use. In conclusion, our results suggest that there are two major periods with eolian activity induced by human impact: the first period caused by extending agriculture during the Slavic middle ages (600-1200 AD) and the second period was induced by deforestation for charcoal burning between the 17th and 19th century.

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The late Holocene palaeoenvironment forcing on human existing and migration within SE Altai (Russia)

AGATOVA A.(1), NEPOP R.(1), SLYUSARENKO I.(2), MYGLAN V.(3), BARINOV V.(3), NAZAROV A.(3)
(1) Institute of geology and mineralogy, NOVOSIBIRSK, RUSSIAN FEDERATION ; (2) Institute of archaeology and ethnography, NOVOSIBIRSK, RUSSIAN FEDERATION ; (3) Siberian Federal University, KRASNOYARSK, RUSSIAN FEDERATION

The issue of the Holocene chronology of the archaeological cultures in Russian Altai is still debated. In spite of the fact that these cultures can be generally regarded as a single economic-cultural type – nomads of arid piedmonts and mountains of temperate zone, the debate commonly centers both on the names of cultures and on the periods of their existence. The Holocene palaeoenvironmental reconstructions within Russian Altai also vary considerably which complicates the correlation between geomorphological events and changing of archaeological cultures. This paper presents an attempt to provide such correlation. It focuses on studying of climate changes, estimating of paleoseismicity, timing and revealing spatial characteristics of giant landslide dammed lakes within SE Altai, Russiaduring the late Holocene.

We report more than 60 new radiocarbon dates of dead trees from moraines and at the upper tree limit on trough slopes, peat layers that cover moraines, wood remains from proglacial forefields which allow us basing the glacier activity on this time period.

We also report dendrochronologically obtained date of a previously unknown strong medieval earthquake. Using radiocarbon method and dendrochronological analysis for trees (both dead and living ones) located on the bodies of seismically triggered landslides and seismically deformed fossil soils gave the opportunity to estimate recurrence interval of strong earthquakes for this area.

Radiocarbon and dendrochronological dates of archeological sites let us to reconstruct periods of existing and outburst of landslide dammed lake which defines the natural habitat of nomads within SE Altai. These data have been also used for reconstruction of landscape prevailing at that time.

In general, suggested chronology of the most important climatic and geological events provides insights for pattern of changes in archaeological cultures and migrations of nomadic population inhabited SE Altai in the late Holocene.

Irrigation on the proto-urban site of Sarazm during the Bronze Age (Zerafshan Valley, Tadjikistan): Method and results

FOUACHE E.(1), CEZ L.(2), WATTEZ J.(3), BESENVAL R.(4), FRANCFORT H.P.(5), BUYLAERT J.P.(6), MURRAY A.(6)

(1) University of Paris Sorbonne, PARIS, FRANCE ; (2) University Paris Panthéon Sorbonne, PARIS, FRANCE ; (3) INRAP, GRIGNON, FRANCE ; (4) CNRS, UMR 9993, PARIS, FRANCE ; (5) CNRS, UMR 7041, NANTERRE, FRANCE ; (6) Technical University of Denmark, ROSKILDE, DENMARK

The UNESCO World Heritage listed site of Sarazm, located on the west bank of the river Zerafshan in the municipality of the present-day village of Avazali, is a proto-urban surface site that was occupied between 3500 and 2500 BC. It lies on the surface of a loess terrace that was dated 55000 +/- y BP by OSL, that is OIS 3.

The terrace overlooks the Holocene alluvial plain of the river Zerashan by a ten meter high abrupt. The remains of a filledirrigation canal were identified in three places on the northern edge of the loess terrace and related to the archaeological occupation of the site. A 4500 +/- y BP OSL dating confirmed that the canal was related to the proto-urban site of Sarazm. The study of the site confirms how long irrigation has been used in the region lying between the basins of the Amu Darya and the Syr Darya, in which Eneolithic canals in the delta of Tedjen (Turkmenistan) and a Bronze Age canal in Shortughaï (Afghanistan) have already been identified.

The geoarchaeological study of the vestiges of the canal of Sarazm required a specific method. The vestiges of the canal were first mapped and drawn, placed within their geomorphological context, while systematic measures of altitude and slopes were carried out. Then samples for micromorphological analyses were taken systematically, as well as samples for OSL dating.

Thus we were able to reconstruct the history of the canal by relating it to the hydrological regime of the river Zerafshan on the long term but also along the shorter term of its annual use. We are presenting the method and our preliminary results.

Key words: Geoarchaeology, Mid-Holocene, Irrigation, Protohistory, Tadjikistan, Zerafshan river.

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Alpine Snow Patches as Archaeological Sites

CALLANAN M.

NTNU-Museum of Natural History and Archaeology, TRONDHEIM, NORWAY

Snow patches are small bodies of perennial snow and ice found at high altitudes. Occasionally, archaeological objects are discovered on snow patches where the frozen conditions mean artefacts are often very well preserved. Snow patch archaeology is a global phenomenon with important discoveries made in Alaska, Canada, the Rockies, the Alps and in Norway and Sweden.

Snow patch artefacts have been collected from the mountains of central Norway for almost a century. The local snow patch record consists mainly of arrowheads, wooden shafts and bows that were either lost or discarded on alpine hunting expeditions in the past. The present collection includes finds from a long time span- c. 5500-300bp. This paper is a presentation of a case study based on one of the most productive sites in the region.

A large number of arrowheads and shafts have been discovered at the snow patch at Kringsollfonna, Oppdal (c.1500 m asl). Archaeological analysis shows discrete chronological patterns within the material-some periods are well represented, while others are not. The central question is what lies behind this patterning? Is it due to cultural factors such as changes in hunting practices and strategies through time? Or could it be due to natural factors and site formation processes specific to snow patches?

Earlier archaeological attempts at addressing this issue focused on the whether snow patches were in movement or not. However, the question could not be answered by traditional archaeological methods alone and remained unresolved. However, recent developments mean we can now revisit this question. The number of finds recovered from the site has increased. A number of finds have been 14C dated and multidisciplinary surveys at the Kringsollfonna have produced important physical observations. In this presentation, the new archaeological data will be brought together as an initial step towards modeling the formation dynamics of snow patches as archaeological sites.

Characteristics of Norwegian ice patches and glaciers with archeological finds

JARRETT L., VATNE G., BERTHLING I.
Norwegian University of science and technology, OSLO, NORWAY

Ice patches are common and persistent features in the high mountain environment in the Northern Hemisphere. Over the last decade, parallel to global warming and downwasting of glaciers, they stand out as key localities for archeological finds, revealing information on local reindeer hunting traditions. Ice patches thus appear to provide ideal conditions for preservation of prehistoric organic and inorganic materials. In contrast to glaciers, data from ice patches on mass balance, temperature, deformation and paleoclimatic significance are scarce. There is further no consensus on how to distinguish between glaciers and ice patches. Ice patches are in general viewed as small perennial bodies of cold ice, frozen to the ground and with negligible movement. The melt out of very old, well preserved archeological artifacts supports the theory of limited ice flow, and suggests that they are robust to climate variations despite their presence sometimes well below regional equilibrium line altitudes. Moreover, observations of striations, flutings, and terminal moraines in front of many ice patches in southern Norway, indicate past sliding. This invites us to look at ice patches in a temporal and spatial perspective, with transitional stages between ice patch and glacier through time. Mass balance data suggests a temporal rather than spatial mass balance pattern, with the absence of a traditional mass balance gradient, and hence also the need for throughput of ice (ice flux). Increased knowledge of ice patch characteristics may reveal why they appear to be climate robust, and help archeologist interpret the spatial pattern and age structure of their finds.

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Archaeomorphology and the social construction of rockshelters : Nawarla Gabarnmang (Australia)

DELANNOY J.(1), DAVID B.(2), GENESTE J.M.(3), KATHERINE M.(4), SADIER B.(1), WHEAR R.L.(4)
(1) EDYTEM laboratory - Univ. Savoie, LE BOURGET-DU-LAC, FRANCE ; (2) School of géography and Environnmental Science, Monash University, MELBOURNE, AUSTRALIA ; (3) Centre National de Préhistoire-Minsitère de la Culture et de la Communication, PÉRIGUEUX, FRANCE ; (4) Jawoyn Association Aboriginal Corporation, KATHERINE, AUSTRALIA

Understanding the roles of natural and human processes in the formation and construction of rock art sites has long been a major objective in archaeological research.

The focus is on the geomorphology, which, though the analysis of the physical evolution of archaeological sites, explores the roles of morphogenic processes and other agents, including anthropogenic ones. This dimension of a geomorphological approach, consists of an interrogation of the role of humans in the morphology of the sites studied, as well as the status of the objects present within them. Research conducted at decorated sites, such as the site of Nawarla Gabarnmang (Arnhem Land, Australia) lead to propose the concept of “anthropogeomorphology”.

Ahigh spatial resolution geomorphological cartography as well as archaeological data and a 3D modeling tool has enable to show the important anthropogenic contribution in the modification of this site over a 40.000 years period of time.

New concepts and evaluation tools in conservation of prehistoric caves, hints from Chauvet and other French cavities

BOURGES F.(1), GENTHON P.(2), GENTY D.(3), MANGIN A.(4), D'HULST D.(1)
(1) Géologie-Environnement-Conseil, SAINT-GIRONS, FRANCE ; (2) IRD/HSM, MONTPELLIER, FRANCE ; (3) LSCE, GIF-SUR-YVETTE, FRANCE ; (4) ECOEX, MOULIS, FRANCE

Preservation of cave wall paintings from Pleistocene poses the problem of robustness of remains against climate changes and recent anthropogenic impacts on cavities. Air/rock temperatures, air compositions and fluid transfers are used to test the stability of caves and to identify microclimates buffering mechanisms. Cave walls integrity deals with CO_2 dynamics as it pilots carbonates dissolution/precipitation and temperatures-pressure which govern water evaporation/condensation.

Long term (>15 years) monitoring in Chauvet, Pech Merle, Niaux, and Gargas caves substantiate previous evidence of underground stability. In the remote cavities, a closely equilibrated thermal environment (tenths of °C in seasonal amplitude, hundredths of °C air/rock gradient) is related to the rock volume inertia and to fluids percolation from surface. The small variations in air temperature correlated with barometric pressure were interpreted as isothermal exchanges with rock volume.

We show that large amount of gazeous biogenic CO_2 from soil and epikarst is transferred downward as part of biphasic flow with rainwater. In caves, it generates seepage of saturated water and air inlet equilibrated with soil atmospheres (CO_2 : 0.5 to 4% Vol., O_2 : 17 to 20.9 % Vol., humidity near saturation). Therefore, negligible physicochemical gradients at the air/rock interface protect the remains and their supports from evolution.

Air production from caves walls (Orgnac estimates from 0.007 to 0.04 $l.s^{-1}.m^{-2}$) is advected along subterranean large voids networks and limits direct outside airflow influence. Near the natural openings, aeraulic active interfaces separate underground confined systems where preservation conditions are optimal from cave segments open to surface influence where energy dissipation, phase changes and chemical exchanges induce intense wall weathering.

In some cases, fluid transfer quantification allows a rough evaluation of karst areas and volumes connected with cave systems.

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Poster presentations:

Palaeoenvironmental reconstruction of the Mid to Recent Holocene landscape surrounding the Minoan site of Phaistos (Crete, Greece)

GHILARDI M.(1), PSOMIADIS D.(1), LONGO F.(2), AMATO V.(3), ROSSI A.(2), DEMORY F.(1), SABATIER D.(1), COLLEU M.(4), SINIBALDI L.(1), FLEURY J.(1), CARAYON N.(1)
(1) CNRS CEREGE UMR 7330, AIX-EN-PROVENCE, FRANCE ; (2) University of Salerno, SALERNO, ITALY ; (3) University of Molise, MOLISE, ITALY ; (4) University of Paris 1 sorbonne, PARIS, FRANCE

The present work aims to reconstruct the palaeoenvironmental evolution of the Holocene landscape in the vicinity of Phaistos, one of the most famous Minoan site in Crete. Within the framework of a scientific partnership with the Italian School of Archaeology in Greece, a geoarchaeological study have been undertaken in the area. Based on the study of seven boreholes, drilled at a maximum distance of 300 meters from the archaeological site and in a maximum depth of 8.35 m below the surface, a landscape reconstruction is proposed. The analytical work included together sedimentological analyses (laser grain size analysis, magnetic susceptibility measurements, loss-on-ignition and carbonate content estimation). The facies identification is based on the micro (diatoms) and macro (mollusks) faunal identifications. The proxies were incorporated into a robust chronostratigraphic framework through 10 radiocarbon datings (A.M.S.) performed along the cores, on charcoal and organic matter samples. The results highlight the presence of a limnic environment during Middle to Late Bronze Age (ca. 2200 to 1050 cal. BC) where seasonal fluctuations of the water table are clearly observed. A period of dryness, recognized by some authors as the "Late Bronze Age collapse", is identified and dated ca 1100 to 950 cal. BC. Subsequently, the landscape evolved during Antiquity to swamps strongly affected by frequent avulsions of the Gria Sitia River. Our researches clearly help to better understand the relationships between the Minoan settling history and the landscape evolution.

Fluvio-Estuarine Paleoenvironments and Geoarcheology in the lower garonne valley: example of the mediaval site of langoiran (Gironde, SW France)

LESCURE S.(1), ARNAUD-FASSETTA G.(2), COLIN A.(3), FARAVEL S.(3), CAROZZA J.M.(4), MATHE V.(5), LE COEUR C.(1), CORDIER S.(6)

(1) University Paris Panthéon-Sorbonne (Paris 1), LGP-UMR 8591 CNRS, PARIS, FRANCE ; (2) University Paris-Diderot (Paris 7), LGP-UMR 8591 CNRS, PARIS, FRANCE ; (3) University Bordeaux 3, AUSONIUS-UMR 5607 CNRS, BORDEAUX, FRANCE ; (4) University of Strasbourg, GEODE-UMR 5602 CNRS, TOULOUSE, FRANCE ; (5) University of La Rochelle, LIENs-UMR 7266 CNRS, LA ROCHELLE, FRANCE ; (6) University Paris Est Créteil, LGP-UMR 8591 CNRS, CRÉTEIL, FRANCE

Since 2010, an interdisciplinary team works in the research program "*Peoples of the Médoc estuary and coastal fringe during Protohistorical, antic and mediaeval times".* The project focuses on the reconstruction of the past human-environment interactions in the lower estuarine Garonne valley. Historical, archaeological, geomorphological, and geophysical investigations are coupled to highlight these interactions in a geoarchaeological view. On the site of the *Castéra* of Langoiran (upper part of the estuary), a mediaeval castrum located in the present-day Garonne floodplain was abandoned around the mid-13th century to be re-established 40 m above the valley floor, on a fluvial terrace preserved. In order to verify possible environmental cause to this change, palaeoenvironmental reconstruction was carried out. This latter includes the 3 hydrogeomorphological approaches (hydrography, hydrology, hydraulics) to assess: (i) the spatio-temporal variability of hydrological hazards (diachronic mapping of hydrological network, changes in the hydrological regime), (ii) the vulnerability of past societies exposed to these hazards, and (iii) the influence of the fluvial constraint (flooding, avulsion) in terms of risk. 13 cores have been drilled on the basis of previous geomorphological and geophysical data. Sedimentological, palaeobiological (pollen, foraminifera, ostracods) and geochronological (OSL, ^{14}C) analyses allowed us to reconstruct the stratigraphy of the fluvial sedimentation before, during, and after the castrum phase occupation (end of the 12th c. up to mid-13th c.). These results were coupled with geophysical analysis to reconstruct the palaeochannel geometry and so the hydraulic parameters (channel capacity, discharge, specific stream power). Results lead to propose a first reconstruction of fluviatile palaeoenvironment around and during the *Castéra's* occupation showing the presence near the site of the main Garonne River palaeochannel or a crevasse play.

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Landscape change around Minturnae and Garigliano river mouth

BELLOTTI P.(1), DALL'AGLIO P.L.(2), DAVOLI L.(3), D'OREFICE M.(4), DI BELLA L.(3), ESU D.(3), FERRARI K.(2), MAZZANTI M.(5), TORRI P.(5)

(1) Dipartimento di Scienze della Terra - Sapienza Universita' di Roma, ROMA, ITALY ; (2) Dipartimento di Archeologia Universita' di Bologna, BOLOGNA, ITALY ; (3) Dipartimento di Scienze della Terra Sapienza Universita' di Roma, ROMA, ITALY ; (4) IRSA AMBIENTE, ROMA, ITALY ; (5) Laboratorio di Palinologia e Paleobotanica Universita' di Modena e Reggio Emilia, MODENA, ITALY

The landscape evolution at the Garigliano River mouth has been drowned for the last 6 ka. In this area at the border between Latium and Campania, the Roman colony of Minturnae developed between the Tyrrhenian Sea and the Via Appia, were the latter crossed the river, during the period between the III century BC an the VI century AD. At the time there were two coastal basin on either side of the river that made environment different from the current, as well as different was the use that man made of the land by following its evolution.

The present study is based on:

- geomorphologic analysis from sets of aerial photographs and ancient cartography ;
- several cores by manual auger and three mechanical cores (up to 4.5/6 m depth) by AF coring system to obtain continuous cores with preserved sedimentary structures;
- grain size analysis by means of mechanical sieving and laser diffractometry for > and < 62µ fractions, respectively;
- ^{14}C datings, $^{13}C/^{12}C$ and C/N ratios, measured on specimens of the cored sediments selected;
- pollen, malaco and microfaunistic analysis.

The results of this study complement the archaeological knowledge acquired on the Roman colony of Minturnae allowing a more accurate reconstruction of the activities carried out in the town. Also better define the landscapes that preceded and followed the Roman expansion.

Magdalenian open-air site location preferences in the Carpathian and peri-Carpathian landscapes (SE Poland)

LANCZONT M., HOLUB B.
Maria Curie-Sklodowska University in Lublin, Department of Geoecology and Palaeogeography, LUBLIN, POLAND

The beginning of reoccupation of the Central Europe area in the post-maximum phase of the Weichselian Glaciation during the ice-sheet retreat was associated with the activities of Magdalenian groups, which migrated eastwards in several waves. Population of this culture penetrated these terrains as far as the right-bank part of the Vistula basin, and this was the most easterly area of Magdalenian settlement. The newly-settled territories stretched between the Middle Polish Uplands and the northern slopes of the Carpathians. This zone includes three physico-geographical regions with different landscapes. In this zone the oldest traces of Magdalenian penetration were dated to the last part of the Upper Pleniglacial (even before the end of the Oldest Dryas), and the twilight of Magdalenian expansion -to the Late Glacial (probably to the Allerød warming). This time interval was characterized by climate changes, rapid and considerable especially in the Late Glacial, which resulted in dynamic transformations of bio-geosystems. Great changes occurred in river valleys where braided river channels changed into large meanders. Magdalenian settlements are not numerous but it is noticeable that most of them occur in river valleys, which were ecological corridors and probably routes of migration. Based on spatial analysis and palaeoecological data there were described the location conditions of seasonal open-air Magdalenian sites in the valleys of the rivers: Carpathian (San River in the mountain section and near the Carpathians margin), peri-Carpathian (San River in its lowland section), and upland (Opatówka River, near its confluence with the Vistula river). The analysed sites have many common morphological features. In the paper we define the factors, which influenced the open-air site location preferences in the eastern frontiers of Magdalenian Culture, in order to understand the environment exploitation strategies of this hunter-gathering population.

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Time scales and geoarcheology: stability vs instability of the ancient maritime site of Ayn Sukhna, Gulf of Suez, Egypt

PEULVAST J.(1), TALLET P.(2)
(1) Université Paris Sorbonne, PARIS, FRANCE ; (2) Université Paris-Sorbonne, PARIS, FRANCE

Studied for the years 2000, the archeological site of Ayn Sukhna is located on the western coast of the Gulf of Suez, on the narrow piedmont of arid sedimentary plateaus, close to a thermal spring and at the outlet of the shortest way linking the gulf to Memphis. It was built and occupied at the times of the Old Kingdom and then of the Middle and New Kingdom, and until the Ptolemaic period, i.e. between 2600 and 300 y BC. The site is now partly obliterated and separated from the sea by modern constructions, but two parts remain accessible: remains of dwellings on colluvial fans and shore platforms of the piedmont, and a set of 10 galleries excavated in the base of the Gebel Galâla el-Baharyya. The aims of its geomorphic study, by the means of field work and image interpretation, are: understanding the potential and constraints that lead the Ancient Egyptians to use this site as a maritime base for expeditions towards the Sinai and production of copper, and defining the conditions of stability or instability that allowed its preservation until the recent period. At large- and mid-scale, we show that gravitational instability responded to faulting and uplift which probably ceased in the Late Miocene, producing a huge landslide in which part of the site is inset. Obliterating the Gulf of Suez rift faults, this landslide may have modified the underground water flow and determined the presence of a thermal spring at its foot. However, no sign of recent activity was found at the base of the mountain, else than effects of slow rock-disintegration and of episodic rock falls, gullying and sudden wadi flows. With its altitudes of 6-7 m, in the continuity of the regional Tyrrhenian shore-line, and its lack of deformation, the ancient shore platform on which part of the site is built confirms a Pleistocene and Holocene tectonic stability. Its study and that of younger shore deposits contradicts older speculations on significant variations of the shore-line since the Antiquity.

A reconnaissance study of a prehistoric settlement in Koyun Island, Southern Marmara Archipelago, Marmara Sea, Turkey

ERTEK T.(1), KILIC E.(2), ERGINAL E.(3)
(1) Istanbul University, ISTANBUL, TURKEY ; (2) Istanbul University, 34459, TURKEY ; (3) Ardahan University, ARDAHAN, TURKEY

Rising from the southwest shelf of the Marmara Sea, NW Turkey, the Marmara Archipelago consists of 23 islands and islets as well as a vast number of reefs. The raised fossiliferous near-shore deposits on the coast of these islands and identifying tectonic uplift rates in such an tectonically active Marmara Sea.

In this study, a shell midden deposit on southwest coast of Koyun Island, a small member of the Marmara archipelago, is studied on the basis of facies characteristics, stable isotope measurements and AMS radiocarbon dating results from fosil shells. The island with an area of 1,71 km² comprises marble, schist and granodiorite. Overlying a brownish colluvial layer, shell mound including plenty of mollusc shells form waste products of the island inhabitants. The shell-laden level has a maximum thickness of 60 cm and extends between 1.5 m and 10 m above the present sea-level. Main fossil components are made up of Ostrea edulis, Mytilus galloprovencialis and Cardium sp. as well as animal bones and fragments of pottery, evoking residuals of consumption left from an archaeological settlement of unknown age. The calibrated AMS14C ages from shells of Ostrea and Mytilus collected from +10 m and +2 m, respectively, yielded values of 6540 – 6370 yrs BP and 6950 – 6750 yrs BP. Based on global sea-level curve, the level of the Marmara Sea during that time span was about at -4 m in proportion to the present. The studied deposit is likely a residual of an island settlement belonging likely to Late Neolithic-Early Chalcolithic.

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Characteristics of ruins in the Neolithic Age in Bibong-ri, Changnyeong and their implications for sea level fluctuations

YOON S.O.(1), HWANG S.(2)
(1) Dept. of Geography and Research Institute for Basic Sciences, Kyung Hee University, SEOUL, SOUTH KOREA ; (2) Dept. of Geography, Kyungpook National University, , DAEGU, SOUTH KOREA

Bibong-ri is located at the marginal areas of alluvial plain of Cheongdo River, a tributary of Nakdong River that is the longest river in Korea, and Cheongdo River joins to Nakdong River 70 km away from the river mouth. The sedimentary facies of the study area consist of bedrock, bottom gravel bed, Holocene gravel bed and Holocene alluvium upward. The earthenwares in the Neolithic Age are included in the Holocene gravel bed. The alluvium can be subdivided into marine deposit, terrestrial deposit, back marsh deposit upward and a great deal of shell deposits and acorn hollows are found. Based on the sedimentary facies, properties of shell deposits, topographical properties of acorn hollows, diatom analysis and AMS age dating, the sea level fluctuations during the middle Holocene are reconstructed. The floodplains in the lower reaches of Cheongdo River are the results of sea level fluctuations during the Holocene and the sea level during the maximum phase of transgression was higher than the present by approximately 1.5 m.

The social construction of rock art caves. Contributions of the geomorphological approach in Chauvet cave

DELANNOY J.(1), GENESTE J.M.(2), JAILLET S.(1), SADIER B.(1), BOCHE E.(2)
(1) EDYTEM laboratory - Univ. Savoie, LE BOURGET-DU-LAC, FRANCE ; (2) Centre National de Préhistoire-Minsitère de la Culture et de la Communication, PÉRIGUEUX, FRANCE

The study conducted in the Chauvet cave provides an exceptional resource for the archaeology, paleontology and geomorphology research.

The different elements of the landscape underground (accumulation, blocks aligned, moving objects, vertical bones…), have been studied only recently. Geomorphological and archaeological studies helps to highlight the cultural features of the landscape and the different types of spatial organization of the site (basins, steps). The methodological approach including geomorphological mapping and 3D surveys allows to discriminate the morphogenic processes and the anthropogenic ones.

These preliminary results show that the Chauvet Cave has, apart from rock art panels, many anthropogenic features inscribed in the underground landscape. These elements offer a new perspective concerning the appropriation of the cave by prehistoric humans.

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Relations between ancient settlement and the physical environment: a case study of the area from Dora Baltea river to Scrivia river (Western Po Plain - Italy)

PELLEGRINI L.(1), DALL'AGLIO P.L.(2), ZIZIOLI D.(1), FRANCESCHELLI C.(3)
(1) Earth and Environmental Sciences Department - University of Pavia, PAVIA, ITALY ; (2) Archaeology Department - Bologna University, BOLOGNA, ITALY ; (3) Centre d'Histoire Espaces et Cultures - Université Blaise Pascal - Clermont II, CLERMONT-FERRAND, FRANCE

As is known,since the prehistory, the interrelationship of the man with the landscape have become increasingly close. The study carried out on the western Po plain between the confluence of the Baltea and Scrivia Rivers, fully confirms this assumption. The study area is characterized by a typically fluvial morphology with Holocene terraces enclosed within the carved late Pleistocene plain (Main Level of Plain) and sometimes in direct contact with the Monferrato hills. The reconstruction of the evolution of the bed of the Po River has highlighted as, in certain reaches, it has been the prevalent tendency to digression and therefore instability, while in other reaches the bed was maintained more stable and less wide. Over the past two centuries, human activities especially of rice cultivation, largely cleared the remains of ancient morphologies and settlements. However it is possible to recognize a link between the distribution of population and landscape. In fact, the settlements, including the Bronze Age of Pobietto, lie mainly on higher terraces. In Roman and Medieval age, the Po river becomes very important related to its wideness or stability: the major road axis crossing the Po were located where the river is more narrow and more stable. For example in these areas, are located the cities of Valenza and Casale Monferrato, which correspond to the Roman *Vardacate* and *Valentia*. A similar location have many medieval “villenove” and the Breme and Aqualongaearly medieval abbeys, which are, with Lucedio and San Genuario, the center of the re-colonization after the late-antiquity crisis. Therefore, it should be noted how are important the integrated contributions of the geomorphological and historical and archaeological study for understanding the evolution of an area.

Study on the properties of reconstituted stones of the Orval Abbey, Belgium

NGUYEN T.(1), FUJIMAKI T.(1), NAKAYAMA T.(1), OSAWA Y.(1), OGUCHI C.T.(2), THOMACHOT-SCHNEIDER C.(3), GOMMEAUX M.(3), DEMURA H.(1)

(1) Graduate Student, Saitama University, SAITAMA, JAPAN ; (2) Geosphere Research Institute (GRIS), Saitama University, SAITAMA, JAPAN ; (3) GEGENA, University of Reims Champagne-Ardenne, REIMS, FRANCE

The Orval Abbey in southern Wallonia, Belgium, was originally built in middle age and rebuilt in modern age. The new building walls mainly made of reconstituted stones agglutinated using cement with crushed natural limestone have been suffering from salt weathering, although the medieval building walls made of natural limestone have not. Deterioration due to salt efflorescence was observed only at the ground floor wall of the modern building.

To elucidate the deterioration mechanism, environmental monitoring and rock-property measurement were performed. Color changes due to weathering are also observed using spectral colorimeter at the site. Pore size distribution, elemental distribution and mineral characterization of the stones were investigated using mercury intrusion porosimetry, scanning electron microscope and x-ray diffraction. Chemistry of groundwater near this abbey site was also determined using ion chromatography.

Temperature and humidity conditions of the investigation site, where reconstituted stones were mainly used in the modern building, fluctuated drastically. The pore size distribution of the reconstituted stones revealed that the stone consists of large fraction of microporosity, which favors salt damages. The main salt causing deterioration revealed sodium sulfate. Sulfur and sodium were detected from reconstituted stones and groundwaters.

From the above findings, the origin of the salt resulted in both stones and waters. Water-rock interaction has been occurred to crystallize sodium sulfate. The environmental condition favors the cyclic conversion between mirabilite (Na_2SO_4. $10H_2O$) and thenardite (Na_2SO_4), which is known as the main damaging mechanism of salt weathering. The Swe-Yu & Oguchi's (2010) salt susceptibility index of reconstituted stones was much higher than the limestones using in the abbey, supporting the occurrence not only efflorescence but also salt deterioration on the site.

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Erosional-detrital phases in the lower Seine Valley catchments (Normandy, France) using a geoarchaeological approach

SECHI S.(1), LAIGNEL B.(2), LEPERT T.(3), MELIS R.T.(4)

(1) Université de Rouen, UMR CNRS 6143, ROUEN, FRANCE ; (2) Université de Rouen, UMR CNRS 6143, Mont Saint Aignan, FRance, ROUEN, FRANCE ; (3) Université Paris I & X,CNRS, Laboratoire ArScan, UMR 7041, PARIS, FRANCE ; (4) Departement of Chemical and Geological Sciences, University of Cagliari, CAGLIARI, ITALY

Actually, the influence of the climate and man-activities in the Holocene environmental changes are still the focus of several discussions. It is obvious that both factors are implicated in changes of hydrological balance, soil erosion and terrigenous sedimentation and can be added to geomorphological factors (local and regional) and the intrinsic lithological proprieties of geosystem.

We define differents geomorphological compartment characterizing the geosystem of the catchments of the Lower Seine Valley (LSV) as: plateaus, slopes, tributaries (TSR) and LSV (which can be also divided to estuarine zone, fluvial organic zone and fluvial detrital zone). There, we have found nine erosion-sedimentation phases during de last millennia. The geological approach lead to define a spatial stratigraphic evolution and the detrital distribution. The relative datation of detritals inputs was obtained by the archaeological remains. Such phases are directly or indirectly triggered by the increasing of anthropogenic pressure combined or not-combined to climate change, local and regional geomorphic processes.

During the Early Holocene climate pejoration, a deep and linear under-scour of plateaus and slopes and changes in drainage network load to the "Mesolithic detritism". During the Mid-Holocene transition, the deglaciation loads to the increase in hydrologic fluxes. Forest Neolithic clearance and agricultural development, added to climate changes, became an important factor of the induced detritism found in all geomorphic compartments. After that, the Bronze Age metallurgy development and tillage practices and the Iron Age regional cultural evolution, induced another detrital phase in the whole environments: plateaus, slops and fluvial zone of the LSV. From the Middle Age to the actual time a generalized detritism was recorded in the whole region.

Destructive abrasion processes of archaeological site Ostolopovskoe

GAYNULLIN I.(1), USMANOV B.(2)
(1) Sh. Marjani Institute of History, KAZAN, RUSSIAN FEDERATION ; (2) Kazan Federal University, KAZAN, RUSSIAN FEDERATION

The problem of archaeological heritage conservation is highly relevant for the Republic of Tatarstan (RT), Russia, because most of archeological sites from the Mesolithic to the late Middle Ages, situated in the coastal zone which is due to the nature of human life in the past and 75% of the Kuibyshev reservoir shores and more than 290 km of small rivers shores in RT affected by dangerous exogenous processes.

Complex of monuments in question - Ostolopovskoe hillfort, Ostolopovsky burial and Ostolopovskie Settlements I and II - located on the shore of the Kuibyshev reservoir at the mouth of Shentala river (Alexeevsky District RT). Comparison of topographical maps and results of remote sensing data interpretation, using GIS technology allow to estimate the rate of hazardous processes and, thus, to determine the risk of destruction of the monument. The displacement of coastline (1958-2005) studied with the help of multi-temporal remote sensing data. The distance of coastal retreat varies from 0.75 to 1.4 m per year. Archaeological site Ostolopovskoe Settelement I, is mostly destroyed by permanent abrasion processes. During the study period the area of 2.74 hectares washed away, cultural layers were destroyed, maximum displacement speed is 1.4 m per year.

Cultural heritage sites monitoring, with information about the chronology, cultural layer value, settlement specifics, etc., taking into account the remote sensing methods used in landscape ecology and field archaeological survey, allows to evaluate damage and the intensity of archaeological sites destruction through the dangerous exogenous processes estimation.

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Geoarchaeology in Cantabrian Mountains (NW Spain): human activity prior to Roman occupation in the Roman Camp Site of Via Carisa?

JIMENEZ-SANCHEZ m., DOMÍNGUEZ-CUESTA M.J., FARIAS P., FERNANDEZ-VIEJO G., RODRIGUEZ-RODRIGUEZ L., OLONA J., BALLESTEROS D., NAVES B.
department of geology, university of oviedo, OVIEDO, SPAIN

A geoarchaeological research (funded by PC10-14 Project, FICYT-Rioglass S. A.) was carried out in the Roman Camp Site of Via Carisa.The relevance of this site comes from its interpretation as a major military camp (*castra aestiva*) built in a mountain environment (1,728 m.a.s.l.) under the legate of Publio Carisio (about 26-22 a BC). The site is close to Via Carisa, a strategic historical path between the Cantabrian Coast and the interior of the Iberian Peninsula.The research aims to establish the interaction between human activity and landscape in a complex mountain environment, by combining geomorphological mapping, geophysical research (multi-technique geophysical research with seismic refraction and multichannel analysis of surface waves methods), core sampling and AMS radiocarbon dating. Landscape features result mainly from fluvial and gravity action, being outstanding the occurrence of large ancient landslides reworked by human activity and partially occupied by the Roman Camp.Several small bogs right on top of the landslides are interpreted as artificial closed structures of unknown age, subsequently filled by a sedimentary sequence, which was sampled with seven hand drill cores.Deogracias-1 core (202 cm deep) located at 1,248 m a.s.l. is composed by alternations of clay, silt and sands (interpreted as waste activity in a pond) and a unit of gravels embedded in a clay matrix (interpreted as colluvial deposits). Radiocarbon data shows that the pond infill would have extended from 2,550 ± 30 yr BP (cal BC from 800 to 570 yr) to 2,410 ± 30 yr BP (cal BC 730 to 400 yr). The results suggest that human occupation is prior to Roman times, reinforcing the strategic significance of Via Carisa as a historic pass across the Cantabrian Mountains

Geoarchaelogical aspects of quaternary geomorphology of Kazakhstan

BAIBATSHA A.
Kazakh National Technical University named after K.Satpayev, ALMATY, KAZAKHSTAN

Favorable conditions for the existence of hominids were fully formed in the Kazakh steppes to the late Neogene period. In the current ranges of Karatau there lived herds of large animals in the forests and woods year-round growing fruit trees and berries, strong siliceous rocks were deposited on the surface required for the manufacture of tools. All of those were favorable factors for the lives of ancient people.

Hominids inhabited the territory of the Kazakh steppe about 2,0 million years ago had long and difficult path in life, endured all the trials and overcoming all the difficulties of primitive society, came to our century. Archaeological studies have given the materials covering the long and complicated path of evolution of the first man. Early Paleolithic era covers, known as Acheulean and Arystandy culture in the Kazakh steppe [*Baibatsha A.B*., 2012].

Arystandy culture. Found in the valley r.Arystandy [*H.A. Alpysbayev, N.N. Kostenko*, 1968] near Range of Big Karatau the primitive pebble stone tools considered as cultural monuments of the earliest people in the Kazakh steppe. Based on a comparison of these crop residues with well-known in the science culture Olduvai hominids in Africa, an archaeologist *A.Medoyev* (1982) proved that they are coeval.

In the area of the Ridge B. Karatau most ancient instruments of a man revealed in the area of the valley r.Arystandy on its left high bank, among the preserved from erosion lower Antropogenic conglomerates. Lower Antropogene conglomerates' thickness is 9 m and more evident in a number of points as the left bank and right bank of r.Arystandy.

About the time of formation lower antropogenic conglomerates can be judged on the basis of archaeological, palynological and other data. Karatau ancient people lived in the era of the first anthropoids and Anthropogene faunal assemblage [*Alpysbayev H*., 1979].

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Using geomorphology and physical geography in obsidian sourcing

MOURALIS D.
Universite de Rouen et CNRS, UMR IDEES, 6266, MONT-SAINT-AIGNAN, FRANCE

The lithic artefacts found in archaeological excavations reflect the diffusion of raw material or artefacts from their geological sources to the archaeological excavations. Since the pioneer works by Cann and Renfrew (1964), an increasing number of studies have investigated the obsidian that have been intensively used by prehistoric people all over the regions of theworld where it outcrops. Obsidian sourcing is thus became a very dynamic field of research.

The obsidian sourcing is based on three proprieties. 1) First, it is possible to characterize physical and chemical properties of an outcrop. 2) Second, the intra-source variation of these characteristics may be neglected in comparison with inter-source variations. 3) And third, it is still possible to find the outcrops of the sources used by prehistoric peoples.

The physical and chemical characteristics (properties 1 and 2) of obsidian –as other volcanic materials- depend to the differentiation processes in the magma chamber and secondary to the weathering occurring after the deposition of the material. These properties are thus linked to the volcanic and morphologic evolution of the studied volcano.

Moreover, it appears that the definition of the sources (property 2) depends greatly from a researcher to another and from the scalar level. In some cases, an "obsidian source" corresponds to an entire volcanic region, whereas in other cases a "source" may be a single outcrop. In some other cases, an obsidian "source" is first of all a chemical group.

Finally, the sources used by prehistoric people for tool-chopping may be found (property 3) if they have not been later eroded of fossilized. This third property is thus directly linked to morphological evolution of the volcano since the obsidian deposition.

In this presentation, we thus demonstrate how geomorphology, and physical geography in general, may play a very important role for obsidian sourcing.

Holocene fluvial and coastal processes, landforms and human settlement: the case of the roman town of Sena Gallica (Marche, Italy)

DE DONATIS M.(1), LEPORE G.(2), SAVELLI D.(1), SUSINI S.(1), SILANI M.(2), BOSCHI F.(2), NESCI O.(1)
(1) Universita' di Urbino "Carlo Bo, URBINO, ITALY ; (2) Università di Bologna, BOLOGNA, ITALY

Sena Gallica (modern Senigallia) was the first roman colony established on the Adriatic Sea at the beginning of the 3th century B.C., in the northern Marche region, central Italy. Since 2010 a new research project has been started by an agreement between Municipality, University of Bologna (DiSCi, Section of Archaeology), University of Urbino (DiSTeVA) and Soprintendenza per i Beni Archeologici delle Marche, with the main goal to reconstruct the ancient landscape, understanding the relationship between geomorphological and historical evolution.

The adopted research method is based on combining old and new data, involving archaeological excavations, topographical and geophysical surveys, geological and geomorphological analysis. The management of all acquired data is favoured by the digital field mapping, GIS elaboration and 3D modelling. The research revealed the presence of an early Holocene coastal fan built by the Misa river. The deactivation of this fan had been followed by a partial erosive dismantling by both wave and stream erosion and then by a partial drowning of its remains.

The particular morpho-evolutionary history of the coastal fan allowed the development, in correspondence to the former fan-head, of soggy flats and depressions enclosing relatively high, isolated sectors, which later were selected for the earliest human settlement. The new environment was also modified by the fluvial action. In fact, the presence of topographic highs bounded by the Misa River meanders, and by the Penna streamlet, induced the roman colonists to found here the town. At the same time, the fluvial morphology influenced several choices in the roman urban planning, as in the case of the urban walls' route, the location of the port, and of the regularization of the Penna channel, which was transformed in a kind of artificial channel, in order to prevent the floods of the Misa river.

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S15 B: What does art can teach us about coastal geomorphological environment ?

MOTTE E.(1), REGNAULD H.(2), RUAULT R.(2), DAIRE M.Y.(3)
(1) Universite Rennes 2, RENNES, FRANCE ; (2) Université Rennes 2, RENNES, FRANCE ; (3) Université Rennes 1, RENNES, FRANCE

Understanding present coastal environment changes and anticipation of its evolution implies some knowledge about past conditions. Available scientific data does not often go back far enough to cover long time scale. Therefore, the idea of this work is to show how art, especially pictorial representations, can be used for such an aim. A collection of paintings, engravings, watercolors and so on have been gathered together, which all deal with the coast of Brittany (western France). The dataset cover a time period from 1750 to 1940, but most of the work of art we used were painted between 1800 and 1920, as Brittany was a major source of inspiration for artists from all over the world. These paintings can bring informations to extend data bases temporally: land cover and land uses, beaches sedimentology (composition and grain size), activities on the intertidal zone. Though contemporary art is not so realistic, a few artists are presently producing works which may be added to the dataset. An other interesting point is that these works may also be interpreted as readings, expressions of past human looks and apprehension of coastal areas, offering consequently new elements to appreciate the relative importance of each type of geomorphological site regarding what is considered as a beautiful landscape. Here we join the concept of "geomorphosites" according to which socially shared affects do exist for some particular types of coastal places. This work, as it will necessary rely on some privileged places (those which have been represented many times), will help to assess how much our present "geomophosites" result from a cultural and aesthetic progressive and ongoing construction.

The environment of tell of Dikili Tash: anthropogenic and climatic changes

GLAIS A.(1), LESPEZ L.(2), LOPEZ-SAEZ J.A.(3)
(1) Universite de Caen Basse-Normandie / Geophen, CAEN, FRANCE ; (2) Universit? de Caen Basse-Normandie / Geophen, CAEN, FRANCE ; (3) CSIC, MADRID, SPAIN

The investigations carried out around the tell of Dikili Tash (Northern Greece), improve our understanding of the evolution of the palaeoenvironment from the beginning of the Early Neolithic (c. 6 500 cal BP) to the Bronze Age, the periods of its occupation. In order to investigate the human and the climatic impacts, mainly Rapid Climatic Change events, around the tell of Dikili Tash, the small-scale alluvial sedimentary archives are valuable sources of palaeoenvironmental and geomorphological information. While global climate reconstructions researches based on the study of the Tenaghi-Philippon marsh, located 7 km from the tell, have focused on forces that drive the environment at the regional or continental scales, we attempt to use the local sediment archives to identify periods of changes around the closer inhabited areas. The reconstruction of environmental changes is based on field work and more than 15 cores located in the wetland and alluvial areas near the archaeological site. Two sources of palaeoecological investigations have been conducted: geomorphological and sedimentological investigations and pollen and non-pollen palynomorphs analyses. Palaeobotanical proxy data give a comprehensive view of anthropogenic impact on the vegetation cover which can be compared to the sedimentological changes undertaken in the lowland areas. Combined with archaeological data, this information allows reconstruction of interactions and/or adaptation of the past local societies to global changes. Marsh boundaries evolution and soils erosion observed from core drillings in the sedimentary filling of the small depression gives evidence of periods geomorphological changes in response to anthropogenic since the Middle Neolithic.

The poster proposed presents the methods and the main results of this local and multi-proxy approach. The palaeoenvironmental and geomorphological investigations give evidence of early anthropogenic disturbance and climatic events impacts.

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The Middle and Upper Pleistocene loess record and Acheulean-Mousterian industries of Saint-Illiers-la-Ville (78 - France)

CHAUSSE C.(1), SCHWENNINGER J.L.(2), DEBENHAM N.(3), BLASER F.(4)
(1) Inrap (7 rue de Madrid - Paris) et Laboratoire de Géographie Physique (UMR 8591) - Meudon, PARIS & MEUDON, FRANCE ; (2) Luminescence Dating Laboratory, Research Laboratory for Archaeology & the History of Art, OXFORD, UNITED KINGDOM ; (3) Quaternary TL Surveys, NOTTINGHAM, UNITED KINGDOM ; (4) Inrap (7 rue de Madrid - Paris) et Préhistoire et Technologie, UMR 7055 - Nanterre, PARIS & NANTERRE, FRANCE

A new sequence of loess / palaeosol was found in a section located at Saint-Illiers (Yvelines) in western Paris Basin (France). The excavation yielded several levels of Palaeolithic artifacts comprising handaxes. An extensive study was carried out to get a reliable chronological framework. In a first step, litho-pedological investigations including micromorphological data were compared with an equivalent succession from north-western France. Then, results were dated using a chronological luminescence framework based both on Thermoluminescence and Optically Stimulated Luminescence methods applied on burnt flints and sedimentary material. Synthesis of results allows to reconstruct successfully the chronology of deposits and the climatic fluctuations since ca 400 kyrs ago.

In summary, the Saint-Illiers sequence consists of several loamy aeolian units deposited during different cold periods. Some of them are reworked by solifluction and colluvial processes. They are related from the oldest to the most recent to MIS 10, 8, 6 and 2. They are interbedded with palaeosol levels developed during interglacial and interstadial conditions linked to MIS 9, 7, 5 and 3. Finally, each prehistoric level can be integrated within its own chronostratigraphical context. The oldest Acheulean settlement (S3N4) is dated endof the glacial stage MIS 10. The second one (S2N2) is attributedto the MIS 7 interglacial period. The third layer of artifacts (S3N2) is contemporaneous of a cold period correlated with MIS 6. The two following levels (S2N1 and S3N1), attributed to the middle Palaeolithic, are associated with various deposits assigned to the Weichselian Early Glacial (MIS 5d-a or 4) and to the Middle Pleniglacial (MIS 3) period.

Iron as raw material: Introduction of iron metallurgy and spatial implications on landscapes. A case study from the forelands of the Harz Mountains, NE Germany

BEBERMEIER W.(1), HOELZMANN P.(1), SCHIMPF S.(2), SCHÜTT B.(1)
(1) Institute of Geographical Science, BERLIN, GERMANY ; (2) Alfred Wegener Institute for Polar and Marine Research, POTSDAM, GERMANY

The knowledge of iron metallurgy spreads at the declining Bronze Age from the advanced civilizations of the Hittite of present day Turkey north-westwards reaching northern middle Europe ca. in the 3rd century BC. Exploitation, smelting and processing of this new raw material requires large amounts of energy feedstock. For the centre of iron smelting in the Mediterranean Populonia, located in western Tuscany at the Tyrrhenian Sea it is assumed that iron production shifted from Elba to the Italian west coast after the island has been nearly deforested. Consequently, it is inferred that the introduction of iron metallurgy to a region is associated with additional pressure on the landscape. The aim of our presentation is to test this hypothesis for two settlement sites of the Przeworsk culture (approx. 2100 a BP) located east of the city of Nordhausen in the southern forelands of the Harz Mountains, NE Germany. The Przeworsk culture immigrated from present-day Poland to this area and possessed – in contrast to the local already existing population - the knowledge of iron smelting techniques. Their settlements are located in close vicinity to clay ironstone layers in the sandstone bedrock (Lower Buntsandstein formation).

Our study is based on the analyses of four valley sediment sequences. Drillings in these sediments bottom out on the bedrock and represent the sedimentary history since the late Pleistocene. The sediments show typical sequences of varying facies that represent periods of enhanced geomorphological activity and phases of stability during the early Holocene. After 3.600 cal a BP an increasing amount of charcoal, coarser grain sizes and angular pebbles are found in colluvial deposits. We interpret this as a consequence of clearing activities. However, up to date the resolution of the ^{14}C-chronology requires refinement to clearly validate or falsify the above mentioned hypothesis.

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Mid-Holocene changes in morphodynamics along the western Calabria coasts (Italy): geoarchaeological implications

RUSSO ERMOLLI E.(1), PACCIARELLI M.(2), ROMANO P.(1), CICALA L.(2), DI DONATO V.(1), RUELLO M.R.(1), TERRASI F.(3)
(1) DISTAR University of Naples Federico II, NAPLES, ITALY ; (2) DSU University of Naples Federico II, NAPLES, ITALY ; (3) INNOVA, CASERTA, ITALY

The western Calabria region, overlooking the Tyrrhenian Sea, is characterized by high relief rocky coasts alternating with large plains, such as the Lamezia-St Eufemia plain. It preserves flights of Quaternary uplifted marine terraces which are dissected by steep catchments draining to piedmont areas where entrenched alluvial fans, Late Pleistocene-Holocene in age, are found.

Archaeological findings of the last decades reveal the continuous presence of human populations since Neolithic, which have found favorable conditions for their settlements both on the gentle terraces and in the large piedmonts of this area.

In order to spread light on the Holocene landscape history of the Tyrrhenian Calabria, chrono-stratigraphic and palaeoenvironmental reconstructions were carried out in the coastal plains by collecting previous and new borehole data. The first results coming from a core drilled in the Lamezia-S. Eufemia plain reveals that an open lagoon system got started in the early Holocene and was abruptly replaced by lacustrine sedimentation at around 5000 y BP, which in turn underwent progressive changing into fluvial environment. The mid-Holocene continental environment persisted until historical times with a sedimentation mainly characterized by fine sands of the fan system distal zones. As for the Lamezia-St Eufemia plain, some minor coastal plains, such the Porto Salvo sector, recorded a prograding trend during the mid-Holocene in response to alluvial fan growth. These reconstructions are the image of a deep morphodynamic change which led to enhanced slope erosion, fluvial transport and accumulation, most probably driven by concurrent human pressure and sub-Boreal climatic variability. The choice of settlement location since Neolithic seems to have been influenced by such a modification, which led to select more stable areas, as the hanging relicts of older landscapes bordering the plains.

Lama-bordos and late Holocene agricultural engineering systems controlling sediment yield in the Mixteca Alta, Oaxaca, Mexico

LEIGH D.S., KOWALEWSKI S.A., HOLDRIDGE G.H.
The University of Georgia, ATHENS, GA, UNITED STATES

The Mixteca Alta, a high-elevation plateau in south-central Mexico, was severely gullied in response to Spanish conquest (1500s-1600s) and related population decline and land abandonment. Depopulation resulted in erosional destruction of prehistoric cross-valley check dams known as lama-bordos that were systematically constructed to facilitate valley-bottom agriculture for millennia. We establish the earliest ages for construction of lama-bordos (including some >5 m high and buried by >10 m of alluvium) and the chronology for sedimentation behind the lama-bordos. Intensive stratigraphic, sedimentologic, and pedologic sampling was conducted on several arroyo walls (up to 20 m high) alongside lama-bordos in small watersheds (<10 km^2). Analytical methods include: radiocarbon and luminescence dating, geochemical/lithological sediment ascription to identify time periods of gully erosion, and correlating stratigraphy with archeology. Preliminary results include more than 60 radiocarbon dates establishing an alluvial chronology, and evidence that severe upland gully erosion had occurred prior to widespread human occupation of the area. Several radiocarbon ages date the initial construction of lama-bordos to >3400 cal yr BP, which is much older than previously known for any agricultural engineering structures in Mesoamerica. Our research reinforces the fact that climatic drivers of sedimentation often are intertwined with human influences. The lama-bordos provide clear examples of human-produced stratigraphy and artificial landscapes (stair-stepped valleys), thus informing discussion on the proposed Anthropocene epoch.

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Geomorphological and sediment records of an intense climate change at the end of the late bronze age (1250-950 BC) in Anatolia: relationships with the end of the Hittite Empire

KUZUCUOGLU C.
CNRS (Laboratoire de Geographie Physique), MEUDON CEDEX, FRANCE

Since the 1990's, an increasing number of papers discussing past climate changes assume the determining role of climate change in triggering cultural changes and civilization collapses. As a contribution to this debate, the paper presents a pluridisciplinary evidence of a succession of rapid and intense climatic events between 1250 and 900 BC. Palaeoenvironmental and geomorphological indicators have been studied in various environments and space-scale contexts in association with archaeological sites. Data were collected in river watersheds and flood valleys, closed depressions and wetlands located in a variety of regions throughout the peninsula: north-central Anatolia, Cappadocia, Mediterranean coast, Syrian border. The synthesis of the sequences illustrates (a) contemporaneous occurrences of climatic events of different intensity at the end of the 2nd mill. BC; (b) a variability in the number and type of environmental signals recorded along two geographic gradients: N-S and W-E.

Results are set in relation with the end of LBA societies in Anatolia and the Eastern Mediterranean facing repeated and intense dry events at the end of the 2nd mill. BC. Based on the end of the Early Bronze Age (2200-1900 BC) in SE Anatolia and northern Syria (*Varia Anatolica*, XIX, 2007), a model interlacing cultural, climatic and environmental components is used for illustrating events related to the fall of the Hittite Empire ca 1190-1170 BC. However, focusing the cause-chain which led to the collapse raises questions: what happened, when, how? What was the exact role of climate change? of its relationships to environment? What was the role of stresses rooted in internal (political, economic) organization and waiting-to-break into socio-environmental conflicts? How much was the reaction of the State organization out of phase with the change in environmental constraints? Answers to the latter questions will depend from further scientific programs.

Studying the impact of the Meio 1498 earthquake and tsunami on the geomorphology of the Hamana floodplain: a geoarchaeological approach

HEYVAERT V.M.A.(1), FUJIWARA O.(2), UMITSU M.(3), SATO Y.(4), ONO E.(5), YATA T.(5)

(1) Geological Survey of Belgium, BRUSSELS, BELGIUM ; (2) Geological Survey of Japan, AIST, TSUKUBA CITY, JAPAN ; (3) Nara University, NARA CITY, JAPAN ; (4) Kyushu University, FUKUOKA CITY, JAPAN ; (5) Niigata University, NIIGATA CITY, JAPAN

The objective of this research is to study the role of a tsunami, generated by the 1498 Meio earthquake (M8.2 - 8.4) along the eastern Nankai on the geomorphological evolution of the Hamana river floodplain, located along the Pacific coastline of Central Japan.

Historical sources document a sudden decline at the end of the 15th century of the harbour town Hashimoto, located along the river Hamana. Before the 15th century, this river connected the Pacific Ocean with an enclosed coastal embayment separated by a sand barrier (i.e. the present-day Hamana lake) from the Pacific.

The reconstruction of the palaeocourse of the Hamana river was carried out on the basis of detailed facies and diatom analyses of undisturbed sediment cores (geoslicer and drilling). The palaeochannel was detected along the western side of the present-day coastal embayment. It seems that the river's mouth was abruptly sealed off due to the migration of huge volumes of sand that initiated the development of a marsh environment upstream along the channel.

The identification and radiocarbon dating of these sandy high-energy flow deposits in several cores (thick sand bed of marine origin intercalated at the estuarine - marsh environmental change boundary) suggests that the river mouth closure was initated by mass sediment transport by a storm surge or tsunami (1498 Meio tsunami and/or 1498 and 1499 large storm surges).

Historical sources document that after the 1498 Meio tsunami, the Hamana back-barrier sheltered environment was reconnected to the Pacific Ocean due to breaching of its sand barrier. Both environmental changes (river mouth closure and barrier breaching)are synchronous with the sudden decline of the harbour town Hashimoto.These data suggest that disruption of the waterway between the harbour town Hashimoto and the Pacific Ocean possibly led to the decline of the harbour at the end of the 15th century.

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From point to surface. Reconstruction of a riverine urban settlement in Padova (NE Italy)

MOZZI P.(1), ABBÀ T.(2), FERRARESE F.(3), FONTANA A.(4), GAMBA M.(5), NINFO A.(4), PIOVAN S.(3), ROSSATO S.(4), ZANGRANDO D.(6)

(1) Dipartimento di Geoscienze - Universita di Padova, PADOVA, ITALY ; (2) Geologist freelance, BORGORICCO, ITALY ; (3) DiSSGeA - Università di Padova, PADOVA, ITALY ; (4) Dipartimento di Geoscienze - Università di Padova, PADOVA, ITALY ; (5) Soprintendenza per i Beni archeologici del Veneto, PADOVA, ITALY ; (6) Geographer freelance, VODO DI CADORE, ITALY

Padova lies in the low alluvial plain of the Brenta and Bacchiglione rivers. The modifications of the hydrographic network greatly influenced the position and evolution of ancient settlements. The first archaeological evidences in Padova date back to the late Bronze Age, whilst the major development of the settlement took place during the Iron Age (9^{th} – 4^{th} century BC). This urban centre maintained its importance during the Roman period, being one of the main *Municipia* in NE Italy.

This research integrates the analysis of the alluvial and archaeological record. Methods span from remote sensing and LiDAR to GIS processing of archaeological and geological data, geological field survey, corings and radiocarbon datings.

According to our results, the Brenta River was crossing Padova during the 3^{rd} and 2^{nd} millennium BC. This ancient river course has been occupied since the beginning of the 1^{st} millennium BC by the Bacchiglione River, as a consequence of the Brenta River diversion to the East. This drastic hydrographic change presumably allowed for the development of the Iron Age village on the stable banks of the river. The reconstruction of the fluvial and archaeological evolution of the area shows that the settlement was in close proximity to the river. Protection from flooding was provided by the Bacchiglione River acting as an underfit stream in the Brenta palaeochannel.

Human activities along the centuries led to the formation of an anthropogenic mound (7 m thick and 1 km^2 wide) which corresponds to the present city centre. The 3D modeling and spatial correlation of selected archaeological features, grouped into time-categories, have led to the recognition of the main phases of upbuilding of the anthropogenic mound. The thickest deposits relate to the Iron Age and the Middle Ages. A major remodelling of the urban surface occurred in Roman times.

Holocene landscape reconstruction of the Southern Sinis Peninsula area (Central-Western Sardinia, Italy): Geoarchaeological approach

MELIS R.(1), SECHI S.(2), DEPALMAS A.(3), ZEDDA M.(4)
(1) Dipartimento Scienze Chimiche e Geologiche , University of Cagliari, CAGLIARI, ITALY ; (2) Université de Rouen - Département de Géologie Laboratoire de Morphodynamique Continentale et Côtière (M2C) UMR CNRS, 76821 MONT SAINT AIGNAN CEDEX, FRANCE ; (3) Università degli Studi di Sassari, Dipartimento di Storia, Scienze Umane e della Formazione, SASSARI, ITALY ; (4) Università degli Studi di Sassari, Dipartimento di Medicina Veterinaria, SASSARI, ITALY

The study area is located along the north-western part of the Gulf of Oristano, south of the Sinis Peninsula (central West coast of Sardinia, Italy), in the alluvial plain of the Tirso River, which is the main river of Sardinia. More exactly, this area, called Sa Osa, is characterized by Pleistocene and Holocene alluvial terraces, close to the shoreline and the Cabras lagoon. The geomorphological context makes this area particularly sensitive to climatic changes, sea level variations and human activities during the Late Pleistocene and Holocene. The archaeological remains, interbedded with alluvial sediments from the Tirso River, testify to human occupation since the last millennia: from the Neolithic to the Iron Age. Human presence was confirmed by fish remains and fruit, seeds, as some coming from cultivated grapes. A lot of grape seeds were found in cylindrical wells and hollows which were dug into the Pleistocene alluvial sediments. The Neolithic settlements were mainly located around the lagoons. Evidence of Bronze Age settlements, which coincide with the Nuragic civilization development were found in all the analysed territory. Geomorphological, stratigraphical, sedimentological, micromorphological, paleontological and archaeologicalstudies added to ^{14}C dating lead to understand that this environment was globally unstable. Human impact was old (pre-history) and added to the natural evolution of this geographic sector.

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Geomorphological investigation in Adam Oasis (Sultanate of Oman) and the implication for the archaeology - The example of the Neolithic site Jebel al-Aluya

BEUZEN T.(1), FOUACHE E.(2), LEMÉE M.(3), GERNEZ G.(4), GIRAUD J.(5)
(1) Université Paris-Sorbonne, PARIS, FRANCE ; (2) Université Sorbonne Abou Dhabi, Institut Universitaire de France, ABOU DHABI, UNITED ARAB EMIRATES ; (3) INRAP, PARIS, FRANCE ; (4) Université Paris 1 Panthéon-Sorbonne, PARIS, FRANCE ; (5) Institut Francais du Proche Orient, PARIS, FRANCE

Like other anticlinal chain, Salakh arch acts as a natural dam in Adam region and allows the existence of Adam oasis, located in a gap created by this chain. At the door of the Rub al Khali desert, this wetter area has been continuously occupied since Paleolithic period and surely was a strategical place for seasonal migration. With the collaboration of the French archaeological team of Adam, we propose an analysis and the cartography of Pleistocene and Holocene palaeosurfaces herited from pluvial period.

Jabal al ‘Aluya is a Neolithic site located at the foot of Jabal Salekh near Adam. The site extends over 65 hectares, loosely occupied with 139 structures and lithic concentrations that were found all over the surface. The numerous cherts (almost bifacial tools) collected from this area date back to the Neolithic. Geomorphological studies show that the site relies on one of those Pleistocene paleosurfaces : a glacis. The study and the cartography this Neolithic site (one of the few to be inland) permit us to conclude that this region took advantage of wetter conditions during Neolithic period even if any age dating were made yet in this region. In addition to this general research, we optimize the surveying method by adding environmental data in order to make strategic choices for covering this 3000m^2 area. Pleistocene fluvial formation and upper part of glacis were pointed out to be protected place where potential archaeological structures were not disturbed by ancient or present time deposits.

Response of upland catchments to environmental change in a temperate highland setting: initial results from the velay, Massif Central, France

DEFIVE E.(1), GUNNELL Y.(2), GUILBERT J.(2), POIRAUD A.(3), MIRAS Y.(4), BERGER J.F.(2), CUBIZOLLE H.(5)

(1) Université Blaise Pascal, GEOLAB, UMR 6042-CNRS, Maison des Sciences de l'Homme, 4 rue Ledru, F-63057 Clermont-Ferrand, France, CLERMONT-FERRAND, FRANCE ; (2) Université Lumière-Lyon 2, UMR 5600 CNRS Environnement, Ville, Société, 69635 Lyon Cedex 07, France, LYON, FRANCE ; (3) GEOLAB, UMR 6042-CNRS, Maison des Sciences de l'Homme, 4 rue Ledru, F-63057 Clermont-Ferrand, France / Bureau d'étude "Inselberg", 261 allée des Bauges, 73000 Chambéry, France, CLERMONT-FERRAND, FRANCE ; (4) GEOLAB, UMR 6042-CNRS, Maison des Sciences de l'Homme, 4 rue Ledru, F-63057 Clermont-Ferrand, France, CLERMONT-FERRAND, FRANCE ; (5) Université Jean-Monnet Saint-Etienne / UMR 5600 CNRS Environnement, Ville, Société, 69635 Lyon Cedex 07, France, SAINT-ETIENNE, FRANCE

Field reconnaissance along 1st- to 3rd-order streams (*sensu* Strahler) in the upper Loire river watershed, France, has uncovered previously unreported alluvial sequences in upland vales and pocket-sized floodplains that record at least the last 1000 years of sedimentary response to land-use and land cover change. Based on stratigraphic field observations and ^{14}C chronostratigraphy, we find evidence of a large stratigraphic hiatus between the Upper Pleistocene glacial formations, which are widespread but poorly dated, and the historical cut-and-fill sequences located in the talwegs. The entire Lateglacial and earlier Holocene record appears to be missing. In all the catchments investigated, the stratigraphy of alluvial deposits dating back to the late Middle Ages consistently exhibits a succession of two major phases. The Middle Ages appear as a period of stable land cover, with steady accumulations of organic matter promoted by optimal climatic conditions and limited human occupation in these remote upland areas. The stratigraphy subsequently records an abrupt phase of land degradation coinciding both with the beginning of the Little Ice Age climatic downturn and the peak of population growth and farming pressure on the local environment, observed in many settings throughout Europe during and after the 14th century. Here, however, the human impact was the main trigger of catchment erosion, as documented by historical archives on hillside agricultural expansion. Further downstream, among 3rd and 4th order channels of the drainage network and beyond, the climatic signal becomes stronger and the land-use signatures are lost. This feature emphasizes the importance of catchment order when interpreting the alluvial sedimentary record, illustrating how it affects the scientific perception of environmental change and the hierarchy of driving mechanisms that we derive from it.

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Eolian dynamics and landforms in South Kharga oasis (Western Desert of Egypt): evidence for two different models before and after farming settlements in Antiquity

CREPY M., CALLOT Y.

Laboratoire ArcheOrient (UMR 5133 CNRS - Universite Lumiere Lyon 2, Maison de l'Orient et de la Mediterranee.), LYON, FRANCE

Kharga oasis, in the Western Desert of Egypt, is located in the hyper-arid core of the Sahara. Agriculture depends on artesian deep wells in the Nubian Sandstone Aquifer System and on fine-grained sediment taken from yardangs. These yardangs have been interpreted by some geomorphologists as playa and loess-like deposits. But in the past, some artesian springs and some hydraulic installations enabled humans to settle. In the south of the oasis the archaeological survey and work of the IFAO (Institut Français d'Archéologie Orientale) show that human occupation in the area was nomadic until 4500BP and the pre-dynastic period. No remains of human activities or settlements dating from 4500BP to 2500-2450BP have been discovered. Sedentary settlements and agriculture began after 2500-2450BP, during the Persian domination, with many hydraulic installations for exploiting the groundwater resources (qanats, wells, aqueducts and canals).

Geomorphological survey, sedimentological analyses and archaeological results enable us to build two different models of environment and landscape evolution at the origin of thick loess-like and Saharan loess deposits in South Kharga oasis :

The first model explains the situation before sedentary human settlements (until 4500BP). Temporary human settlements and eolian deposition of silt and fine sand were linked with artesian springs and limited by their flow periods.

The second model shows how hydraulic installations between 2500-2450BP (Persian domination) and 1500-1450BP (late Roman times) modified the first model and how human sedentary occupation had a large morphogenic impact. As human activities expanded in areas of vegetation, eolian deposition became less localized and the thickness of the deposits increased more rapidly. This system lasted until the groundwater level lowered with the increase of arable land, which dried up the wells and qanats. At this time, much of the region was abandoned and ablation began to affect the entire area.

The Holocene sedimentary records of the Lower Seine Valley tributaries as indicators of the landscape evolution during 10 000 years in Normandy: the exemple of the archaeological settlement of Brionne (Eure, France)

GONNET A.
Université de Rouen, ROUEN, FRANCE

The Holocene archives of the Lower Seine Valley tributaries are indicators of the landscape evolutions during the last 10000 years in Normandy (France). They permit to evaluate the anthropic and climatic factors that influence these evolutions on each geomorphologic compartments (valley, slope, plateau). The gallo-roman occupation of Brionne (Eure), has revealed a stratigraphy interesting to understand the relationships between human practices and environment evolution. Located at the confluence between two hydrosystems, the settlement's stratigraphy show detrital sedimentation from the beginning of the Holocene, and tuffa deposits above. The extra-site study of this settlement permits to understand the origin of these detritic deposits for a local (the hydrosystem) scale. The macroscopic approach, completed with analysis in sedimentology, and micromorphology permits to apprehend the local chronostratigraphy and the process of sedimentogenesis of this site. This study is included in the regional geomorphologic context and will be correlated with other sites from the Lower Seine Valley tributaries.
Keywords: geoarchaeology, Holocene, Lower Seine Valley, Risle Valley.

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First data on Holocene hydro-geomorphological dynamics in the valley of Wadi Tassa (Azilal, High Atlas, Morocco).

LE DREZEN Y.(1), LETANG M.(1), BALLOUCHE A.(2), EL KHALKI Y.(3), LE COEUR C.(4)
(1) PRODIG UMR 8586 CNRS, PARIS, FRANCE ; (2) 2. LETG-Angers LEESA, UMR 6554 CNRS, Université d'Angers, UFR Sciences, ANGERS, FRANCE ; (3) 3. FLSHBM, Université Sultan Moulay Slimane, BÉNI MELLAL, MOROCCO ; (4) 4. Laboratoire de Géographie Physique, Université Paris1 Panthéon Sorbonne, MEUDON, FRANCE

Likemany valleys of the Moroccan High Atlas Mountains, the watershed of the river Tassa, at 1800 meters altitude near Azilal has undergone intense landscape changes over the past decades. Headward erosion of the valley has resulted in many badlands and digging deep gullies of 2 to 4 meters in the last century. Our studies in photo-interpretation and remote sensing have shown that these rapid changes in landscapes are mainly related to changes in land use and transformation of production systems. Changes have particularly affected the agro-forestry system in the watershed area.

The first observationson the sedimentary sections identify the main features of the evolution of the valley and the catchment hydro-geomorphological responses to environmental changes over the past centuries and millennia. The analysis of these deposits showed, in particular, the repetition of rhythmic fluviatile sequences (alternation of sandy and shaly layers) whose seasonal or multi-annual periodicity remainsto be documented. The current study should clarify the respective shares of hydro-climatic changes and anthropogenic factors (fire, agropastoralism, clearing...) in the described dynamics.

These first international multidisciplinary researcheswant allow us to propose a future research program that would focus on landscape dynamics of some valleys in the Tadla-Azilal region under the crossed anthropogenic and climate controls during the Holocene.

The Ribeira de Bensafrim Estuary, Lagos (Portugal) - human establishment and geomorphological evolution in the late holocene

ARA_JO-GOMES J.
Centre of Geographical Studies - IGOT, University of Lisbon, LISBON, PORTUGAL

On the right bankof the estuary of the Ribeira de Bensafrim is located the present town of Lagos. This town in the SW area of Portugal was founded by Imperial Romans after they transfer their previous pre-Roman location from the left bank of the river to the opposite shore.

In this presentation we will try to understandthe last millennia evolution of thehuman history in this location as well as the geomorphology of this asymmetric estuary. We will also try to understand why the Romans decided to switch their river bank establishment to continue to live in the same area. We will see that the geomorphological data as well as the geoarchaeological analysis brings us relevant information to the understanding of this subject multi-approach subject.

The main objectiveof this work lies in understanding of the reason why Romans changed their place from one river bank to the other. For this analysis will be used geoarchaeological methods that may help us understand what archeological science alone does not explain.

Through the sedimentanalysis gathered from the estuary, estuarine paleoenvironmental changes forcing that establishment change are discussed. Cross-examined sedimentological data with the archaeological sediments, malacological and mammalogical data of the pre-Roman archaeological site of Monte Molião (left river bank) will be analyzed attempting to find clearer answers. We will also add archaeoseismological data observed on the archaeological site.

This work will be presented with achronological reading of the geomorphological evolution of the estuary in which we focus on the crucial role of alluvial sediments for the paleoenvironmental evolution of this unique and sheltered Atlantic estuary.

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Late-Glacial aeolian activity in North-West Belgium: A contribution of OSL dating near the Moervaert paleolake

VAN NIEULAND J., VANDENBERGHE D., DERESE C., GELORINI V., CROMBÉ P., VAN DEN HAUTE P.
Ghent University, GHENT, BELGIUM

The Moervaert area is characterized by a depression, linked with a large paleolake. It is thought to originate as a result of the aeolian formed sand ridge of Maldegem-Stekene which dammed the braided river system that drained the greater part of Flanders, also called the Flemish Valley. This has led to an exceptional geological setting with major consequences on the early human development in the region. Although the Moervaart area is one of the most intensively studied landscapes in Belgium in terms of archeology, its geological evolution is still debated, in particular owing to a lack of absolute age determinations for the windblown sediments.

This study aims to determine the time and duration of the different phases of aeolian sedimentation in this area using quartz-based SAR-OSL dating. Sequences were sampled at three strategic locations, revealing a spatio-temporal framework of the ridge, the lake sediments and the substrates.

All quartz samples (n=22) exhibit satisfactory luminescence characteristics; the OSL signals are bright and decay fast with stimulation time, and the SAR protocol passes all procedural tests (recuperation, recycling, preheat plateau, dose recovery). The SAR-OSL ages for the ridge range between ~18 ka and 12 ka. Dose rate measurements are ongoing. However, the first age determinations of the eaolian substrate in which the paleolake developed during the Late-Glacial reveal an age of ~20 ka, which is in line with classical theories. The age results will be presented at the meeting and discussed in relation to the evolution of the landscape and human development.

Geomorphology and geoarchaeology: The Indian context

KOTAPALLI S.M.
Retired, NAGPUR, INDIA

Prof Lord Curzon visualized that it was in exploration and study of purely Indian remains, in the probing of the archaic mounds, in the excavation of old Indian cities and in the copying and reading of ancient inscriptions that a good deal of the work of the archaeologists will in future live. Truly enough, it was the excavation of the mounds near Mohen-jo-Daro and Harappa that put back the Indian civilization as much older than the others b at least three thousand years!. The geomorphic processes caused by rivers were mostly responsible for those mounds, just as the marine processes resulted in Lothal and other areas. The Buddhist Stupas were always recognized by the mound-like form, outwardly in several, parts of the country and their excavations subsequently led to the formation of the Archaeological Survey of India. The Ajanta-Ellora caves in the Deccan Traps, or the Kanheri caves on the west coast near Mumbai were clearly the result of geomorphic processes that operated then. There are also natural arches like the one neat Tirumala, Andhra Pradesh that was formed by geomorphic processes.

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New insights into the development of the Roman Harbour of Ephesos, Western Turkey

STOCK F.(1), LAERMANNS H.(1), STESKAL M.(2), LADSTAETTER S.(2), BRUECKNER H.(1)
(1) Institute of Geography, University of Cologne, COLOGNE, GERMANY; (2) Austrian Archaeological Institute, WIEN, AUSTRIA

The ancient city of Ephesos in Western Turkey was an important harbour city during Antiquity. Around 6000 years ago, the sea transgressed up to 18 km inland. Due to the progradation of the Küçük Menderes delta since that time, the coastline has continuously shifted westwards. As a result, Ephesos lost its connection to the sea, implying subsequently the construction of a harbour canal. Several attempts to clean or dredge the great harbour of Ephesos are known from inscriptions since the 1st century AD of. However, many questions remain open: When did the siltation of the harbour started? When was the canal constructed? How long was the harbour in use?

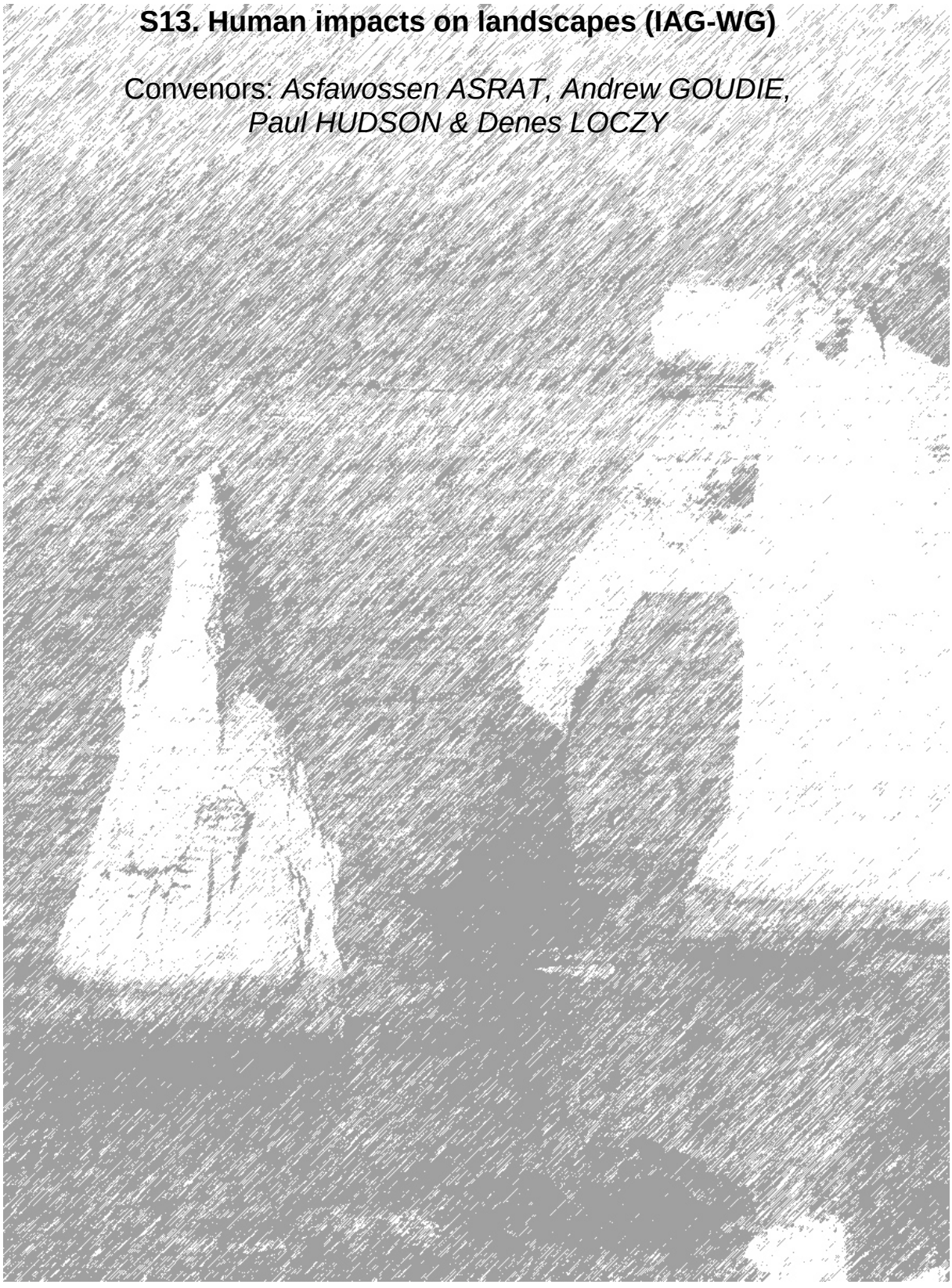
This research aims to identify the spatial and temporal shifts in the coastline during the past millennia, to clarify the development of the harbour and the harbour canal, to calculate sedimentation rates and to reconstruct the vegetation history in this area.

In total, 30 drill cores up to a maximum depth of 19 m were retrieved from geo-bio-archives in and around the harbour and the canal. Sediments from corings were examined with geochemical, sedimentological, microfaunal and palynological analyses. The chronological framework relied on AMS-14C ages and diagnostic ceramics.

First results reveal that the Roman harbour was accessible until the 14th century AD. A core in the middle of the Roman harbour shows a stratified layer which dated between the 2nd century BC and the 5th century AD. This corresponds to the period of prosperity and an intensively use of the harbour. Detailed geochemical investigations are still in progress.

S13. Human impacts on landscapes (IAG-WG)

Convenors: *Asfawossen ASRAT, Andrew GOUDIE, Paul HUDSON & Denes LOCZY*



Oral presentations:

The significance of small farm dams in the Karoo, South Africa

BOARDMAN J.(1), FOSTER I.D.L.(2)
(1) University of Oxford, OXFORD, UNITED KINGDOM; (2) University of Northampton, NORTHAMPTON, UNITED KINGDOM

In the South African Karoo (rainfall 200-500mm) farm dams are commonplace and have been built since the 1840s. Their purpose is largely water provision for stock in the dry season. In the twentieth century some were built as erosion control structures across gullies.

In the Sneeuberg uplands we have recorded over 100 small dams in a sample area of ca. 100 km^2. Most of the dams are earth built and almost 50% are full of sediment and store little water. As the dams fill, and are overtopped during storms, the potential for breaching is high. Almost 30% are breached and have therefore begun to release stored sediment. Many dams store <50,000 $m^3$of sediment; the largest, recently breached dam has the potential to release ca. 320,000 $m^3$of sediment.

The main impact of dam breaching is on downstream water storage reservoirs. In the Sneeuberg, the Nqweba dam is predicted to be full of sediment by 2025. Breaching of small farm dams will shorten its life span. High magnitude rainfall events are increasing in frequency in the region and add to the risk of breaching. South Africa has an acknowledged water crisis with 98% of its available water already allocated. Increased sedimentation in major reservoirs will add to the problem.

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Flood sedimentation during the extreme 2011 flood along the Lower Mississippi River, USA

HUDSON P.(1), HEITMULLER F.T.(2), KESEL R.H.(3)
(1) Leiden University, THE HAGUE, NETHERLANDS ; (2) Department of Geography and Geology, University of Southern Mississippi, HATTIESBURG, MISSISSIPPI, UNITED STATES ; (3) Department of Geography and Anthropology, Louisiana State University, BATON ROUGE, LOUISIANA, UNITED STATES

The effectiveness of extreme flood events to modifying floodplain environments remains an important and inadequately understood topic, particularly in the context of humanized fluvial systems. The 2011 flood along the Lower Mississippi River established new stage records at multiple locations along the lowermost alluvial valley, and had a peak discharge of 67,394 m^3/s at Natchez, Mississippi. This study documented the sedimentary deposits produced from the 2011 flood at 55 sites between Natchez, Mississippi and St. Francisville, Louisiana, and considered the geomorphic effectiveness of the event. For context, the study makes an explicit comparison with sedimentary deposits from the extreme 1973 flood, which was sampled at the same location. Results show considerable variability in sediment thickness, ranging from <1 mm to 620 mm with the thickest deposits along natural levees. Overall, most sites are characterized by less than 10 mm of overbank sediment, considerably less than thicknesses measured following the 1973 flood. Additionally, in comparison, the texture of 2011 deposits is coarser than the 1973 deposits. These data indicate relatively energetic, sediment-deprived overbank flow conditions that possibly eroded pre-existing surficial floodplain sediments and transported them to distal floodplain zones. The well-documented decline of suspended-sediment loads along the Lower Mississippi River could explain the unimpressive sedimentation in 2011, as it represents almost additional four decades of sediment reduction (due to upsstream dams) since 1973. Alternatively, the event sequence could be important, as a smaller discharge event occurred prior to the maximum flood event was associated with a much higher sediment load. These results have important implications for flood control and environmental floodplain restoration efforts.

Human impact and rehabilitation potential on a floodplain in Hungary

LOCZY D.
University of Pecs, PECS, HUNGARY

With very few exceptions, the Hungarian rivers are channelized and the communication between the channel and floodplain features is restricted to hyporheic (groundwater) flow. In addition to flood-control dykes, drainage ditches and canals, navvy pits, road and railway embankments, artificial mounds and others represent manmade landforms on the floodplain. Their dimensions and distribution pattern are influential both for flood hazards and floodplain land use. Geomorphological research can contribute to flood control design through mapping floodplain features, the intersections of dykes and old filled-up channels, localizing potential boils and seepages, unstable banks, the effect of vegetation cover. The large-scale inundations following extreme rainfall events in May-June 2010 provided good opportunities for the survey of excess water hazard on the protected floodplain of the Kapos River, Southwest-Hungary. The extent of anthropogenic transformations and the rehabilitation potential are assessed for the individual segments of the Kapos floodplain, identified by a morphometric index. With improving connectivity and landscape diversity indicators, the rehabilitation measures would enhance floodplain biodiversity and strengthen nature conservation function. Foreseeable conflicts between floodplain rehabilitation (its landscape ecological benefits) and land use (negative impacts on agricultural cultivation) are analyzed. In the light of the implementation of the European Union's Water Framework Directive, the applicability of research to other small-river floodplains in the Carpathian Basin are also considered.

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Human impact on floodplain geoecology. A Holocene perspective for the Dijle catchment, Central Belgium

BROOTHAERTS N.(1), VERSTRAETEN G.(1), NOTEBAERT B.(1), KASSE C.(2), BOHNCKE S.(2), ASSENDELFT R.(2), VANDENBERGHE J.(2)
(1) KU Leuven, LEUVEN, BELGIUM; (2) VU Amsterdam, AMSTERDAM, NETHERLANDS

Floodplain deposition rates have increased markedly under influence of human impact throughout the Late Holocene in many Western and Central European catchments. These variations in sedimentation rates have changed the geomorphology and ecology of many floodplains. In this study we discuss the human impact and its influence on floodplain geoecology for the Dijle catchment (760 km²), located in the Belgian loess belt. The geoecology of the floodplain and the regional vegetation was reconstructed based on sedimentological and palynological analysis. Age depth models for each of the studied sequences were obtained through 60 radiocarbon dates. Based on statistical analysis of the pollen data (e.g. cluster analysis and canonical correspondence analysis) human impact in the catchment was quantified. Our data shows that until ca. 2500 cal BP, human impact was either absent or limited to local disturbances yielding no clear influence on the floodplain geoecology. The river environment was in a stable phase and consisted of a marshy environment were organic material could accumulate, which is interpreted as the natural state of the floodplain. From ca. 2500 cal BP onwards, human impact gradually increased. However, only when human impact in the catchment crossed a threshold, the floodplain geoecology changed with clearing of the Alder carr forest, the creation of a single channel river and the dominance of minerogenic overbank sedimentation.Spatial variability in the coupling between increasing human impact and changes in floodplain geoecology can be attributed to differences in hillslope-fluvial system connectivity and local differences in human impact. Overall, this study provides new insights of how river systems respond to environmental change. It also shows that the contemporary morphology of the floodplains, with a typical meandering river bordered by levees and mineral floodplain deposits, has an indirect anthropogenic origin.

The legacy of mill dams in low-order streams in central Europe

LARSEN A.(1), JOSHUA R L.(2), FUELLING A.(3), BORK H.R.(1)
(1) University of Kiel, KIEL, GERMANY ; (2) University of Queensland, BRISBANE, AUSTRALIA ; (3) Humboldt University, BERLIN, GERMANY

Historic dams of largely unknown age are a widespread feature within German 1st to 3rd order streams. It has been proposed that accelerated slope erosion due to deforestation and agricultural land use is the reason for the aggradation of some central European floodplains, however this process only explains the delivery of sediment to these rivers. First results show that valley bottom damming was also a critical mechanism for the effective trapping of this increased sediment load. In this study we determine the onset and magnitude of this first impact of humans on riverscapes as a result of valley bottom damming, and examine the management implications. The extensive sedimentation of loam floodplains was precipitated by dam induced changes to the flow regime, and in turn caused the observed (stratigraphical) change of the channels from multithread to meandering. This floodplain loam also blankets a palaeo-wetland soil, which formed an efficient carbon sink. A modelling approach combined with the quantification of the stored sediments enables us to predict potentially remobilised sediments after dam-removal.

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Predicting and Managing Fluvial Processes: Opportunities for a Non-structural Approach

BRIZGA S.
S. Brizga & Associates Pty Ltd, CLIFTON HILL, VICTORIA, AUSTRALIA

Geomorphological analysis supported by hydraulic modelling allows areas of land at risk of fluvial erosion and sedimentation to be predicted with sufficient confidence to enable proactive management.

This paper presents predictions of river bank erosion, avulsion and crevasse splay deposition for selected rivers and floodplains in Victoria, Australia, and discusses opportunities and constraints for non-structural management. The case studies, including the Tambo, Snowy and Bunyip Rivers, range from relatively natural to highly modified systems. One- and two-dimensional hydraulic models were used to support assessments of current geomorphological processes and future scenarios.

Geomorphologists often advocate for a non-structural approach to the management of geomorphological hazards. However, in Australia, engineering measures continue to be widely used to address conflicts between fluvial processes and land use. Non-structural measures that rely on legal or planning tools have been less often used. Floodplain land in Victoria generally has freehold tenure, with patterns of land use and infrastructure that have evolved over many decades. The statutory planning system does not impinge on existing land use as it is only triggered by land use change and new development. Regulatory changes that increase constraints without compensation are unpopular. Relocation of infrastructure or purchase of easements to accommodate geomorphological processes is expensive and has not been widely undertaken.

Interest in the use of non-structural approaches to address natural hazards is increasing, particularly in relation to climate change. Greater uptake of a non-structural approach would require changes to the Victorian planning system to better address risks from fluvial processes. There is a fundamental need for consistent and widely-accepted principles that define the circumstances in which to protect assets, accommodate fluvial processes, or retreat from at risk zones.

Understanding sediment provenance during storm events in an eroding blanket peat catchment in the Peak District National Park, UK

SHUTTLEWORTH E., EVANS M., ROTHWELL J.
University of Manchester, MANCHESTER, UNITED KINGDOM

Large areas of the UK's blanket peat are significantly degraded and actively eroding due to climatic and anthropogenic perturbations. This impacts carbon storage through the physical export of particulate organic carbon (POC). The near surface layer of many of the UK's peatlands are also contaminated with atmospherically deposited metals (e.g. lead). The stability of peatlands is therefore important for the preservation of this carbon store and limiting pollutant mobilisation. However, little is known about the contribution of various sources of sediment entering the fluvial system. Previous work in the area has identified rapid changes in lead concentration in storm runoff which is potentially indicative of changes in sediment source.

Peat erosion is widespread in the Peak District National Park, UK, and the Bleaklow Plateau has been a focus of restoration over the past decade. Time integrated mass flux samplers (TIMS) have been used to collect suspended sediment across a range of flow conditions. Electrical resistance sensors have been attached to the TIMS to give a high resolution record of stage depth. A fingerprinting approach has been developed using geochemical and environmental magnetic parameters, which is previously untested in organic systems. The contaminated nature of the near surface peat distinguishes sediment mobilised from the peat surface from that eroded from gully walls. This paper will discuss the results of the ongoing monitoring campaign.

Understanding the physical process dynamics relating to sediment flux is essential in order to identify sources of material entering the fluvial system and understand the mechanisms by which it does this. This information can be used to inform management strategies which require a clear understanding of the locus of sediment production in order to target restoration.

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Changes of land use between 1979 to 2009 in the lower medium Araguari River Valley - Brazil

RODRIGUES S.C.
Universidade Federal de Uberlandia, UBERLANDIA, BRAZIL

The Araguari River is located in the central uplands of Brazilian and in the last forty years these region suffered a huge change in the regional economy due to the agricultural green revolution. The medium valley of Araguari River shows a landscape which changes from a flat regional surface over deep soils developed over Quarternary laterites in the interfluves to a deep valley with outcrop rocks where the river flows over pre-cambrian rocks. The land uses varies from automated agriculture in the flat areas, to irrigated horticulture in the valley slopes, to pasture and natural vegetation on the high gradient slopes. The main changes in the landscape were the construction of four hydroelectric plants on the valley bottom, and now in the first 200km of the valley, only 9km has the original features. Even the river discharge in this small area is not the same, because the river flow was derived by a adduction tunnel and only a small discharge remain in the original channel path. The changes in the land use are derived from the insertion of technology on the agricultural production and uses of the river. New data obtained from the land use maps from 1979 to 2009 show that enviromental laws promotes the regeneration and development of areas with natural vegetation, which contributed also to the new scenario of the area.

The Environmental Impact of Feeding One's Family

DOOLITTLE W.
University of Texas, Austin, UNITED STATES

Two long-prevailing theories about the origins of technology in a given place or location are independent invention and diffusion. This holds true for agriculture and resultant landscapes as well as for other types of technologies. Diffusion and independent invention both involve deliberate actions of planning and construction. Rarely, if ever, considered is the notion of agricultural technology evolving de facto out of normal everyday farming practices, and hence, cultivated landscapes developing as a natural and unintended consequence. This presentation demonstrates the role of farming as a geomorphic process. Regardless of how ecologically conscious farmers might be, their actions result in transformed environments. Recognizing the process of incremental change is paramount for planning and management purposes. Evidence is presented from Mexico, the US Southwest, Sweden, and Tanzania.

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Geomorphic Impacts of Maya Civilization

BEACH T.(1), LUZZADDER-BEACH S.(2), DUNNING N.(3)
(1) Georgetown University, Washington, DC, UNITED STATES ; (2) George Mason University, FAIRFAX, VA, UNITED STATES ; (3) University of Cincinnati, CINCINNATI, UNITED STATES

We present a new synthesis of research on human impacts across the Maya lowlands of Central America. This presentation draws from the literature and our own field studies from 1991-2013 of quarrying for mound and temple construction, lake cores, wetland excavations, alluvial coring transects, and catena studies of soil formation. To understand geomorphic changes, we synthesize evidence for mining impacts and examine stratigraphy with relative and radiocarbon dating and a host of paleo-environmental proxies from carbon isotopic ratios, elemental analysis, pollen, phytoliths, macro-botanicals, and soil and water chemical analyses. Human impacts occurred by the start of the fifth millennium BP. Most depositional environments show impacts during the Maya period of the last 3 millennia with evidence for surprisingly severe, though variable impacts from the Preclassic Maya, nearly 3,000 years ago. Many geomorphic repositories have organic, slow deposition or stable soil formation before agriculture and fire diffused over the landscape in the third millennium BP. From 3000 to 1000 BP this led to accelerated soil erosion and deposition of “Maya Clay” layers in some areas. We also distinguish anthropogenic from geological drivers such as drought, pluvials, tropical storm intensification, water-table rise and gypsum precipitation, and volcanic eruptions. Maya farmers responded to geomorphic change with soil conservation technologies and new land-uses that had large impacts on the region’s geomorphology in many areas. After the Maya Terminal Classic, c. 1000 BP, many landscapes stabilized, again indicated by organic, slow deposition rates and steady soil formation. The Late Preclassic around 2000 BP and Late Classic about 1200 BP experienced widespread droughts coupled with intensive human land uses and geomorphic impacts, but intensive climate changes of the Little Ice Ages without intensive human impacts had little effect on regional geomorphology.

High impact: 10 000 years of human-environment interaction in the Silvretta Alps

KOTHIERINGER K., LAMBERS K.
University of Bamberg, BAMBERG, GERMANY

The beginning of a continuous human presence in high alpine zones in the Early Holocene has recently become a highly discussed topic. It is to assume that in an extreme environment like the Alps, human activity, economy and culture have always been very sensitive to climatic variations throughout the Holocene. Thus, the valleys of the Silvretta Massif in the Central Alps between Paznaun (Austria) and Lower Engadin (Switzerland) were selected as an appropriate study area for analyzing the relationship between Holocene climate, settlement dynamics and human impact on the landscape in the course of an interdisciplinary research project.

Building on archaeological research initiated by the University of Zurich in 2007, recent palaeoecological, geoarchaeological and pedological investigations aim at reconstructing human-environment interaction in the Silvretta from the Early Holocene to the modern era. For this purpose, archaeological sites as well as environmental archives such as peat bogs and soils have been documented and analyzed. Palaeoecological data indicate a climatic cold phase from about 4700 BC, leading to a decrease of the timberline by 100-200 meters. This effect was intensified by high alpine pastoral land-use, i.e. livestock grazing, from about 4000 BC. There is evidence that soil formation was disturbed repeatedly by human activity like slash-and-burn. Palaeosols like fossil podzols situated on moraines high above the modern timberline show high ratios of macroscopic charcoal resulting from the former presence of extensive vegetation cover. Current laboratory analysis will provide further information on the age, origin (autochthonous vs. eolian) and development of soils. Based on the results of this reference region, the goal is to obtain an overall view of human-environment interaction in the Central Alps in high temporal resolution.

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Ethiopia in the 1930s: historical aerial photographs and their fusion with current remotely sensed imagery for retrospective landscape analysis

NYSSEN J.(1), FRANKL A.(1), MOHAMED S.(2), PETRIE G.(3), GEBREMESKEL G.(2), SEGHERS V.(1), HADGU K.M.(4), DE MAEYER P.(1), HAILE M.(5)
(1) Department of Geography, Ghent University, GENT, BELGIUM ; (2) Ethiopian Mapping Agency, ADDIS ABABA, ETHIOPIA ; (3) School of Geographical & Earth Sciences, University of Glasgow, GLASGOW, UNITED KINGDOM ; (4) Institute of Geoinformation & Earth Observation Sciences, Mekelle University, MEKELLE, ETHIOPIA ; (5) Department of Land Resources Management and Environmental Protection, Mekelle University, MEKELLE, ETHIOPIA

The aerial photographs (APs) acquired by the 7a Sezione Topocartografica during the Italian occupation of Ethiopia (1935-1941) have recently been discovered, scanned and organised. The oldest APs of the country that are known so far were taken in the period 1958-1964. The APs over Ethiopia in 1935-1941 are presented as assemblages on approx. 50 cm x 20 cm cardboard tiles, each holding a label, one nadir-pointing photograph flanked by two low-oblique photographs and one high-oblique photograph. The four APs were exposed simultaneously and were taken across the flight line; the high-oblique photograph is presented alternatively at left and at right; there is approx. 60% overlap between subsequent sets of APs. One of Santoni's glass plate multi-cameras was used, with focal length of 178 mm, flight height at 4000-4500 m a.s.l., which results in an approximate scale of 1:11 500 for the central photograph and 1:16 000 to 1:18 000 for the low-oblique APs. The surveyors oriented themselves with maps of Ethiopia at 1:400 000 scale, compiled in 1934. The flights present a dense AP coverage of Northern Ethiopia, where they were acquired in the context of upcoming battles with the Ethiopian army. Several flights preceded the later advance of the Italian army southwards towards the capital Addis Ababa. Further flights took place in central Ethiopia for civilian purposes. As of 1936, the APs were used to prepare highly detailed topographic maps at 1:100 000 scale. These APs (1935-1941) together with APs of 1958-1964, 1994 and recent high-resolution satellite imagery are currently being used in spatially explicit change studies of land cover, land management and (hydro)geomorphology in Ethiopia over a time span of almost 80 years, the first results of which will be presented.

Landscape resilience and sustainability in subtropical Argentine

SAYAGO J.M.
Consejo Nacional de Investigaciones Cientificas y Tocnicas, SAN MIGUEL DE TUCUMON, ARGENTINA

The subtropical arid / semi-arid northwestern Argentina, during the last centuries affected by deforestation, overgrazing and uncontrolled agriculture, has varying degrees of desertification. The intensity of deterioration, has been a marked decline in the productive capacity of the land, risking the possibility of a future sustainable production. In this vast region some areas apparently overcame their resilience (defined as the possibility of a return to the conditions climáxicas an ecosystem after a disturbance or climate change). In order to evaluate the intensity of this process and develop management criteria to improve the productive capacity of desertified landscape, we evaluated the influence of topography, climate, vegetation and soils in the resilience of the land, expressed by the closeness or distance to the threshold of resilience. Geomorphological sectoring was performed on each unit determined the influence of climate (rainfall erosivity), soils (soil erodibility) and vegetation cover (hydrological protection of vegetation), following the criteria of the Universal Soil Loss Equation (USLE). Validation of degradation intensity was performed by measuring the seasonal changes of coverage (dry and wet) and found that in some terrain units, resilience has been exceeded and some not. The results allow to establish a first aproximation of the productive capacity of the land and define criteria for sustainable management, especially against the effects of future environmental changes.

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Geomorphological and landscape impacts of the development of the port of Veracruz (Gulf of Mexico) between the 16th and 21st centuries

MENANTEAU L., GAILLARD S.
LETG-Nantes GEOLITTOMER UMR 6554 CNRS and University of Nantes, NANTES, FRANCE

Veracruz, the main port of Mexico since the arrival of Hernán Cortés in 1519, has played a key role in transatlantic trade between America and Spain. The configuration of the site remained almost identical until the major works between 1882 (in fact, since 1895) and 1902. The site was radically altered by being converted to a port basin. Thus, in 1887, communication with the sea to the NW, the traditional route for the galleons of New-Spain, was closed by a seawall, to which a wide container-wharf was attached in 2005; to the East, breakwaters were built around the only access to the outer harbour. The result is: the loss of the insular character of La Gallega, the coral reef opposite the city port on which the fort of San Juan de Ulloa is built; fossilisation, through infilling, of the former shore and the shallows (e.g. La Caleta reef) bordering the north of Veracruz, eventually leading to the building of a new quarter and the Malecón.

The authors evaluated the geomorphological and landscape impact of the changes by analysing and comparing several bathymetric charts of the port. The first, drawn in 1887, provides a precise view of the site before work began; others, dating from 1904 and 1911, correspond to conditions after work was completed in 1902. Each chart was geometrically corrected and georeferenced in UTM based on a 2007 (INEGI) vertical aerial photograph; next, bathymetric soundings (8715 for the 1887 document) were obtained (in x, y, z) in order to build digital elevation models (DEM). The data made it possible to produce maps of the nearshore seabed and evaluate the impacts, in terms of volume and surface area, of the developments between 1882 and 1902. The integration of data prior to 1880 (especially 18th century) as well as current allowed the authors to evaluate the impacts with greater precision.

Old hydrotechnical constructions - their impact on present landscape and morphological processes in depopulated areas; Central Sudetes Mts., SW Poland

LATOCHA A.
UNIVERSITY OF WROCLAW, INSTITUTE OF GEOGRAPHY AND REGIONAL DEVELOPMENT, GEOMORPHOLOGICAL UNIT, WROCLAW, POLAND

The Sudetes Mountains were substantially depopulated, starting from the end of the 19th century and especially after the World War 2nd. However, there are many traces of former human activities which can be still detected in the contemporary landscape. Old anthropogenic landforms and features are connected mainly with former settlements, agriculture, industry and water management. Especially the last ones are numerous in the study area. They include channel linings, bridges, culverts, drains, dams, leats and mill-ponds.

Detailed geomorphic mapping has shown that these constructions, despite not being maintained, influence contemporary morphological processes. Collapsed or uncleared constructions become artificial obstacles for water flow, leading to the development of new zones of erosion and deposition, wetlands, incisions of side-channels, channel braiding and anastomosis. However, in some places old structures have been 'fossilized' after the abandonment as a result of natural processes and their impact on the fluvial system has diminished or is no longer detectable. This is the case of some leats, which are now dry and partly filled with mineral and organic material, yet still recognizable as elements of valley floor relief.

Field analysis has revealed that past human impact is very long-lasting in the landscape. Old hydrotechnical constructions continue to influence the fluvial system, in spite of various states of their preservation and often neglect. An understanding of the role of old hydrotechnical constructions as important elements of both anthropogenic landscape and fluvial system can help in proper management of water resources in the mountain areas.

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Humans as geological and geomorphological agents in the Anthropocene

PRICE S., FORD J., COOPER A.
British Geological Survey, NOTTINGHAM, UNITED KINGDOM

Humans have become dominant forces in the transformation of the Earth's landscape and its corresponding geological and geomorphological response. The deliberate, current and historical anthropogenic modification of the landscape and its subsurface creates sediments and landforms in the form of artificial ground. Artificial ground is recognisable as distinct geomorphological landforms or where its sediments are buried in the ground.

The magnitude and rate of intentional human landscape transformation and creation of artificial ground has fluctuated through time. It is estimated that the deliberate global movement of rock and soil through mineral exploitation and processing exceeds that of sediment transport to the oceans by almost a factor of three (Douglas & Lawson, 2001). In Great Britain it has been estimated that over 66 500 M (Million) tonnes of material has been moved in about 150 year as a result of mineral exploitation alone.

Localised working for minerals and domestication of land for food production, rapidly expanded as human population grew. Subsequent industrialisation, burning of fossil fuels and rapid urbanisation in developed countries resulted in large scale land transformation as populations grew, lived longer and generated more wealth. The rate and magnitude of the creation of artificial ground has varied through time, but it is now significant on a global scale. The role of humans in shaping the landscape and creating distinctive and novel landforms and sediments is unique in Earth's history. This style of '*anthroturbation*' may be one of many changes to the Earth's biological, chemical and physical systems that characterise the proposed new epoch of the Anthropocene.

Douglas, I. & Lawson, N. 2001 The Human Dimensions of Geomorphological Work in Britain. *Journal of Industrial Ecology* **4**, 9-33

Maintaining the Integrity of the Environment in an Arctic Delta During Modernization

WALKER H.(1), MCGRAW M.(2)
(1) Louisiana State University, BATON ROUGE, UNITED STATES ; (2) Southeastern Louisiana University, HAMMOND, UNITED STATES

Many parts of the Arctic are being modified by ever-increasing rates of political, industrial and commercial activity. Early developers gave little thought about its effect on the environment.One area now being subjected to modernization is the Colville River Delta in Arctic Alaska. Although long a key location for Inuit fishing and hunting, remnants of their presence are a few turf-house foundations. Major changes began in 1971 when Nuiqsut was founded. About the same time, the integrity of the Arctic was becoming a major concern, a concern that led to numerous governmental and industrial regulations.

Changes to the Delta include the construction of numerous buildings insulated from the fragile tundra surface, the development of two major runways, the construction of a large oil field and its pipelines, and a road system.

Successful construction in a permafrost-dominated landscape demands techniques that preserve its frozen characteristic. One procedure is to use gravel to insulate permafrost from above. Gravel, however, is in short supply across much of the North Slope. An exception is the unfrozen material present as a talik (thaw bulb) in the deep parts of river channels. In 1981, a dredge was used to pipe it to an enclosed 1500 m long site placing it directly on the surface. There was minimal disturbance to the surrounding tundra; adjacent ice-wedge polygons and a beaded stream remained intact. The next major modification came with petroleum exploration, development and production. Seismic work was done when snow protected the tundra. Further, production facilities were constructed behind protective berms. A first in the Arctic was the development of a road-less on-land drill site.

The geomorphic impact on the Delta has been minimal primarily for two reasons: strict regulation of construction on the North Slope and the recency of its development allowed developers to take advantage of the technological improvements that have accompanied arctic engineering.

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Measuring the impacts of pastoral activities on wind erosion using a grazing gradient: case study in Western New South Wales, Australia

AUBAULT H.(1), MCTAINSH G.(1), STRONG C.(1), LEYS J.(2)
(1) Griffith University, BRISBANE, AUSTRALIA ; (2) Scientific Services Division, NSW Office of Environment and Heritage, GUNNEDAH, AUSTRALIA

Wind erosion is widespread across the World's drylands, including the arid and semi-arid rangelands of Australia. Livestock production, is thought to intensify wind erosion processes through increases in the land erodibility, i.e. the susceptibility of the land surface to wind erosion, by reducing the surface roughness (vegetation cover) and modifying the soil surface stability (break downs crust and aggregates). However, the extent to which pastoral activities accelerate rates of wind erosion remains largely unknown.

Here we present land erodiblity measurements, including vegetation and soil erodibility, along a grazing gradient from a watering point to quantify the effects of stocking intensity on wind erosion of sandy open grasslands in New South Wales.

The results show that stocking intensity is highest within 0.5km of the watering point with 150 dungs/m2 and reducing to 15 at 4km. Land erodibility increases with stocking intensity. Within 500 meters of the watering point, the soil is unconsolidated, no crusts and aggregates and an erodible fraction (d<84um) greater than 80%. Despite favourable climatic conditions, vegetation offers little ground protection (<50%). As stocking pressure decreases, soil stability increases with large areas of biological crust and aggregation demonstrable with smaller erodible fraction (<20%) but remains sensitive to disturbances. The current ground cover within this zone (up to 90%) prevents wind erosion, however this cover will be reduced under drying conditions and if grazing is maintained the land erodibility is expected to increase along the gradient at a faster rate than under natural conditions.

By using a grazing gradient from a watering point to quantify the effects of stocking intensity on wind erosion has provided first measurements of the impacts of pastoral management at a landscape scale. These finding can be extrapolated spatially through the use of remote sensing techniques and further applied at a regional scale.

Are erosion rates relevant for soil erosion studies?

GARCIA-RUIZ J.M.(1), LANA-RENAULT N.(2), NADAL-ROMERO E.(3), SANJUAN Y.(1), BEGUERIA S.(4)
(1) Pyrenean Institute of Ecology (CSIC), ZARAGOZA, SPAIN ; (2) Area of Physical Geography, University of La Rioja, LOGROñO, SPAIN ; (3) Department of Geography, University of Zaragoza, ZARAGOZA, SPAIN ; (4) Estación Experimental de Aula Dei, CSIC, ZARAGOZA, SPAIN

Recording erosion rates (Mg km2, yr-1) has been an obsession and a main purpose for many scientists worldwide, regardless of the conditions under which they are obtained. Nevertheless, after decades of quantitative studies and experiments, the results are not convincing because of their extraordinarily high variability. Published erosion rates for different land covers and land uses do not show a clear and reasonable trend. Such variability is related to: (i) the scale-dependent character of soil erosion, and, as a consequence, the difficulties for comparing erosion rates obtained from, for instance, experimental plots and catchments, or between catchments of remarkably different size; (ii) the use of various methods also determines the results, since each method is designed to measure a particular erosion process; (iii) connectivity is a crucial factor for explaining the accessibility of soil particles to the fluvial channel, in such a manner that a catchment with a dense shrub cover may deliver more sediment than another catchment with evident eroded areas, although disconnected from the stream. It is also arguable if the values obtained from a catchment can be considered as a global soil erosion value, given the presence of sediment sources directly located on the bedrock and not on the soil. The authors propose the conditions under which soil erosion rates may be useful and necessary.

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Human impact on erosion and burial of soil carbon through time

HOFFMANN T., STRAUCH A.
University of Bonn, BONN, GERMANY

The effects of soil erosion on atmospheric carbon is governed by three key mechanisms that are i) the replacement of soil organic carbon (SOC) at eroding sites, ii) the mineralization of SOC during erosion and transport and iii) the stability of buried SOC at depositional sites. Markedly different assumptions have been made about the relative importance of the key mechanisms, resulting in a global release of 1 Pg C yr^{-1} to a global uptake of 1 Pg C yr^{-1}.

Here we present results of a sediment-associated carbon budget in a small headwater catchment in Germany, to indicate the importance of the factor time in controlling the relative importance these mechanisms. Therefore, we estimate the loss of SOC through land use change from forests to arable land and compare it with SOC losses at degraded sites and burial of SOC in colluvial deposits.

Our results show that the transition of forest to arable land (without erosion and deposition of soils and sediments) resulted in a loss of SOC from 11.8 kg C m^{-2} to 7.2 kg C m^{-2} in our study site. Eroded sites are characterised by carbon stocks of 6.9 kg C m^{-2} compared to depositional sites with 27.9 kg C m^{-2}. Thus the combined effect of soil erosion and deposition results in a net withdrawal of atmospheric CO_2, which compensates land use driven losses. We show that the net effect of SOC degradation and burial depends on the rate of soil erosion and time since the erosion commenced.

Pedogenic Effects of Mid to Late Holocene Conversion of Forest to Pasture in the Western French Pyrenees

LEIGH D.S., GRAGSON T.L., COUGHLAN M.R.
The University of Georgia, ATHENS, GA, UNITED STATES

Agropastoral conversion of forest to pasture over thousands of years hypothetically redirects pedogenic processes and changes soil chemical and physical properties. We test this hypothesis using paired soil samples straddling the forest/pasture boundary on hillslopes in the western Pyrenees near Larrau, France (15 sample pairs at two separate sites).
Pastured A horizons are significantly thicker than forested counterparts, averaging 19 cm vs. 4 cm. Pastured soils lack eluvial (E) horizons, which forested soils contain, and exhibit strong granular pedogenic structure while forested soils have moderate subangular blocky structure. We suspect the pastured A horizons are upbuilding over time due to greater production of amorphous silica (phytoliths) in grasses by comparison to trees, and our paired t-tests on chemical extracts of amorphous silica indicate pastured soils do contain significantly more phytoliths than forested soils.
Efforts are underway to date the forest/pasture conversion by measuring the initial increase in amorphous silica in colluvial stratigraphic sections in zero-order hollows near paired sample sites to mark the establishment of pastures. Charcoal concentrations are also being measured in these sections as fire was commonly used to create and maintain pastures. Charcoal ages of 1.1-1.2 ka at 75 cm depth in Vallon Antchuloguia (1180 ^{14}C yr BP +/-20, UGAMS-11776) and 3.9-4.0 ka at 75-80 cm depth in Vallon Mulhedoy (3600 ^{14}C yr BP +/- 20, UGAMS-11775) suggest stratigraphic records sufficiently long to capture the paleoenvironmental history of forest/pasture conversion. In addition, a radiocarbon date from near the basal layer in a footslope peat bog (Oronitz Bog) of 4.7-4.8 ka (4200 ^{14}C yr BP+/-25, UGAMS-11774) shows further promise for paleonenvironmental reconstruction.
Our data contribute to a millennial history of human influence on landscapes of the Pyrenees Mountains and inform discussion on the Anthropocene.

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Comparing geologic and contemporary erosion rates: implications for land management in the Great Barrier Reef catchments, Australia

BARTLEY R.(1), CROKE J.(2), THOMPSON C.(2), FIFIELD K.(3), TIMS S.(3), WILKINSON S.(4), KINSEY-HENDERSON A.(5), HAWDON A.(5)
(1) CSIRO, BRISBANE, AUSTRALIA ; (2) Australian Rivers Institute, Griffith University, BRISBANE, AUSTRALIA ; (3) Department of Nuclear Physics, Research School of Physics and Engineering, Australian National University, CANBERRA, AUSTRALIA ; (4) CSIRO, CANBERRA, AUSTRALIA ; (5) CSIRO, TOWNSVILLE, AUSTRALIA

Excess sediments and associated nutrients from agricultural areas are having a detrimental impact on the Great Barrier Reef, Australia. There is a need to define the amount of erosion that is acceptable in these catchments for the purpose of sustaining healthy agricultural areas and aquatic ecosystems. This requires an understanding of the natural or pre-European erosion rates, and how much these rates have changed under agricultural land use. Such information would allow more appropriate estimates of catchment disturbance, and allow the setting of practical and achievable soil erosion and water quality targets that have taken pre-European erosion into consideration. Terrestrial Cosmogenic Nuclide (TCN) analysis involves the measurement of long-lived nuclides, particularly beryllium-10 (^{10}Be), that have accumulated in the upper few metres of the Earth's surface as the result of cosmic ray bombardment of rock and soil. Due to the long half-lives of these nuclides (1.4 Ma for ^{10}Be), concentrations can provide quantitative estimates of the timing and rate of erosion in streams and catchments over geological time scales (0.5–5 Ma). This makes them very useful for estimating erosion rates prior to agricultural development (or European settlement). This study will present the preliminary results of the application of TCN analysis to the Burdekin catchment, Australia. The long-term erosion rates will be compared with contemporary sediment yield data collected over the last decade from hillslopes and sub-catchments within the catchment.

Fluvial geomorphology and landscape evolution analyzed through the cartography of a large river. The case of the Argentinian Paraná

FORGET M.
Université de Savoie - Laboratoire EDYTEM - UMR5204, LE BOURGET DU LAC, FRANCE

The Paraná river, fifth river of the world when considering its flow and the size of its watershed is poorly known nowadays, despite the research programs on its course. That can probably be explained by the youth of its discovery and the difficulty of gathering information in a river watershed greater than 3 million kilometers square. The physical data available is often incomplete and generally covers a short period of time. It is then difficult to understand the changes in its morphology over a period of time that exceeds sixty years. We then wondered about the data which would permit to redraw the river dynamics and to show if the modification of the land cover over the past 200 years (the stigmas of the recent colonization are still visible) show in the river pattern?

By centering us on the Argentinian course of the river, we collected 43 old maps which scales vary from regional (1/100,000) to continental (1/18,500,000). Through their analysis, depicting a period covering the fifteenth to the early twentieth century, it is possible to trace the causes from the changes picked out in the river bed. The methodology used is a map-to-map comparison, realized in a Geographic Information System, following the theory of river systems (Schumm, 1977). Therefore, sandbanks, islands and river planforms are considered to be markers of the river dynamics, given their sizes and the degree of revegetation (Smith, 1981, Ramonell et al., 2008). The causes are themselves related to the spatial and climatic phenomena. Early maps show a braided planform in the upper reach of the Paraná and a Paraguay channel free of deposits. The current dynamics indicate an inversion in sedimentary transportation and deposit. The deforestation mechanisms in the Misiones territory and their abandonment (Levington, 2009) could lead to a shift in the sediment load. This hypothesis will be demonstrated through analysis of the maps, its validation by texts and the results of a field study.

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Palynological signals of mid-Holocene natural or human induced erosion episodes in the Alcabrichel estuary, central littoral Portugal

DANIELSEN R.(1), RAMOS-PEREIRA A.(2), MENDES P.(1), RAMOS C.(2), ALEIXO C.(2)
(1) Laboratory of archaeociences, DGPC, LISBOA, PORTUGAL; (2) Centre of Geographical Studies, Institute of Geography and Spatial Planning, University of Lisbon, LISBON, PORTUGAL

The mouth of the Alcabrichel River consists of two alluvial plains separated by a limestone gorge. This estuary was selected for the evaluation of the balance between fluvial and marine influences, responses to climatic fluctuations and impact of human activities in the drainage basin.

Samples from one borehole, situated on the inland side of the gorge, were analysed for pollen and non-pollen palynomorphs. Gradual diminution of marine influence, increased sedimentation rates and intensified anthropogenic signals were encountered through time. Pollen assemblages indicate large environmental changes and four stages of vegetation development were found.

Initially around 5900 yrs BP (conventional ages) the landscape was an open oak/pine forest with dense garrigue vegetation. The riparian zone consisted of stands of elder and ash. Marine influence was continuous and weak signals of anthropogenic influence were found. At the next stage, 4900 to 1900 yrs BP, forest cover was reduced, anthropogenic activity strongly increased and ocean influence was shifting in strength. Signs of erosion and accumulation are found both in the pollen assemblages and the sediment textures.

During the last two stages further degradation of local forest cover, garrigue and riparian vegetation took place. Increased values of pine pollen through the final stage were a consequence of regional reforestation measures implemented during the last centuries. Human impact was constant and sedimentation rate high probably as a result of increased erosion from cultivated fields in the alluvial plain and surrounding slopes. The sediment has a terrestrial source and disappearance of marine indicators is detected testifying a post-transgressive origin.

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Anthropogenic Geomorphology of a highly urbanised fluvial plain: Pinheiros River, Sao Paulo, Brazil.

LUZ R., RODRIGUES C.
University of Sao Paulo, SAO PAULO, BRAZIL

This research seeks to assess changes in both landforms and surface processes in a highly urbanised fluvial plain in tropical humid environment. The study area is the Pinheiros River Fluvial Plain in Sao Paulo, Brazil, that has been the site of human interventions related to the urbanisation processes of one of the biggest metropolitan areas of the Americas.

Cartographic techniques in a historical approach and selected geoindicators to measure environmental changes were utilised in an urbanised meandering fluvial system. Three geomorphological maps were produced on the scale of 1:25,000: the pre-disturbance map, the active disturbance map and the post-disturbance map.

Historical changes in the landforms and related hydrological functions that occurred over the last 80 years of urbanisation processes were analysed, measured and compared. The following geoindicators were selected: fluvial terraces and floodplain areas; flooding frequency and area; channel form and processes indicators (length, width, sinuosity, pattern, meandering belt area and flow characteristics); levees and backswamps form indicators.

The results revealed the high efficiency of human activities upon fluvial landforms and the high magnitude of changes in the hydrological processes which are comparable to medium and long-time natural events.In a decadal time-scale, the channel form and processes was completely changed, the pre-disturbance meandering channel was straightened, its length was reduced by 46.2%, its width was increased by 101.9%, and its flow was reversed. Beside this, the floodplain was eliminated and different terrace levels were created by anthropic agents.

Furthermore, those retrospective and historical studies which seek to understand the evolution of anthropogenic geomorphologic systems have produced results that can be utilised in environmental and territorial management due to their capacity to measure the negative impacts of the urbanisation processes in a changing fluvial system.

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On explaining urban river morphology

ASHMORE P.
University of Western Ontario, LONDON, CANADA

Geomorphologists' explanations of river morphology and characteristics have become increasingly focussed on sophisticated mechanical models of processes and development. Quantitative predictions of river response to urbanization are theoretically possible given sufficient information on of the pre-urban conditions and on hydrological changes and other relevant variables. However, these models may prove to be inadequate for because of both physical and engineering circumstances. But beyond this, a 'physical-only' explanation fails to reveal a complete understanding of why rivers may have the form that they have in these environments. Admittance of the significant influence of, for example, historical, political and cultural contingencies is necessary for a more complete understanding of fluvial dynamics. These ideas are illustrated from a case study of fluvial response to extensive urbanization in a watershed in Toronto, Canada and developed from other historical examples.

Possitive impacts of global geomorphic change: generation of renewable geologic materials?

CENDRERO A.(1), HURTADO M.H.(2), FORTE L.M.(2), DANGVAS N.V.(2), GIMÉNEZ J.E.(2), M. DA SILVA M.(2), BRUSCHI V.M.(1)
(1) Universidad de Cantabria, SANTANDER, SPAIN ; (2) Universidad Nacional de La Plata, BUENOS AIRES, ARGENTINA

Work carried out by different authors during the last decade has shown that there seems to be a "global geomorphic change" caused by the direct and indirect human modification of land surface. This change, apparently not related to climate, is manifested in increasing excavation and mobilisation of geologic materials (the "human geomorphic footprint"), higher erosion/sedimentation rates, or frequency of disasters related to geomorphic processes. Most such effects have negative consequences for people, but geomorphic change perhaps also opens some opportunities.
A case study is presented showing that the acceleration of geomorphic processes in the humid Pampa (Buenos Aires province, Argentina) is generating renewable geologic resources, the exploitation of which could help solving some of the environmental problems derived from geomorphic change. Truly sustainable mining could be based on the exploitation of recent lake sediments as a raw material for the brick industry, presently based on topsoil mining. This would reduce or eliminate land degradation caused by present practices and, if sedimentation rates are high enough, renewal of the resource according to existing needs might be possible. The extraction of the growing amounts of sediment carried into the numerous shallow lakes in the region (many of which are being silted-up) would help to maintain these valuable units as well as their flood-buffering capacity. Data are presented on the suitability of lake sediments for brick-making, estimates of existing reserves and renewal rates as well as the possibility to cover present and future needs.

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Stream geomorphology is dramatically altered by small amounts of urbanisation

VIETZ G., RUTHERFURD I., FLETCHER T., WALSH C.
The University of Melbourne, MELBOURNE, AUSTRALIA

Urbanisation of a catchment induces often extreme physical responses in receiving streams: with channel enlargement most commonly reported. Common management responses, focused on localised interventions, are both ecologically and economically unsustainable and are driven by a limited understanding of explicit relationships between urbanisation and stream geomorphology. This paper addresses three weaknesses in the literature relating urbanisation to geomorphic change: (1) urbanisation is usually characterised by total imperviousness (TI) when more important is the proportion of TI connected to the stream via drainage systems (termed effective imperviousness, EI); (2) effects of urbanisation are usually explored as a binary problem (comparing urbanised and not urbanised) rather than across a gradient of urbanisation; and (3) most studies do not consider ecologically relevant changes in geomorphology (such as bedload sediments, and bars and benches). In this empirical study we relate geomorphic attributes of streams to TI and EI across a gradient of urbanised catchments near Melbourne, Australia. We demonstrate that EIs as low as 2%commonly relate to significant channel incision, low bedload sediment depths, severe bank instability, a loss of bars and benches, and little to no large wood (with little further change for a ten-fold increase in EI). This is a much lower threshold of urbanisation than previously reported, and EI provides consistently stronger relationships than TI alone. Our findings demonstrate that geomorphic attributes are highly sensitive to excess urban stormwater runoff from impervious surfaces directly connected to the stream. We suggest actions addressing urban drainage (e.g. stormwater harvesting) will have more effect on geomorphic change than addressing catchment imperviousness alone. The sustainability of cities, for people and ecological values, is dependent on water management which realises the multiple benefits possible.

Human induced land surface alteration in and around Pune city, India

PARDESHI S.(1), PARDESHI S.(2)
(1) University of Pune, PUNE, INDIA; (2) Annasaheb Magar College, Hadapsar, PUNE, INDIA

The era of man and the machine is a phase of never before alteration of the earth's surface and processes. The parts of globe where such machines are developed initially experienced such changes first. Relatively the parts of the globe which are still going for mechanisation are in the phase of modifying the earth's surface. It's time to assess all such changes caused by human intervention in different types of landscape and their consequences on the environment. After the technological development, the rate of change of landscape has increased tremendously. To make more land available around urban centres, man is changing the nature of landscape on a large scale. Like many other urban centres, Pune city is fast growing in to a metro. Natural landscape around Pune city is greatly disturbed by human activities. Construction of roads, buildings and other infrastructures are the major causes of landscape disturbance. Present study is an attempt to identify the areas that are highly disturbed and tries to identify the areas of potentials of change in natural processes in general and geomorphic processes in particular. Based on the surveys carried out at various sites around Pune city, it was found that natural systems are partially altered or completely changed. Such alterations will cause change in natural processes and the response of the surface to these processes. If the same rate of alteration continues, the areas will be degraded with greater intensity and it will lead to decrease in aesthetic value of these areas.

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Water and wastewater pipelines - geomorphological challenges

GILCHRIST D.
Sydney Water - Engineering & Environmental Services, SYDNEY, AUSTRALIA

Sydney Water is Australia's largest water utility with over 1.3 billion litres of wastewater collected and treated per day. This is done via a network of 24,000km of pipes, 670 pumping stations, 13 water-recycling plants and 16 wastewater treatment plants.

The installation of water and wastewater delivery infrastructure often presents challenges that the planner and pipeline engineer do not consider in their initial alignment design. Initially the focus of their work is upon a design with respect to meeting future growth. This basically means the pipe size and layout must allow for increased demand due to changes in population density, land use changes, and other water management strategies like recycling and wastewater mining etc. over the 50-100 year design life of the asset.

It has proven beneficial at Sydney Water to set up Potentially Unstable Areas (PUA's) as regions on our Geographical Information System (GIS). A PUA is an area that has a rapid change in slope or where the slope angle is greater than 15 degrees. Any work in these regions, whether it is the amplification of an existing pipeline or a new pipeline altogether, triggers the need to have an earth scientist involved in review. This happens early in the design and so with the earth scientist's focus being on geomorphology and ground stability, a truly more sustainable design is achieved. The number of possible routes is often quickly reduced and a geotechnically preferred and least risk alignment becomes apparent.

This multi-criteria analysis (MCA) is relevant for the design of any large piece of infrastructure and the key is to set up a process that ensures a geomorphologist or engineering geologist is involved early in design.

This paper will reference recent projects including the installation of water pipelines through talus material, a gravity wastewater system on an infilled paleo-estuary, and the assessment of an 1800mm diameter water pipeline that runs along the base of an old garbage dump.

Impact of the quality and spatial resolution of Holocene land cover reconstructions on geomorphic model results

DE BRUE H., VERSTRAETEN G.
KU Leuven, LEUVEN, BELGIUM

During the last decade, several global land cover (LC) reconstructions covering the Holocene have been produced. These are being used more and more to analyze the long-term anthropogenic impact on various environmental processes including C-dynamics, climate change and soil erosion. However, their low spatial resolution (i.e. 5 arc-minutes at best) questions their use in geomorphic models. Furthermore, existing GLC reconstructions do not differentiate the typology of human impact, although the susceptibility of different LC typologies towards erosion varies greatly. Here we assessed the sensitivity of an erosion and sediment delivery model that operates at high resolution (100 m) to the quality and spatial resolution of LC maps. First, low-resolution LC (expressed as % non-natural vegetation) maps were downscaled to 100 m resolution without spatial LC allocation. Second, estimated non-natural vegetation was spatially allocated to a high-resolution grid (100 m) using a logistic model that relates contemporary LC to slope, soil characteristics, landforms and distance to rivers. For both LC maps, different scenarios for the ratio between arable land and grassland were simulated. Analyses were performed for several time periods throughout the Holocene, for the Scheldt Basin (19,000 km^2; Belgium and N France). Results indicate that low-resolution LC information, regardless of the considered arable/grassland ratio, leads to largely overestimated sediment fluxes when compared to field-based sediment budgets. Allocation of LC at higher spatial resolution yields better results. Variations in model outcomes are related to differences in landscape connectivity between allocated and non-allocated LC. Also, model results differ greatly for different arable/grassland ratios. This indicates that there is not only a need for LC reconstructions at high spatial resolution, but also that differentiation between arable land and grassland is essential for accurate geomorphic modeling.

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Dynamics of eolian processes in the geosystems of the Western Transbaikalia (South Siberia)

KOBYLKIN D.(1), RYZHOV Y.(1), ANDREEV S.(2)
(1) V.B. Sochava Institute of Geography SB RAS, IRKUTSK, RUSSIAN FEDERATION; (2) Baikal Institute of Nature Use, ULAN-UDE, RUSSIAN FEDERATION

The relevance of the study of aeolian exomorphogenesis is caused by the increased interest in the study of desertification and related environmental issues. This is particularly topical for the Western Transbaikal area, which is intensively used by human being since the Paleolithic. Large data arrays were used for the research the dynamics of aeolian processes in steppe and forest ecosystems of the Western Transbaikalia: topographic maps of different time, remote sensing, historical and archival materials, radioisotope dating, laboratory analysis of rock samples, dendrochronology, etc. The time interval embraces the period from 25,000 years ago to the present. Surveys have identified several steps of enhancing of aeolian processes associated with both man-made and the natural factors. The first stage of activation of aeolian processes occurred about 21,000 - 11,000 years ago, according to the availability of ancient aeolian overlying sediments of the last interglacial period. After the onset of the Holocene optimum we reconstructed six periods of formation of aeolian deposits: more than 6000, about 5000, 2900-2200 years ago, marked by organogenic deposits of buried soils. Dendrochronological and historical data can distinguish several stages of climate aridization. Between 1650 and nowadays seven stages of aridity are identified (1725 - 1750, 1765 - 1775, 1847 - 1870 1875 - 1905 1942 - 1963 1973 - 1988.). The last three episodes are recorded on topographic maps, aerial photographs and satellite imagery in the form of newly formed aeolian forms, which suggest their formation in previous stages. Animal husbandry has been actively developing in the area under study since about 3500, and farming since about 1700 years ago. Extensive development during periods of drought due to high wind speeds, light texture and structural soil features lead to degradation of large areas and anthropogenous deserts**.**

Study on vegetation-cover change and grazing intensity in the Alai Valley, the southern Kyrgyz Republic

LIU J.
Hokkaido University, SAPPORO, JAPAN

In the Kyrgyz Republic, grazing activities have brought about some significant impacts on the local environments. The main objectives of this study are to verify changes of vegetation-covered area from the 1960s to today, to examine grazing intensity nowadays, and to discuss causes of the changes of the vegetation-covered area and the grazing intensityin the Alai Valley, the southern Kyrgyz Republic. The study area was classified into basins A–I (based on mountain ridges, from west to east). Corona satellite imageries taken on 1st May 1965 for basins A–H, those taken on 20th June 1967 for basin I, and ALOS satellite imageries taken on 2th November 2009 for all basins were used to analyze the changes of the vegetation-covered area. Grazing model (Howard and Higgins, 1987) was applied to classify the measured slopes (N=180). It has been indicated that vegetation-covered area in basins A–I has decreased from 80.3% in the 1960s to 76.5% in 2009. It is suggested that an increase in the settlements is probably one of the reasons for the vegetation decrease. Moreover, on the slopes with degree <40º, vegetation-covered area has decreased in 2009, but it has increased on the slopes with degree ≥40º. Slope degrees in most bare area range from 10º to 30º both in the 1960s and in 2009. Grazing intensity model and the result of interview in the study area were harnessed to classify 180 measured slopes into 74 overgrazed slopes with terraces, 19 slopes that can accept more livestock, and 87 slopes without terraces. The results demonstrate that families who graze livestock only in summer would have overgrazed, compared with families who graze livestock there in early spring and late autumn. Furthermore, the percentage of the overgrazed slopes decreases with the increase of the distance to the main road. The slopes that can accept more livestock are always at least 500 m away from the main road.

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An exploration of the role of human activity in the generation and maintenance of hummocky meadows ('Buckelwiesen' landscapes) in the European Alps.

EMBLETON-HAMANN C.
University of Vienna, Department of Geography, WIEN, AUSTRIA

The study of hummocky meadow landscapes (“Buckelwiesen”) over the 20thcentury has emphasized the necessary condition of calcareous substratum and the triggering effect of tree-throw events as causal factors in their origin. If these were the only factors, forest regeneration would tend to eliminate this distinctive landscape. “Buckelwiesen” landscapes appear to occur only in the European Alps and emerged at a time in history when land use intensity was accelerating. Increasing population density and forest management have played important roles in their development. The huge medieval demand for charcoal (opening up gaps in the forest and using the tree throw debris) and the grazing of cattle in the newly formed gaps in the forest guaranteed the continuity of form. The thesis of this study is that human activity has been critical both in the generation and maintenance of these landscapes. After a discussion of the nature of, and the historical context of, their formation (through archival research and radiocarbon dating) the essential nature of human activity in the maintenance of these landscapes is emphasized.

GeoRISK: Geo-analysis of landscape level degradation and natural risks formation

SVOBODOVA E., JAKUBINSKY J., BACOVA R., HERBER V., KUBICEK P.
Department of Geography, Faculty of Science, Masaryk University, BRNO, CZECH REPUBLIC

Long-term increase trend of the human activities has negative impact on the function and landscape stability. Anthropogenic pressure influences directly or indirectly approximately 30 % of the Earth surface. Environmental problems, which are caused by inappropriate land use changes, have adverse effect on human society. This landscape degradation is demonstrated by local predisposition to occurrence of natural risks (flood events, slope instabilities).

The transdisciplinary approach was applied on the selected areas in the Czech Republic. Model areas (the Svitava River Catchment, the Leskava Brook Catchment, and the Borovský Brook Catchment) are specific by difference natural conditions and human activities. The research within the GeoRISK project solved identification of landscape level degradation, anthropogenic landforms inventory, ecosystem services evaluation, and uncertainty concept in spatio-temporal data.

The main aim of the project is presented by quantitative identification and verification of dependence between landscape degradation and propensity to natural risks formation using geographical analysis and cartographic visualization. One of the main project goals is to identify the most degraded areas, compare them with values of natural risk susceptibility. Observed characteristics are enriched with spatial and thematic uncertainty characteristics to obtaining reliability pattern. The paper's authors expect confirmation of high degree dependence between natural risks predisposition and anthropogenic landscape affect.

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Water and sediment loss from superficial runoff in areas of forest and pasture cover in southwest Amazonia Area-Acre, Brazil

SANTOS W.(1), AUGUSTIN C.(2)
(1) Universidade Federal do Acre, RIO BRANCO, BRAZIL ; (2) Universidade Federal de Minas Gerais, BELO HORIZONTE/MG, BRAZIL

The southwest of the Amazon area has undergone a rapid transformation of its natural environment as a result of the substitution of forest by pasture cover. In order toidentify differences in loss of water and sediments in areas of forest and in areas where the forest was transformed into pasture four parcels of 10 m² were installed, two of each type of cover in two slopes of the Judia creek basin in the state of Acre, Brazil. The data was collected from 10/2010 to 03/2011, during the rainy season. At each plot daily precipitation, vegetation, infiltration capacity, porosity and penetration resistance in soil was measured. In the pasture cover of both slopes the total precipitation reached 1172 and 1145 L/m^2 with a loss of 162.94 and 134.73 L/m^2 of water while sediment loss was 32.032 and 25.972 g/m^2, respectively. In the forested plots of both slopes, the total rainfall was 936 and 935 L/m^2, with water losses of 84.01 and 82.13 L/m^2 and sediment loss of 72.372 and 86.090 g/m^2, respectively. Test of variance (*T-Student*) identified significant differences in water loss in the pasture plot compared to that of the forest cover (p = 0,000) in the slopes 1 parcels. However, sediment loss (p = 0,168) presented higher values for the parcels covered by forest. In slope 2 there were no significant differences in the values of water loss for the parcels with both types of vegetation covers (p = 0.289). However, it was significant the difference in the values of sediment loss of the forested parcel in slope 2 (p = 0.0911) at 10% significance level in comparison with that with grass cover. The higher values of sediment loss in parcels covered by forest seems to be associated to a more intense stirring up of earth material by mesofauna coupled with the intensity of precipitation caused by rain water accumulation on the leaves. On the other hand higher levels of compaction may have favored greater water loss in pasture areas.

Monitoring of Erosion and Slope Deformation on Agricultural Land in the Czech Republic

SMOLIKOVA J., KAPICKA J., ZIZALA D., VANOVA V.
Research Institute for Soil and Water Conservation, PRAGUE, CZECH REPUBLIC

Soil is an important component of the environment and is the basic means of agriculture production. It is threatened by a number of natural and human processes that lead to reduction even destruction of soil functions. The most common type of land degradation in the Czech Republic is erosion, less common but an important type in terms of non-renewability of its functions is slope deformation. Degradation of soil is significantly accelerated during the last 30 years, because the conditions of farming in accordance with environmental protection are very mild, thus the need of collecting a data about events is highly desirable for improving the situation.

In 2011 a joint project a web portal of Monitoring of erosion was found by the Central Land Office and the Research Institute for Soil and Water Conservation to develop a spatial database, where all occurrences of erosion and slope deformation on agriculture land are recorded in depth as soon as possible. A total of 135 incidences were recorded during the first 2 years of function and the database is still expanding. The recorded data will be used to analyse causes using GIS tools and mathematical models of erosion. The results can be used to find out extremely susceptible areas that should be more protected.

The goal of the article is to introduce a methodology used to record erosion events and to present an analysis of selected events of erosion and slope deformation on agriculture land.

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Drivers of drift sand dynamics; a reconstruction for the Wekeromse Zand, the Netherlands

SONNEVELD M., HENDRIKS C., WALLINGA J.
Wageningen University, WAGENINGEN, NETHERLANDS

Inland active drift sand landscapes are regarded as unique ecosystems of great historical and geomorphological value. Recent studies have highlighted the role of multiple factors in the initiation and stabilization of drift sand landscapes. To unravel the importance of different forcings (e.g. agricultural practices, climate) and their interplay, insight in the chronology of drift sand dynamics is essential.In this study, we aimed to reconstruct the dynamics of the drift sand landscape of the Wekeromse Zand (central Netherlands) and to develop a conceptual model to understand the processes involved. The Wekeromse Zand study area is located on the border of a central push moraine and is characterised by open active drift sands and vegetated hills and valleys. The surroundings are dominated by modern agricultural practices, and remnants from ancient iron age Celtic Field systems. For the study area we: i) analysed historical maps going back to the early 19th century, ii) performed a field survey to map the palaeolandscape (before drift sand activation) and iii) employed optically stimulated luminescence (OSL) dating of drift sand deposits on 11 samples from two locations to determine the timing of drift sand deposition. Analysis of the available topographic maps showed no substantial aeolean activity of the area outside its morphological boundaries. OSL dating revealed that two drift sand layers were deposited between 1373 and 1462 AD and between 1680 and 1780 AD. The Wekeromse Zand has known three relatively stable periods: i) a period between the start of the Holocene to the Late Medieval Period, ii) in between the Medieval climatic optimum and the climatic Maunder minimum, and iii) current situation. The two active phases appear to correspond with active phases in the coastal dune systems and are probably the combined result of anthropogenic land use and climatic changes.

Humain impact on the mountains landscape in Macedonia and Serbia

MILEVSKI I.(1), LUKOVIC J.(2)
(1) Institute of Geography, University "Ss. Cyril and Methodius, SKOPJE, MACEDONIA ; (2) Geografski Fakultet, Studentski trg, BEOGRAD, SERBIA

Mountains are the predominant morphostructures in the checkerboard topography in the Republic of Macedonia as well as in central and southern part of the Republic of Serbia. In Macedonia there are more than 30 mountain ranges from which 13 extending above 2000 m, while the highest - Korab, reach 2753 m. The highest mountain ranges are found in the western and central part of the country, generally composed of marbles, limestones, granites and other hard rocks. Mountains in eastern part of the country are dominantly composed of more erodible crystalline rocks. In Serbia, there are about 20 mountain ranges from which the highest is Stara Planina with Midzor peak (2169 m). Here, mountains in the east part of the country are composed mostly by limestones, while in western part by crystalline rocks. These groups of mountains in Macedonia and Serbia were shaped generally during the Neogene–Pleistocene. However, as a result of demographic, socio-economic and technological changes, the level of anthropogenic modification of the mountain landscape in both countries is significant. Together with the influences of changing climate, human impact will be decisive in future mountain landform evolution. The most typical direct and indirect human interventions in the mountain landscape in Macedonia and Serbia are accelerated erosion, opencast mining, road building, canal, dams and reservoir constructions on rivers. On lower altitudes with south aspects, forests are usually degraded, destroyed or replaced by cultural vegetation. The same case is with highest parts, were winter-sport centers are built recently. Because all of that, accelerated soil erosion occurs, devastating the mountain landscape. Thus, one of the most significant tasks in mountain protection and conservation is appropriate monitoring of human impact on the landscape. Aside of numerous traditional approaches, modern GIS and satellite imagery analyses became fundamental tools for this purposes.

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Poster presentations:

Slash-and-burn agriculture: establishing scenarios of runoff and soil loss for a five-year cycle

THOMAZ E.
Universidade Estadual do Centro Oeste do Parana - UNICENTRO, GUARAPUVA, BRAZIL

Shifting cultivation is an age-old agricultural system that coexists with modern agricultural systems, particularly in the tropics. The history of land occupation in the study area is strongly related to the exploitation of natural resources. Today, agriculture is an important economic activity in the Guarapuava region, and is characterized by two main types of systems. The first is modern commercial agriculture that uses advanced technologies. The second is subsistence agriculture, which produces primarily corn and beans, and occupies less productive soils located on steep slopes that border escarpments and well-dissected valleys The characteristics and effects of shifting cultivation are well documented in the literature, including: soil degradation and erosion, nutrient depletion, impacts on biodiversity, and economic trends. Although studies report soil loss during the cropping period under shifting cultivation, few studies have assessed soil erosion during a full slash-and-burn cycle. The objectives of this study were to 1) characterize runoff and soil loss patterns over a full 5-year cycle; and 2) discuss the soil loss tolerance limit for a 5-year regeneration cycle. The study area have a wet, subtropical climate with precipitation of 1,915 mm, and temperature of 17^{o}C.The measured slope formed by contiguous land in the study area is 32^{o}. The soil consists of Regosols formed from basalt rock, and an approximate texture size distribution of 36% sand, 20% silt, and 44% clay. The measurement of runoff and soil loss was based on a small erosion plot approach. Three agricultural plots in different stages of regeneration were monitored. The data were analyzed by month and year for the 5-year regeneration cycle. Runoff and soil loss decreased exponentially from the burned phase (6.12 t/ha) to the early stage of secondary forest (0.16 t/ha). Runoff and soil loss exhibited patterns similar to those of a forested area after only 5 years of regeneration (0.093 t/ha).

Late Holocene dune mobilizations in the northwestern Negev dunefield, Israel: A response to combined anthropogenic activity and short-term intensified windiness

ROSKIN J., KATRA I., BLUMBERG D.G.
BEN-GURION UNIVERSITY OF THE NEGEV, BEER-SHEVA, ISRAEL

This study proposes a paradigm of anthropogenic activity and windiness fluctuations to explain aeolian sedimentation and dune mobilization in the northwestern (NW) Negev Desert dunefield. The proposed paradigm contributes a different approach to estimating the effect of climatechanges on the unprecedented agricultural and urban settlement expansion during the late Roman to Early Islamic period and on the decline in the northern and central Negev Desert. Based chiefly on luminescence ages coupled with analysis of archaeological finds and historical texts, we suggest that intermittent dune mobilization during the late Holocene, at ~1.8 ka and mostly 1.4–1.1 ka, are linked to periods of human occupation. The idea that the late Pleistocene dune encroachments alone that formed the NW Negev dunefield between the Last Glacial and the onset of the Holocene is connected to northern hemisphere cold-event windy climates that may have intensified East Mediterranean cyclonic winter storms, cannot explain the late Holocene dune mobilizations.We conceptually model a connection between late Holocene dune mobilization, widespread anthropogenic occupation and activity, and windiness. We maintain that historic grazing and uprooting shrubs for fuel in the past by nomads and sedentary populations led to decimation of dune stabilizers – biogenic soil crusts and vegetation, causing dune erodibility and low-grade activity. Short-term events of amplified wind power in conjunction with periods of augmented anthropogenic activity that triggered major events of dune mobilization (elongation) and accretion have been preserved in the dune chronostratigraphy. This study demonstrates the sensitivity of dunes in arid and semi-arid regions to a combination of local and short-term fluctuations in windiness at times of widespread grazing (anthropogenic activity.) The results remind us that in similar future scenarios, sand mobilization may be similarly retriggered to varying degrees.

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Factors promoting heavy metals leaching in Cantabrian seaboard estuaries. Bay of Biscay.

FERNANDEZ S.(1), GONZALEZ M.(2), ALVAREZ M.(2), RODRIGUEZ C.(2)
(1) University of Oviedo, MIERES, SPAIN ; (2) INDUROT, MIERES, SPAIN

Estuarine sediments are important sinks of heavy metals since they can be immobilized in the sediments by means of adsorption, complexation and speciation processes. However, estuarine areas also could be potential sources of heavy metals to the coastal systems promoting by changes in pH, Eh, EC or organic matter of the estuarine sediments. These variations can be caused by anthropogenic processes such as desiccation of estuaries due to land reclamation, a common practice along the Spanish Atlantic seaboard since centuries ago. The potential of the estuarine sediments to act as source or sink of heavy metals in relation to the management of the area was studied in two river basin of the Cantabrian Range with local baseline in the south coast of Bay of Biscay. NalónRiverdrains 7043 Km^2 of siliciclastic rocks. The estuarine sediments cover 53 Km^2, 15 of them are reclaimed lands. The daily discharge is 56 m^3 s^{-1}. Sella River drains 1272 Km^2 of calcaric rocks. The estuarine sediments cover 27 Km^2 and has 20 of reclaimed lands. The daily discharge is 43 m^3 s^{-1}. 123 samples in fluvial plains and 27 in estuarine areas were sampled. Concentrations of Mn, Zn, Cr, Pb, Ba, V, Co, Ni, Cu, Ti, Sn, As, Mo, Ag, Cd, Sb and Hg were determined by means of ICP-MS. pH, organic matter (%), clay, silt and sand (%) and electrical conductivity (mS m-1) were analyzed.The highest concentrations of heavy metals as Ag, Cu, Sn or Cr are found in the natural estuarine soils and lowest concentrations are found in reclaimed areas. The reclamation of estuarine soils seems to promote the leaching of heavy metals, probably due to the increase of their mobility by the significant drop of pH. Therefore, the recovery of currently reclaimed estuarine areas, with the resulting enhancement of their role as sinks of heavy metals, could be one of the possible mechanisms for decreasing the loading of heavy metals from rivers to the transitional body waters.

Morphodynamics studies of the relief in the watershed of the stream Feijó/ Metropolitan Region of Porto Alegre / Brazil

REHBEIN M.(1), ROSS J.(2)
(1) Universidade Federal de Pelotas, PELOTAS, BRAZIL ; (2) Universidade de São Paulo, SÃO PAULO, BRAZIL

The watershed of the stream Feijó, located in the Metropolitan Region of Porto Alegre / Brazil, includes areas of several urban environmental impacts, many of them related to geomorphological processes. In order to contribute to understanding these processes, this study aims the identification and analysis of the relief morphodynamics in the watershed Feijó. Ab'Saber (1969), Ross (1992) and Fujimoto (2001) are presented as main theoretical and methodological references. Operating activities include literature surveys, preparation of maps, field work and analyzes.Were mapped in the watershed of the stream Feijó four standards similar forms of relief, plains, high hills, hillocks and small hills. The modifications on these relief standards forms, caused by the urbanization in the watershed, changed hydrogeomorphological dynamics, conditioning other rhythms to the erosion and deposition processes, intensifying them drastically. In the high hills, hillocks and small hills was observed an increased overland flow and a consequent reduction of infiltration.In the plains was observed collapses in the functionality of fluvial channels, with undermines of riverbanks, siltings and floodings. Trying to mitigate the floodings, rectifications are carried in waterways. This practice is necessary, but does not solve the problem of flooding and ends up intensifying erosion and depositional processes. Anyway, a significant amount of material remains transported from adjacent slopes. In order to qualify the current environmental scenario, morphodynamics studies of the relief may serve as basis for taking action in areas of the watershed Feijó.

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Successive human impacts in a tropical Andean valley: the case of Medellin, Colombia

HERMELIN M.
Universidad EAFIT, MEDELLIN, COLOMBIA

The Aburra valley is a deep, elongated depression which stretches in two 30 km long segments in the northern part of the Central Cordillera; its floors is at 1500 masn and it is surrounded by plateaus and summits reaching 3000 masn. Its origin is probably tectonic with an age of about 2 Ma and it is formed by a variety crystalline rocks; the slopes are covered of mass movement deposits and the floors by loosesediments with thicknesses which vary abruptly. Its climate is warm and humid, with average temperatures of 20°C and annual rainfall of 1500 mm in the center of the valley. It was originally covered by thick Andean forest.

When Spaniards first reached the area during 16th century, they found a relatively scarce Indian population, but also remnants of broad paved trails and of “earth buildings”. The valley was progressively occupied by dispersed Spanish settlements dedicated to agriculture and cattle rising and became the main source of food for the surrounding gold mining districts. These activities produced the increase of commerce and wealth of Medellin and a population growth which signified its recognition as capital of the province at the beginning of 19th century. Despite of poor communications, the city continued to grow and starting in the first decades of 20th century, several major projects began to modifly the topography of the valley: road cuts, railroads, streets, bridges, river deviation (for mining and later for building terrains), clay and rock extraction, tunnels and landfills. The result is not only a change in topography but also in geomorphic processes: landslides and flash floods tend to increase, as well as risks due to natural factors.

The difficulty to enforce rules restricting terrain occupation contributes to deteriorate the situation, despite of very praised efforts from the local government to improve living standards through better communications, educations and urban projects.

Effect of past land degradation on the present shallow landsides in Yamaguchi Prefecture, western Japan

DAIMARU H.(1), MURKAMI W.(1), KUROKAWA U.(2)
(1) Forest and Forest Products Research Institute, TSUKUBA, JAPAN ; (2) Kansai Research Center, Forest and Forest Products Research Institute, KYOTO, JAPAN

The heavy rainfall on 21 July 2009 triggered serious surface erosion on the mountains in Yamaguchi and Houfu districts. Many gullies initiated in the narrow valleys filled by granitic sand. The C14 age of the charcoal under the granitic colluvium was Cal AD 1440 – 1470 and indicates that the valley fill deposition occurred after the 15 centuries. In the middle to western Japan, there were many treeless hills called in the granitc mountain because these mountains locate in suburb area and seriously affected by such as deforestation, gathering fertilizer from forest. The old aerial photographs taken in 1947 showed much human-induced bare hill (hageyama) on the south facing mountain ridges and many small landslides occurred in the marginal area of the treeless area. Thus, the past land degradation significantly affected on the distribution of the 2009 landslides through the formation of the valley fill.

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Urban constructions in deep zones. A diachronic analysis of Mexico City

RAMIREZ NUNEZ C., PARROT J.F.
UNAM, MEXICO D.F., MEXICO

Mexico City is a good example of a chaotic development of megalopolis. The earliest urban zones were firstly located in the inner flat area of an endorheic basin belonging to a mayor system known as the Trans-Mexican Volcanic Belt. Afterwards the expansion of the city invaded the hill slopes surrounding the basin and little by little, in conjunction with a high population pressure, the tendency to build on deeper slopes increased strongly. Nowadays must of the surrounding zones are occupied. The local government is trying to limit this tendency by multiplying the regulations and decrees which define the conditions of construction and prohibitions, but the means of control remain deficient. Based on a diachronic study and Digital Elevation Model treatments, the present work shows the percentage of evolution of the land use according to the slope. In a first step, the distribution of slope ranges takes into account the whole surface actually reached by the urban development in order to follow the evolution of the space occupation over the last years. It is peculiarly clear that the number of illegal constructions increases strongly every year whatever the difficulties of building and accessibility are, leading to a sharp increase of the risk zones. It is generally considered that the maximum angle of building zones, whatever the nature of the substratum, must be lower than 16%. In fact, from 1953 to 2010 the annual surface building rate of augmentation in deeper slopes (>15%) was around 2.5 km^2. The goal of such an approach is to provide the critical data that allow us proposing an extrapolation of the urban expansion coming.

Dynamics of land use and your interference in morphohydrographic system in aera of limestone mining: a case study in the inland of Sao Paulo, Brazil.

PASCHOAL L.G.(1), CUNHA C.M.L.(2)
(1) Universidade Estadual Paulista, RIO CLARO, BRAZIL ; (2) Universidade Estadual Paulista, RIO CLARO - SÃO PAULO, BRAZIL

Activities of open pit mining are responsible for major changes in the landscape and promote the emergence of morphologies of anthropogenic character. In the Brazilian context, approximately 73% of the mines are located in the Southeast and South. Of this total, 90% are related to the extraction of the main non-metallic minerals used by industry and construction segment: limestone, clay, gravel and sand. With the objective of identifying and analysing changes to land use imposed on dynamic morphohydrographic, through human actions linked to mining activity, was selected as the study area watersheds Córrego Marroti and Córrego Gonçalves.Together these basins totaling 9.6 km^2 within the state of São Paulo - Brazil, and present a broad interfluve mischaracterized by the activity of exploitation of limestone.Mappings were performed of the land use and geomorphological features of the scenarios of 1962 and 2010, in scale 1:10.000. The mappings have identified an increase in the area of plots intended for mining activity, from 5,83% increased to occupy 25,83% of watersheds in the respective period.On this land use, it was possible to identify and quantify morphologies of anthropogenic origin in the landscape, such as the existence of levels generated in open pit mine, from 4,16 km in 1962, passed to total 34,66 km in 2010.The exploitation of limestone below the groundwater level gave rise to artificial dams, quantified by 0,04 km^2 in 2010.The mappings allowed to identify that mining activities occurred near the headwaters and the river beds, causing changes in its course and the type of valley bottom.Thus, this type of analysis provides parameters for a diagnosis of the area, to be used during the development of programs related to environmental planning and management of natural resources in the area.

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Integrated geomorphological study of the center of Moscow

LIKHACHEVA E.(1), ANIKINA N.(2), VOLOBOY A.(3), CHESNOKOVA I.(4)
(1) Institute of Geography Russian Academy of Sciences, MOSCOW, RUSSIAN FEDERATION ; (2) Moscow State University, MOSCOW, RUSSIAN FEDERATION ; (3) Moscow Stste University, MOSCOW, RUSSIAN FEDERATION ; (4) Institute of Water Problems Russian Academy of Sciences, MOSCOW, RUSSIAN FEDERATION

On the territory of the megacity, which is used extensively not only the ground, but the underground space, and the depth of the impact on the geological environment is measured by many tens of meters, research of paleorelief is very importance. Paleorelief study is an obligatory stage of complex geomorphological assessment of the urban area.

On the territory of Moscow there are 2 major systems paleovalleys formed in Latecarbonic-Jurassic and Paleogene-Quaternary continental stages of the area. For the first time their presence was established in the 30th years of XX century. In the present relief in general, there is the influence of paleorelief: unchanged ratio of river valleys and interfluves, the direction of flow. With paleovalleys mainly preglacial, related to many negative phenomena happening in the city, such as holes, subsidence, karst-suffusion processes. In addition, they are associated with areas of erosion of Jurassic impermeable clay and high water saturation zones in areas combining several aquifers.

Separately, it should be said about technoconcealed valleys, i.e. modern river valleys, channels which in the last few centuries, enclosed in a collector or covered with man-made deposits. They are pretty common occurrence in the central part of the city of Moscow, where so much of the converted river network (Neglinnaya, Presnya etc.). Mottled composition, unsorted and unconsolidated technogenic soil filling the valley determines a significant imbalance of relief. Therefore, there is a maximum intensity of modern geological processes. They confined the failed-sagging phenomenon, quicksand, high conductivity seismic area deformation of buildings and communications, etc.

Integrated geomorphological studies in the city included the assessment of the sustainability of the natural and modified in the course of urban development. Particular attention was paid to the attendant exodynamic processes, including man-made geophysical and hydrogeological field.

Land use change in a Mediterranean catchment: implications for soil erosion

ROY H.(1), FOX D.M.(2), EMSELLEM K.(2)
(1) UMR 7300 ESPACE CNRS, Universit_ de Nice Sophia Antipolis, NICE, FRANCE ; (2) UMR 7300 ESPACE CNRS, Universit de Nice Sophia Antipolis, NICE, FRANCE

The Mediterranean landscape has changed greatly since 1950. Changes in vineyard area have major repercussions on soil erosion. Erosion impoverishes the soil and contributes to sedimentation in channels. The study objective was to analyze land use changes from 1950 to 2008 and evaluate their implications for soil erosion.

The catchment of 235 km^2 is situated in SE France. Air photos (1950, 1982, and 2008) were digitized to produce land cover maps with 4 categories: forest, vineyards, grassed land, and built areas. Initial resolution was changed from 0.5 m to 1 m to facilitate digitization. These data were complemented by a 25 m DEM and field observations.

Vineyard depletion was important for the catchment. About 2487 ha were vineyards in 1950; this decreased to 2128 ha (-359 ha) in 1982. Vineyards decreased further to 1641 ha (-487 ha) in 2008. Total loss was 846 ha in 1950-2008. Swapping was most important with grassed areas: vineyards lost 388 ha to grass and gained 169 ha during 1950-1982. Values reach 430 ha and 133 ha, respectively, during 1982-2008. Vineyards also lost 141 ha and 175 ha to built area during 1950-1982 and 1982-2008, respectively. Built area was 47 ha in 1950 and increased to 291 ha in 1982; it reached 709 ha in 2008, more than twice the area in 1982. Exchanges between vineyards and forest were roughly equal at about 650 ha in 1950-2008.

Slope and surface area of vineyards are major factors influencing soil erosion in the study area. Urbanization in the plain shifted some vineyards to foothills: increases in 1950-2008 in mean (6% to 8%) and median (4% to 6%) field slopes were observed. Values were calculated from the DEM, but observations showed that conversion of forest to vineyards on foothills was accompanied by terracing, so actual slopes are lower than calculated values. Surface area of vineyards decreased by 34% in 1950-2008, suggesting erosion probably decreased substantially.

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Human impact on runoff forming and gully development in the Bug River valley side (E Poland)

GODLEWSKA A., RODZIK J., TERPILOWSKI S.
Maria Curie-Sklodowska University in Lublin, Department of Geoecology and Palaeogeography, LUBLIN, POLAND

In this paper the authors present the development of a modern gully, which cuts a sandy side of the Bug River valley in eastern Poland. The gully developed along the ground road separating plough fields from the “Szwajcaria Podlaska” nature reserve. The change of transversal pattern of fields into downslope one, which was made in 1972 in order to easier reaching the fields, contributed to the gully development. However, the formation of a new runoff system with flow concentration along the ground road lasted 30 years. In 2002 several factors occurred, which triggered a rapid development of the gully: heavy rainfall resulting in a sudden runoff from the largest field under potato cultivation on the ground road. The gully formed in this way was 75 m long and to 10 m deep.

Then the gully has developed by the formation of branches along balks and furrows separating individual fields. Its development has been monitored since the beginning -geomorphological survey and geodetic measurements of the whole form were made after each great change. The greatest changes occurred in the years 2004-2009 when the gully volume increased by about 30%.

Despite the gully development, the mode of land use has not been changed. The downslope fields are brought under cereals and potatoes. The road, over and over again destroyed by the gully, has been often moved at the expense of plough fields. Erosion can be considerably limited by a return to the former, transversal pattern of fields but it would demand an agreement between several land owners.

Changes in trends of development of microtopography: effects of oil exploration and production in NorPatagonia, Argentina

CIANCIO M.E.(1), TCHILINGUIRIAN P.(2), ZULETA G.A.(3)
(1) Dept. of Ecology & Environmental Sc., CEBBAD, Maimónides University, CIUDAD AUTÓNOMA DE BUENOS AIRES, ARGENTINA ; (2) Dept. of Ecology & Environmental Sc., CEBBAD, Maimónides University - CONICET & Dept. of Geology, FCEN, Buenos Aires University, CIUDAD AUTÓNOMA DE BUENOS AIRES, ARGENTINA ; (3) Dept. of Ecology & Environmental Sc., CEBBAD, Maimónides University - Faculty of Engineering, National University of Lomas de Zamora, BUENOS AIRES, ARGENTINA

Oil exploration and production (E&P) create disturbances that may affect the geomorphological dynamic of the landscape. In particular, the construction of oil wells and seismic lines has an profound impact on soils and microtopography patterns. Regional geomorphological dynamics in NorPatagonia are controlled by ephemeral rivers associated to alluvial fans and playa lake deposits (“barreales”). Wind is involved in the transportation and deposition of sand and nutrients, which accumulate around vegetation and generate mounds or nebkhas. In order to evaluate the changes in trends of development of microtopography we compared the characteristics of mounds located inside 73 well locations with those in nearby natural areas (control sites). We performed an stratified random sampling, according to the geomorphological units at the local scale in the study area. We measured height (H), lenght (l) and width (w) of mounds, and calculated the horizontal component (L). We observed that H increases with the increase in L across all landforms (positive trend or growing phase) until a maximum H (equilibrium phase). From this value on, we detected a negative trend (degrading phase) as H decreases with an increase in L. Finally, there was an increase in the dispersion of data in both equilibrium and degrading phases, which could be explained by changes in geomorphologic dynamics within the oil wells. These results contribute to explain ecosystem regeneration and threshold variability during the post-disturbance process.

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Transformation of Earth's surface by humans

MARTÍN DUQUE J.F.(1), HOOKE R.L.(2), PEDRAZA J.(3)
(1) Department of Geodynamics and Geosciences Institute (CSIC, UCM), MADRID, SPAIN ; (2) School of Earth and Climate Sciences and Climate Change Institute, ORONO, MAINE, UNITED STATES ; (3) Department of Geodynamics, Complutense University, MADRID, SPAIN

Earth is moved and the landscape modified, commonly degraded, by many human activities. Mining, infrastructure expansion and urban development are obvious ones. Plowing moves huge amounts of earth and leads to accelerated erosion. Grazing and logging also increase erosion. Much of the eroded sediment ends up as colluvium on hillslopes and as alluvium in floodplains, thus subtly altering the shape of the land. The rest is carried away by streams and rivers.

As of ~2007, human activities had altered the shape of ~53% of Earth’s surface (Hooke et al., 2012). Most of these activities also had indirecteffects well beyond the area directly affected, so the full impact of land transformation was much larger than 53%. Both the direct and the indirect impacts compromise ecosystem services that are essential for human survival, some of which are irreplaceable.Thus, these changes may be the most significant component of Global Change for decades to come.

Continued degradation of agricultural land and expansion of urban land at the expense of prime agricultural land, together with our continuing disruption of crucial ecosystem services, are likely to limit Earth’s ability to provide an acceptable standard of living for even current populations. Indeed, we already appear to be in a state of overshoot. Overshoot is a situation in which a population exceeds the carrying capacity of the environment and, after a delay during which a storehouse of resources is consumed faster than they are replaced, the population crashes.This long-term sustainability issue is more serious than, but exacerbated by, climate change.

To restore sustainability we can: 1) reduce demand; 2) develop technological solutions; and 3) adopt measures that would first slow population growth and then reverse it. The first two are unlikely to solve the problem alone.

Reference: Hooke, R.LeB., Martín-Duque, J.F., and Pedraza, J. 2012. Land transformation by humans. *GSA Today*, 22(12): 4-10.

Suburbanization of the village Cernosice depending on the geomorphology of the terrain and transport services

NEUBERGOVA K., HYKS O.
CTU in Prague Faculty of Transportation Sciences, PRAGUE, CZECH REPUBLIC

Geomorphologyis one of the determining factors in the design of transport routes, important also for the further development of the area. This contribution aims at outlining the impact of geomorphology on suburbanization and transport service. The issue is first described theoretically and then demonstrated on a model locality, the village Cernosice located nearby of Prague. This village lies in the valley along the river and on the adjoining slopes. Its formation was closely related to the historic journey from Prague to the castle Karlstejn, the seat of Czech kings. At the beginning of this part of the paper, the historical context of the geomorphology, transport and community developmentis mentioned.

Till the second half of the 19th century, the character of the settlement was solely agricultural. Then the developing Czech upper middle class started to build summer houses along the stream, near the ford crossing the river. After the World War I, a building boom erupted with greater intensity, the character of the original agricultural community was completely changed and Cernosice became one of the most famous villa and cottage satellites of the former Czechoslovak Republic. The houses were built not only along the railway line, following the river, but a completely new residential area comprising one hundred new buildings grew up in a greater distance, thus depending on the road transport.

The second part of the contribution concerns the recent situation in this village, especially the new wave of the residential suburbanization, which began in the 1990's.The construction of family houses and apartments runs so far, bringing problems of various kinds to the municipality.

The contribution brings the detailed description of eachdevelopment period, accompanied by clear maps and pictures. In the conclusion, generalized facts are detected and possible solutions of the current situation, typical also for many other localities around greater cities, are discussed.

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The "Tanger Med" harbor complex: impacts of its construction on its landslide prone hinterland (Rif Mountains, Morocco)

PATEAU M.(1), FORT M.(1), BEN MOUSSA A.(2)
(1) Université Paris Diderot, Sorbonne Paris Cité, PRODIG UMR 8586, 75013 PARIS, FRANCE ; (2) Université Abdelmalek Essaâdi, Faculté des Sciences, Département de Géologie, BP 2121 93000 TETOUAN, MOROCCO

Located about 25 kilometers east from the city of Tangier, the "Tanger Med" complex is one of the largest Mediterranean harbors at the crossroads of Europe and Africa (the Strait of Gibraltar): it has three harbors, logistic and industrial free zones as well as motorway and railway networks linked to the capital town Rabat.

Its hinterland is a landslide prone area. It encompasses a zone where flyschs bedrock predominates. The climate is particularly aggressive (drought period alternating with severe stormy rains) and favoursboth landsliding and gullying.

This work is based on a study of changes in land use over the past decade by using diachronic sets of satellite images and aerial photographs, fieldwork inventory and interviews. We show that the "Tanger Med" construction has highly modified landscapes, the way of life of country people and the intensity of geomorphologic dynamics. Numerous examples are pointed out: (i) roads built on unstable embankments; (ii) slopes excavation modifying water flows hence creating water retention with potential saturation (exceeding plasticity limits); (iii) uncontrolled drain favoring gullies. (iv) Repeated passages of large trucks, carrying materials from the quarries to the harbor, induce vibrations that can trigger landslides and earth flows during winter when soils are saturated. (v) Relocation of expropriated populations in naturally unstable areas makes them even more in danger than in their former settlements…Collectively, these developments result in an increase of landslide hazards and population vulnerability in areas with high economic potential.

Environmental and Social changes in the southern Balkans from the Neolithic: questions and methods of investigation

LESPEZ L.(1), GLAIS A.(1), LOPEZ-SAEZ A.(2), LE DREZEN Y.(3), TSIRTSONI Z.(4), DARCQUE P.(4)
(1) Geophen-LETG Caen-UMR 6554 CNRS, UCBN, CAEN, FRANCE ; (2) CSIC, MADRID, SPAIN ; (3) UMR PRODIG 8586 CNRS Université de Paris 1, PARIS, FRANCE ; (4) ARSCAN - UMR 7041 CNRS, NANTERRE, FRANCE

Research on the Holocene environment in Greece compares indicators of geomorphological and palaeoecological changes. It gives evidence of both climatic, particularly Rapid Climatic Change events, and anthropogenic changes. Nevertheless, the cultural changes caused by environmental changes are more often inferred from the co-occurrence of the different changes than proved by the observation of the environmental change and their real consequences for the society at the local scale. To assess the possibility of socio-economical crises triggered by environmental changes, we need accurate appraisal of climate change and its consequences on hydrosystems and biosphere at different time scales. Furthermore, because human populations can react at local to regional or supra-regional scales, investigations must be conducted at different spatial levels in order to assess environmental changes from inhabited areas to the broader cultural group scale. This paper presents geoarchaeological investigation conducted in Eastern Macedeonia (Greece) in order to understand the magnitude of the perturbation and evaluate possible tipping points. Palaeenvironmental research (fluvial system, vegetation) are conducted from local (small watershed, pond) to regional scales in order to understand the triggers (natural and induced by human activities) and consequences of the environmental changes from local living space to the regional cultural areas. To understand the adaptation capabilities of societies in relation with their technical control and practices, they are compared with the archaeological data available locally (site of Dikili Tash). The first results covering the last 10 millennia give indices on the role of the climatic oscillations in local environmental changes but the consequences of these changes seems to have been limited for the Neolithic societies.

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Emptied beaches : example from Lebanon

LE COEUR C.(1), LE COEUR C.(1), FEISS-JEHEL C.(2)
(1) University of Paris 1, PARIS, FRANCE ; (2) Ecole pratique des hautes Etudes, DINARD, FRANCE

Sand removal from beaches results in the retreat of large coastal spits. In the case of cove beaches, the already restricted sediment stock cannot self-regenerate.

Naqoura cove, located in south Lebanon, offers evidence of a completely sand depleted beach. In this area, located not far from the southern border, the coast has not suffered from rapid urbanization. However it has suffered from extensive and uncontrolled sand and gravel removal for more than 70 years. A railway track built along the shore in the 1940^{s}, removed much gravel from the strand as ballast. Then illegal extractions of sand for building purposes completely emptied the small cove of Minat el ramul. Further north, the Tyr sand spit also suffered from uncontrolled extractions on the beach and dune banks.

Sedimentary destabilisation is manifested on one hand in an outline of small cliff on the pebble beach north of Naqoura pier and, on the other, in the exposed beach rock banks in the Minat el Ramul cove, and their partial demolition by winter swell.

Natural refill from river input is quite poor due to removal of water to feed large irrigation schemes. Winter floods can deliver loamy material (such as suspended load from soil erosion) that spreads into the sea and stony material can feed pebble spits. Nonetheless sandy input from water depleted rivers is restricted and cannot accumulate on the shore. In fact, beach sand feeding is only provided from gale wave erosion into a raised beach deposit (+1m) or indeed by shell debris whose production increased when dynamite fishing was stopped.

Other examples can be seen in Southern France, where ancient sand removal emptied some small coves, and induced remobilization of eemian (?) deposits from the upper parts of the beach.

Relationship between forest use for charcoal production and landform units

SAIJO K.(1), MATSUBAYASHI T.(2)
(1) Miyagi University of Education, SENDAI, JAPAN ; (2) Tohoku Fukushi University, SENDAI, JAPAN

Charcoal production had been a major traditional use of forest in the hilly areas of Japan before the late 1950's when common fuel drastically changed from firewood or charcoal to fossil fuel. Before that, forests for charcoal production had been cleared repeatedly, mostly every 15 to 30 years. It is certain, therefore, that the forest use for charcoal production had played an important role of hill landscape development, for example the formation of secondary forest. The purpose of this study is pointing out the characteristics of the past charcoal production in hilly areas from a geomorphological viewpoint, for evaluating the effects of forest resource use as fuel on hill landscape. Although charcoal production in Japan ceased about half a century ago, we can still recognize many remnants of past charcoal production in the hills, especially abandoned charcoal producing kilns as a kind of characteristic micro-landform. The distribution of the abandoned charcoal producing kilns in several areas in Japan shows that most of the kilns, made of mud and stone collected nearby, were located on concave breaks of slope. These concave breaks of slope correspond with the boundary between the valley bottom and hillside, landslide scarp and depression, landslide deposits and depression etc. Kiln entrances are facing downhill without exception. These characteristics indicate the existence of following close relationship between working processes of charcoal production and landform units. First, it is important that the steeper slope is located on the upside of the kiln, because fallen trees can be easily gathered to the kiln by sliding. On the other hand, works for burning trees and taking out burnt charcoal from the kiln require a flat place on the downside. As a result, the kilns are selectively made on concave breaks of slope which satisfy various requirements from working processes of charcoal production. Such uses of slope should have affected the hill landscape formation.

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The anthropogenic influence on vegetation and soil properties in Gorce Mts. (Polish Carpathians) during last 50 years

BUCALA A.(1), BUDEK A.(1), KOZAK M.(2)
(1) Institute of Geography PAS, KRAKOW, POLAND ; (2) Institute of Botany UJ, KRAKOW, POLAND

In Polish Carpathian socioeconomic transformationsin last 50 years, especially after the 1989 year,have influence on environment components. During this period the human activity were recorded in vegetation changes and soil properties. The study was conducted in two small catchments Jaszcze and Jamne in the Gorce Mountains (Polish Carpathians).The catchment of the Jaszcze stream is a narrow valley with very steep slopes while Jamne is wider with gentler slopes. The slopes of Jaszcze valley in the upper parts are covered by forests, meadows and pastures, in the lower dominate agricultural lands. The valley of Jamne is mainly deforested and arable lands here extend up to 1100 m a.s.l. In this region Brown soil (Dystrohrept) occur, developed on loamy and sandy parent material. In slope catenas, the thicknessof soil profiles increased from 1.0 m to 1.6 m in lower part of slope. Land use changes led to alteration of soil properties, especially soil structure. The studies of vegetation were compared with the phytosociological map made in the 1960's. During the last 50 years significant part of segetal communities were replaced by the floristically very poor plots of fallow communities. While on mowed for a long time and regularly fertilized sites, fresh meadows developed. Formerly widespread in the lower altitudes patches of floristically rich dry pastures with heather almost completely disappeared. They changed into dense thickets as a result of secondary succession process, caused by cessation of management. Land use changes between 1954 and 2009 years lead to decreasing of the arable land area byabout 90%, and parallel increasing of forest areas.

Cessation of tillage (change ofarable landto grassland) led tochanges insoil propertiesand plant communities.

The projectis funded by the NationalScience Center (NN 306 659 940).

Anthropogenic genesis and age of the Lower Bavarian sand dune landscape around Abensberg and Siegenburg

VOELKEL J.
Technische Universitat Munchen, Professur fur Geomorphologie, FREISING-WEIHENSTEPHAN, GERMANY

The Lower Bavarian sand dune landscape in the Abensberg/Siegenburg area (Lower Bavaria) originated in an area where the Late Tertiary deltaic sediments of the Ur-Naab are overlain by a complex system of Pleistocene Danube gravels as well as those of the Abens river. The sand dunes and aeolian sands occurring there have been known for a long time, and their mostly glacial age origin can be stratigraphically inferred. During the Holocene there were repeated phases of aeolian remobilisation, each of them related to an overexploitation of the carrying capacity of the landscape. It can be excluded that remobilisation was caused by changing climate. Today the dune fields, up to 10 m high, have partly been set aside as nature reserves, or are used for agriculture and forestry. Based on geophysical prospection, at four selected dune chains and their surroundings a distinction has been made of the underlying aeolian sand sheet, the dune cores, and younger aeolian accumulation bodies and sedimentogically characterised. The dune sands have been dated by OSL, macro-remains and the humose material of fossilised soil horizons by radiocarbon. Forest clearing of much of the landscape began during the Neolithic period, related to the operation of a flintstone mine at Arnhofen. Two significant phases of sand dune growth have been dated to the Bronze Age and the High Middle Ages, largely determining the aspect of the present dune landscape. There is evidence of younger remobilisation phases up to the 1950s. With reduced settlement pressure, each time the dunes landscape returned to a phase of morphodynamic stabilisation, without any evidence of directed reforestation or dune stabilisation measures of the sands. Today, under the name of Dürnbuch Forest, the former hunting preserve of the Wittelsbach noble family, this dune landscape is one of the largest contiguous forest areas of Bavaria. (DFG funded VO 585/13), Völkel et al. (2012): Annals of Geomorphology 55,4, 515-536.

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Peri-urban growth in Mexico-City. A local evaluation of the landscape damage due to a massive house production

GARCÉS-ESCAMILLA I.(1), PARROT J.F.(2), RAMÍREZ-NÚÑEZ C.(3)
(1) Institut des Hautes Etudes de l'Amerique Latine. IHEAL, Paris 3, PARIS, FRANCE ; (2) LAGE, Instituto de Geografia, UNAM , Mexico, MEXICO D.F., MEXICO ; (3) Posgrado en Ciencias de la Tierra, UNAM, Mexico, MEXICO D.F., MEXICO

The increasing phenomenon of massive house production since 2000 in the peri-urban area of Mexico City has led to a quickly urbanization of the former lacustrine zone and the piedmont transition zone. The old towns and now municipalities, at the east and northeast of Mexico City are the new centers of gravity to which the city is growing around. An example of that is the Municipality of Tecámac, located in the northeast of Mexico City, where more than 71,000 houses of social interest has been constructed and 4,000 more are planning to build. New parameters based on satellite image treatments and Digital Elevation Models were developed in order to study the fragmentation intensity of the build areas as well as the attraction level between these urban areas. Taking into account the real weight of these parameters, such a model brings to an objective estimation of the urban invasion ratio through the piedmont and lacustrine remaining regions. We assume that such an approach may allow measuring the impact of the eventual damage caused to the environment and defining weather an urban policy exists or not in relation with the capital of investment.

Holocene Tufa changes as response to human impact on landscape (High Ebro Basin. Nothern Spain)

GONZALEZ-AMUCHASTEGUI M.J.(1), SERRANO E.(2)
(1) University of the Basque Country, VITORIA-GASTEIZ, SPAIN ; (2) Universidad de Valladolid, VALLADOLID, SPAIN

Tufa buildups of the high Ebro basin river are geomorphic elements of high environmental interest. In this area geomorphic evolution has been led by the incision of the Ebro river, the intense karstification and the tufa filling of the main valleys. The High Ebro River basin is located in Southern slope of the Cantabrian Range in Northern Spain; it is a folded calcareous cover defining a structural relief drained by the Ebro River.

The aim of the study is to stablish the different tufa growing and destructive stages during the Holocene and differentiate between natural and human-induced environmental changes. Seventeen Holocene and present-day tufas have been studied. Fieldwork, geomorphological mapping, analysis of morpho-sedimentary units, and fifteen Uranium/Thorium and radiocarbon dating of tufa deposits have been made.

The different techniques applied have allowed to establish Holocene geomorphic evolution of High Ebro river, the chronology of tufa deposits and the incidence of human activity on the geomorphic evolution is considered. Five Quaternary tufa sedimentation stages have been established: the first three ones correspond to Middle-Late Pleistocene, and the others to the Holocene age. During this time, karst processes made a very intense work on calcareous places of Upper Ebro Basin and tufa sedimentation rates in the valleys were also high. During the last six millennia in the high Ebro basin, coinciding with first human settlement, expressed by frequent megaliths in the study area, tufa sedimentation stopped and the down cutting processes on valley deposits started on. The erosion process on tufa buildings may be caused both human activity and complex responses of the natural system.

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Transformation of relief in the loess areas of small denivelation under agricultural land use on the basis of soil profiles analysis (Lublin Upland, Poland)

RODZIK J.(1), REJMAN J.(2), PALUSZEK J.(3)
(1) Maria Curie-Sk?odowska University, LUBLIN, POLAND ; (2) Institute of Agrophysics, Polish Academy of Sciences, LUBLIN, POLAND ; (3) Institute of Soil Science, Engineering and Environmental Management, University of Life Sciences, LUBLIN, POLAND

The studies comprise an analysis and comparison of present and primary relief, i.e. before the start of agricultural land use. The primary relief was developed on the basis of reconstruction of soil profiles of brown-grey soils (Haplic Luvisols). Structure of undisturbed soil cores was studied in 480 sampling points in the catchment of dry basin of relatively low denivelations (max. up to 17 m) and the area of 5.6 ha (Lublin Upland, E Poland). Primary relief was reconstructed in each sampling point by comparison of soil structure in the point to the thickness of non-eroded soil in the nearest neighbourhood of similar topography.

The study area has remained under cultivation for about 200 years.The agricultural land use of the area resulted in considerable transformation of relief due to erosion of soils. Within convex part of relief, a significant reduction of soil profile was observed (max. 1.5 m), whereas on concave slopes the soil profiles were overbuilt by accumulated soil material (max. 1.75 m). Maximum denivelation decreased by 10% in the whole basin, and inclination of slopes decreased considerably. The area of inclination £4º increased by 50%, whereas the area of inclination ≥5º decreased twofold. In the top part area of the catchment, denivelation decreased even by about 100%, and soil erosion resulted in disappearance of small forms of relief as closed depressions and hillocks.

Quantifying anthropogeomorphological transformation by using the concept of "hemeromorphy" a case study from Hungary

NOVÁK T.J., INCZE J., RÓZSA P.
University of Debrecen, DEBRECEN, HUNGARY

Effectiveness of anthropogenic and natural geomorphological processes could be expressed by volume or mass of dislocated material per area and time unit, and on this basis the ratio of anthropogeomorphological transformation (R_{ag}) can be calculated as follows:

$R_{ag}=V_a/V_n$

where V_a = amount of dislocated material by human activities; V_n= amount of dislocated material by natural processes (both in tons or $m^3 \cdot ha^{-1} \cdot yr^{-1}$). This approach allows quantifying the degree of anthropogeomorphological transformation in spatial units. However, it meets the requirement to be independent from the volume, quality and intensity of the natural and anthropogenic land forming processes, and allows the comparison of landscapes with completely different conditions. Lower R_{ag} values characterize landscapes of low moderate anthropogeomorphological transformation, while high values indicate the totally artificial surfaces, where the amount of anthropogenic dislocated material is much higher than that of natural transportation.

On the analogy of the 'hemeroby' concept, which expresses the degree of human influence on ecosystems, this approach could be termed 'hemeromorphy' which is suitable to express the degree of human influence on geomorphosystems (complexes of land forming processes) independent from their geomorphic process combinations, relief and climate. Smallest landscape units, which are homogeneous according to their hemeromorphy, could be referred to as hemeromorphotops (*ήμερος*=domesticated, educated, *μορφή*=form, *τοπος*=place, locality).

The concept itself and an application after estimating natural and anthropogenic material fluxes in the case of Hungarian landscapes will be presented, where R_{ag} values ranging from R_{ag} <10, in the case of agricultural, hilly areas, to R_{ag} >10 000 in the case of quarries.

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The effect of the geomorphology of terrain on transport development in the context of suburbanization

STURMOVA I.(1), KOCARKOVA D.(2)
(1) Faculty of Transportation Sciences, CTU , PRAGUE, CZECH REPUBLIC ; (2) Faculty of Transportation Sciences, CTU, PRAGUE, CZECH REPUBLIC

The proposed article will address the suitability of different means of transport for servicing suburbanized area depending on the geomorphology of the terrain. Suburbanization is a phenomenon when housing and economic activities are moved beyond the border of the core city. Most often the suburbanization processes are seen in the vicinity of large cities where afterwards the daily commuting of people to work in the core city occurs. This servicing of suburban areas is usually made by road or rail transport, or a combination of both systems. The selection of suitable transport system, respectively design parameters of each system, is limited by the shape of Earth's surface. Especially the design of railway tracks is more complicated in terms of finding an appropriate lead according to terrain. The geomorphology of terrain influenced the creation of old trade routes from historical perspective and thus the foundation of settlement. By comparing historical and current maps we can observe the similarity between the old trade routes and today's major road network. In the conclusion of the article the examples of suburban development in an area around the capital city of the Czech Republic will be presented.

Anthropogenic geomorphology: Changes in the Hydrographic basins of river Jequitinhonha lower course main channel drainage pattern and delta

SILVA V.(1), PEREZ FILHO A.(2), GIGLIOTTI M.D.S.(2), SANTOS P.S.(3)
(1) Universidade Federal Fluminense - UFF, CAMPOS DOS GOYTACAZES, BRAZIL ; (2) Universidade Estadual de Campinas - UNICAMP, CAMPINAS, BRAZIL ; (3) Universidade Federal da Bahia - UFBA, BARREIRAS, BRAZIL

The anthropogenic changes of the morphology of the main river channel and delta allowed to interpret the diverse dynamics to which the river Jequitinhonha system was submitted, in its lower course. The drainage pattern characterization, identification and analysis in the main channel and Delta were possible investigating the parameters: sinuosityindex, channel morphology, channel neighborhood migration, optically stimulated luminescence dating, granulometric, biological and chromatic description of the sediments in the outfall and Delta. The results showed the identification of the rising systemic complexity due to the anthropogenic intervention in the hydrographic system. So, it is suggested that the delta morphology may have been modified in order to the river to establish a new geomorphologicalbalance, to respond to the construction of the barrage and main channel rectification. It is suggested that with time the form of the delta will be altered in the way it is happening now, abandoning its bisected configuration and transforming in a single channel directed to the left margin, with the disappearance of the channel located in its right margin.

Keys-Words: Anthropogenic geomorphology; controlled system, riverchannel; delta

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Urban geomorphology ok kolkata megacity: an interpretation of anthropocene landscape of humid tropics

SATPATI L.
Department of Geography, University of Calcutta, KOLKATA, INDIA

In India, like many other developing countries of the (humid) tropics, population base as well as growth is still very high; and most of the increase of population has been taking place in the urban areas mainly due to migration. The Kolkata Metropolitan Area (KMA) is one of the largest urban agglomerations in India, and it stands over the two levees of the River Hooghly. The KMA includes more than 15 million population (as in 2011) in 3 municipal corporations, 38 municipalities and 24 panchayat samities spreading over an area of 1850 square km in 6 districts, namely Nadia, North 24 Parganas, South 24 Parganas, Kolkata, Howrah and Hooghly in West Bengal, an eastern province of India. In 1901-2001, the cumulative growth of population within the KMA was about 381 percent, which was more than twice that of the national average (190) of India.

The urban growths, in most of the occasions, are unsystematically expansive to accommodate the influx of population; and as a consequence, there is a continuous change in the urban infrastructures, like buildings, transportation networks, water supply, drainage, waste disposal systems, etc. These necessarily alter the hydrological, geomorphic and other environmental conditions of different locations. The post-liberal drive for urban renewal heavily affects the hydro-geomorphic settings. Very often a cyclic process operates within micro-scale urban environments to keep a metastatic balance with human intervention over the landscape.

The main objectives of this paper are to identify and interpret the nature of human intervention to the natural forms of land in the KMA area, and to establish the relationship between urban renewal and hydro-geomorphic conditions under different scales of interactions. The methodology consists of close observations, some measurements, consultation of various existing maps and literatures, interviews and discussions with relevant persons and groups.

Detection of mining subsidence in the ruhr district (Germany) using historic maps and dems

HARNISCHMACHER S.
Philipps-Universitat Marburg, MARBURG, GERMANY

For the first time, an area-wide and large-scale calculation of differences in elevation between 1892 and today was conducted for the Ruhr District (Germany), a metropolitan region influenced by subsidence due to deep-seam coal mining starting in the middle of the 19th century. Elevation data on historical maps from 1892 was digitised with the help of a Geographic Information System and the interpolated historical surface was intersected with a current Digital Elevation Model, in order to calculate the differences in elevation. As a result, the highest values of elevation differences, amounting to more than 25 m, were observed within the coalfields of the former coal mine “Zollverein” which is distinguished for its long mining history and its World Heritage status. Two examples from the cities of Essen and Dortmund analysed in detail reveal that not only depressions but also elevation features are affected by mining subsidence. These kinds of surface transformations are not visible in the field without a comparison of digital topographical models. The change detections allow for a correlation with mining activities, because most of the mining subsidence areas are located next to a former coal mine. Furthermore, tectonic features of the Carboniferous strata are reflected by the location of subsidence areas, since they are located along synclines with a gentle dip of coal seams or confined by the location of predominant faults. The average amount of a surface lowering was calculated for all maps digitised and analysed, resulting in a maximum value of 5.16 m for the map of Gelsenkirchen within the central Ruhr District with a total area of 128.5 km^2. A comparison of single reliable elevation data, derived from surface levelling data of the land registry office, with the interpolated values from 1892 reveals an astonishing correlation with differences of not more than 1 m.

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Conditions and stages of Holocene evolution of closed depressions in loess area reflected on soil-sediment sequences. A case study from Nałęczów Plateau (E Poland)

KOLODYNSKA-GAWRYSIAK R.(1), MROCZEK P.(2), CHODOROWSKI J.(3), ZGLOBICKI W.(4), KIEBALA A.(4), PLAK A.(3), CHABUDZINSKI L.(5)
(1) Department of Geology and Litosphere Protection, Maria Curie-Sklodowska University in Lublin, LUBLIN, POLAND ; (2) Department of Geoecology and Paleogeography, Maria Curie-Sklodowska University, LUBLIN, POLAND ; (3) Department of Soil Science and Soil Protection, Maria Curie-Sklodowska University, LUBLIN, POLAND ; (4) Department of Geology and Lithosphere Protection, Maria Curie-Sklodowska University, LUBLIN, POLAND ; (5) GIS Laboratory, Maria Curie-Sklodowska University, LUBLIN, POLAND

Closed depressions are a common landform in loess areas of Europe. Conducted studies pointed on their natural (cryogenic and piping processes) or anthropogenic origin. However, the number of information on origin of closed depressions is still very limited. About 1700 closed depressions were found on the Nałęczów Plateau, E Poland (area 493 km^2). Majority of them concentrates on loess plateau tops (72 % objects). They are mostly oval in shape and 25-50 m in diameter (53% objects). Four closed depressions were chosen for detailed studies. They are located within agricultural land (3 sites) and afforested field (1 site). Examined closed depressions are filled up with soil-sediment sequences, which are 1-2 m in thickness. They consist of several layers of colluvial sediments, separated by fossil soils horizons. Research on morphometric features and soil-sediment sequences was performed. The soil-sediment sequences cover the Late Glacial-Holocene fossil soil horizon. It covers the original bottom of closed depression on loess *in situ.* The range of laboratory analysis included: physico-chemical, micromorphological, geochemical analysis and radiocarbon dating.

Four major stages of Holocene evolution of closed depressions were recognized. They occurred under changeable environmental conditions during the Holocene. Two stages are connected with stabilization of land surface by natural plants and soils development (the first: Late Glacial-Mesoholocene, the third: XI-XVII). In two remaining stages the filling of closed depression by colluvial sediments occurred (the second: Neolith-early Middle Ages, the fourth: modern times). Phases of colluvial sedimentation correlate clearly with colonization and agriculture development since Neolith to recent times, near closed depressions.

Mine tailings dispersion and arsenic concentration. The San Antonio-El Triunfo district, Baja California Sur, Mexico

HERNANDEZ-CRUZ G.B.(1), PARROT J.F.(2), RAMIREZ-NUñEZ C.(1)
(1) Posgrado en Ciencias de la Tierra, UNAM, MEXICO CITY, MEXICO ; (2) LAGE, Instituto de Geografia, UNAM , Mexico, MEXICO CITY, MEXICO

In the southern part of the Baja California Peninsula, Mexico, the catchment area of San Antonio-El Triunfo registers a high concentration of arsenic. This concentration results either from the natural background values of the substratum that corresponds to a part of an oceanic crust or from the former mining activity. Nowadays, many old mine tailings are present in the study region and the dispersion of these residues would explain the observed local concentrations. A high resolution Digital Elevation Model is used to show the effect of torrential rainfall in this semiarid region. According to the simulations done, the removed material from the mine tailings arrives always to the highest arsenic concentration measured in the field.

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Urban Runoff and Environmental Impact in a Mediterranean Climate Area, Ariel, Israel

INBAR M.(1), ANKER Y.(2)
(1) Department of Geography, University of Haifa, HAIFA, ISRAEL ; (2) R&D Regional Center, Shomron and Jordan Rift Valley, ARIEL, ISRAEL

Urban impervious areas produce a large amount of water during rainy storms which may be an alternative water resource for municipal or regional environmental and recreational needs. Knowledge on the impact of urban development and patterns of building is critical to understanding the threats to the environments as well as the benefits of an expanding water resource for local infrastructure development

The city of Ariel is located in the Yarkon river watershed area, at an altitude of about 700m.The region is characterized by a developed karstic terrain. Rainfall annual average is 500mm. Several building patterns are found, from single houses to apartments blocks and public large buildings. The percent of impervious area ranges from 15% to 45% in the different sub-basins.

The main objective of the study is to find the runoff/rainfall relationship for a medium size town under different physiographic and urban patterns, to find the discharge peak flow concentration time and its relationship to the urban pattern of impervious area, the physiography of the area and the climatic characteristics of the rain storms. Another objective is to assess the urban water quality and to identify pollution sources.

An initial assessment shows that the potential storm water volume that may be harvested from the city of Ariel areas ranges between 80,000 m^3 to 500,000 m^3 over the course of an average year, depending on the contributing area, amount of precipitation and evaporation depth.

Chemical analysis of the runoff water showed that the quality of the water was good, and in general the urban runoff water may be used as a source for the enrichment of ground water, and for municipal use as well.

Hydrological influence of an artificial channel on trees of picea abies (L.) Karst. Along a tourist trail. The case of the "torrent-neuf" (Valais, Switzerland)

IRENE B.(1), REYNARD E.(2), PELFINI M.(1)
(1) Universita degli Studi di Milano, MILANO, ITALY ; (2) Université de Lausanne, LAUSANNE, SWITZERLAND

A study on the interactions between an artificial channel used for irrigation and the surrounding natural environment, focusing especially on vegetation, are presented. The investigated site is a cultural trail recently developed in Valais (Switzerland) along the Torrent-Neuf, one of the *bisses* (irrigation channels) that have been used since Medieval times to move water resources from tributary valleys to irrigated land. The geomorphic processes inducing slope instability, along mountain sides where the channel had been built, justified the abandonment of the channel in 1934 opting for underground solutions for the water transport. As a consequence, long part of the channel was deviated during the time interval 1934-2005 when water was completely restored to flow into the channel and it was re-opened to public as tourist path equipped with informative panels about channel history and building techniques.

The Torrent-Neuf area is characterized by abundant vegetation among which *Picea abies* (L.) Karst. is dominant. Dendrochronology analysis has been conducted in order to highlight difference of behaviour in three main groups of trees located: i) in the stand but not along the channel; ii) along the portion of the channel temporarily closed; iii) along the undisturbed portion of the channel. In literature, some Authors highlighted a prolonged suffering of trees and a difficult recovery after stopping irrigation by artificial channel but herein no drastic divergences relatively among trees series have been individuated except for different growth rates. The rainfall regime may be probably sufficient to compensate for scarce water availability consequent to the deviation of the artificial channel.

The presence of an already developed tourist trail allows the possibility of proposing an integration of the data coming from scientific researches for highlighting the relation of channel building techniques with geomorphological processes, vegetation dynamics and climate.

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Terracing slopes to make a living in the Darjeeling Hills

SIL A.
Bhairab Ganguly College, KOLKATA, INDIA

Terracing the slopes is a common practice in the darjeeling Himalayas. The difficult terrain has poor accessibility in many places where the Gorkhas, the dominant racial group in the region have no other alternative means but to terrace the slopes in their indigenous method. Rice is the staple crop and practiced intensively in the Kalimpong subdivision of Darjeeling district, but the method of terracing sometimes invite landslides causing disaster to life and properties in many areas. Still unaware of the fact, this is the main source of living of the Gorkhas in most of the villages. But the Gorkhas of Rishov village of Ladam - Khasmahal mouza, with a little change in crop pattern, mainly cash crops have resisted this menace knowingly or unknowingly of the possible hazards. They form the focus of present study. this article deals with the socio-economic conditions of the Gorkhas in their present geomorphological settings, as a case study. Though they have well adapted it but socio-economically they still remain backward, despite much potential as human resource as an industrious race,nature's bounty with a temperate climate for altitudinal reasons, etc. Here problems like unemployment, child marriage, early motherhood etc, are still prevalent. This study aims at highlighting the problems, physical and socio-economic and to suggest some remedial measures for the socio-economic uplift of the people of the area concerned. If proper planning is done and implemented, their success in combating natural hazard may cite an example how changing crop pattern can help them keep away their poverty as well as landslide hazard of the region.

The effect of terrace abandonment on the restitution of the drainage network and soil erosion

RUIZ-FLAÑO P.(1), LANA-RENAULT N.(2), ORTIGOSA L.(2), GALILEA I.(2), LLORENTE J.A.(2), ARNÁEZ J.(2)
(1) Department of Geography, University of Valladolid, VALLADOLID, SPAIN ; (2) Area of Physical Geography, University of La Rioja, LOGROñO, SPAIN

Bench terraced areas are an essential part of the Mediterranean mountain landscapes. Terrace construction resulted in a complete transformation of the hillslopes to a series of flat sectors and almost vertical steps. This strategy, which involved a redistribution of soils and a re-organization of the drainage network, provided fertile soil over steep slopes, improved infiltration and controlled overland flow under conditions of intense rainstorms. During the XXth century, rural population declined and agricultural practices were abandoned. The maintenance and reconstruction of the terrace walls became therefore impossible and the system collapses. A small catchment was monitored in the Iberian Range (northern Spain) for studying the geomorphic evolution of the bench terrace abandonment. Wall collapse caused by small landslides affects most of the terraces, especially those located in the lower parts of concave hillslopes. Scars are frequently affected by gullying and livestock trampling. The authors investigate how, after fifty years of farm abandonment, the natural drainage network is re-established in such environment and what are the soil erosion consequences.

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Anthropogenic relief of urban areas as a factor of changes of lake landscapes

KASHIRO M.
Tomsk State University, TOMSK, RUSSIAN FEDERATION

The relief of urban areas is exposed to considerable transformation.The relief has crucial importance for existence of landscapes and relief transformation influences all components of natural complexes. Water landscapes are in strong dependence a relief of a territory, and its can serve as a vivid example of interaction of natural and human components of an urbanized area. Anthropogenic transformation of a relief changes a complex of hydrological, hydrochemical and hydrobiological processes in water ecosystems, it causes chemical pollution of water reservoirs, increases the scales and rates of plant overgrowing, disrupts the ecological balance and self-regulation processes.

Lakes are representative of water landscapes and also city lakes have greater impact on the processes of urban areas development: form microclimate of riparian land, affect city construction processes, and attract a lot of those people who want to have a rest and relax.

12 lakes of a natural and anthropogenic origin in the city Tomsk (Russia) have been chosen totrack anthropogenic influence on change of city water landscapes.

Genesis of city lakes hollows isn't connected with ancient geological and endogenous processes. Lake systems of the city Tomsk are modern, its arose after isolation of river terraces and interfluves in the quarter. Prevailing number of city lakes (about 90%) is in flood plain of the river Tom' and have the water-erosive genesis. A terrace and interfluves have no many lakes. About 7% of lakes is a result of human activity and 3% have eolian genesis. The morphometry of the city lakes depends on genesis of reservoirs.

Change of the city relief which more than 400 years proceed, led to increasing of exogenous processes. Ran off and mud flow increase mechanical loading and chemical pollution of reservoirs (especially for lakes of flood plane) that leads to gradual reduction of lakes depth and their growth of water vegetation. As a result esthetic value of water objects is lost.

5 millennia of Mediterranean mountain disturbance: soil erosion and vegetation dynamics recorded in Lake Petit (2200 m, South-Western Alps)

BRISSET E.(1), MIRAMONT C.(2), GUITER F.(2), CARTIER R.(1), ANTHONY E.(3), POULENARD J.(4), DELHON C.(5), ARNAUD F.(4), MEUNIER J.D.(6), SYLVESTRE F.(6), PAILLES C.(3)
(1) CEREGE/IMBE Aix-Marseille University, AIX EN PROVENCE, FRANCE ; (2) IMBE - Aix-Marseille University, AIX EN PROVENCE, FRANCE ; (3) CEREGE - Aix-Marseille University, FRANCE, FRANCE ; (4) EDYTEM - Savoie University, CHAMBÉRY, FRANCE ; (5) CEPAM-CNRS, NICE, FRANCE ; (6) CEREGE-IRD, AIX EN PROVENCE, FRANCE

Ancient human presence in the mountain landscapes of the Alps has been documented by archaeological and palaeoecological studies which show a change from gathering to pastoralism over the last 4 ka. Above 2000 m, landscapes have been exploited at least since the Bronze Age. Human activities rendered soils vulnerable to colluviation, increasing erodibility and erosivity. Most studies on long-term soil erosion have focused on gullying and hillslope erosion especially at lower altitudes. In mountain areas, well-dated deposits are scarce. Lake sediments are therefore a valuable landscape archive because they record a broad range of proxies responding to changes in slope stability and vegetation cover.

We present high-resolution multiproxies interpretations of a cored profile from the Alpine Mediterranean Lake Petit covering the last 5 ka. Sedimentological, geochemical and botanical data from this core document weathering and erosion in relation to vegetation dynamics, climatic fluctuations and human activities. Lake Petit has recorded since 4770 cal. BP continuity of anthropogenic taxa identified by nitrate enrichment of Alpine grassland. Even though discrete, grazing activities were already extant at this time but did not lead to significant soil erosion. The first increase in anthropogenic taxa occurred at 3000 cal. BP, concomitant with an increase in Ericaceae and intensification of erosion. Soils, without tree protection and probably altered by domestic livestock, were frequently eroded. Four important detrital pulsations occurred synchronously with depletion in tree pollen, while pollen from anthropogenic-related taxa increased. Reported archaeological sites and mining activities also show the presence of Humans in the Lake Petit catchment at 1800 cal. BP and 500 cal. BP, respectively. Widespread deforestation occurred, probably to maintain Alpine pastures and to supply fuel for smelting, contributing to the continuity of anthropogenic landscape perturbation.

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Assessing the diversity of the hydro-geomorphological response of marginal territories in mediterranean mountain areas

LANA-RENAULT N.(1), GALILEA I.(1), LLORENTE J.Á.(1), NADAL-ROMERO E.(2), SERRANO-MUELA M.P.(3)
(1) La Rioja University, LOGRONO, SPAIN ; (2) Zaragoza University, ZARAGOZA, SPAIN ; (3) Instituto Pirenaico de Ecología (CSIC), ZARAGOZA, SPAIN

Historically, Mediterranean mountains have suffered intense human pressure, including deforestation, cultivation of steep slopes and construction of bench terraces. The decline of rural population during the 20th century and the abandonment of agricultural practices has resulted in a complex expansion of vegetation, with subsequent consequences on water resources, soil erosion, stream dynamics, and reservoir silting. The hydrological and geomorphological evolution of abandoned hillslopes is an extremely complex process affected by a variety of factors such as the time of abandonment, the type of fields (sloping fields or bench terraces) and the land management regimen following abandonment. Thus, most of the Mediterranean mountain areas are nowadaysmarginal territories with a high degree of uncertainty in terms of water availability, soil degradation and productivity. Research at the small catchment scale enables the understanding of the functioning of such environments and, ultimately, the prediction of the trends of water resources and soil erosion following farmland abandonment. Four experimental catchments were monitored in the central Spanish Pyrenees and the IberianRange: a farmland abandoned catchment where sloping fields were previously cultivated, a catchment with abandoned bench terraces, a catchment afforested with pines in the 1960s and a densely forest-covered catchment. All catchments have similar lithology and size, allowing the comparison of their hydrological response against similar rainfall events. Results show the diversity of their hydro-geomorphological behaviour and highlight the need of effective and tailored policies for the management of marginal lands in the Mediterranean region.

Human impact in the Apennine area of the Municipality of Fiorano Modenese (Northern Italy)

CASTALDINI D.(1), CORATZA P.(2), LIBERATOSCIOLI E.(2), TOSATTI G.(2)
(1) Dipartimento di Scienze Chimiche e Geologiche, Universita di Modena e Reggio Emilia, MODENA, ITALY ;
(2) Dipartimento di Scienza Chimiche e Geologiche, Università di Modena e Reggio Emilia, MODENA, ITALY

Morphological, man-induced landscape changes, occurring from the mid-20th century to date in an area located in the western sector of the Modena Apennine margin, have been investigated. The study area has elevations ranging from about 100 to about 400 m a.s.l. From a lithological standpoint, only marine silt-clay soil types (Plio-Pleistocene in age) are exposed. The area belongs to the Municipality of Fiorano Modenese which lies in the ceramic district where hundreds of factories were built after World War 2 for the production of ceramic tiles. The materials utilized are taken from soil pits dug in the clays cropping out in the Northern Apennines.

The most evident natural morphological features to be observed on the slopes are badland landforms, slide and earth flow-type landslides.

This research was carried out according to traditional survey as well as digital processing methods on maps and aerial photographs. It led to the elaboration of schematic geomorphological maps related to changes occurried from 1954 to 2012.

Soil excavation began in an improvised, makeshift way in the 1930s. By the 1960s, though, excavation was carried out in a more organized, industrial way. The place with the most evident human impact is the Torrent Corlo valley, but several other soil pits are found. In the study area the exploitation of clayey soil for the ceramic industry ceased completely in 2008.

As concerns the hydrographic features, tens of small artificial ponds were excavated in the 1960s for irrigation purposes as well as for quarrying activities. Since the 1990s, though, they have lost their function and are now abandoned. As a consequence, many of them evolved in a natural way: some have turned into swamps whereas others have been filled by palustrine deposits.

Finally, the role played by man as a morphogenetic agent and the impact of anthropogenic activities on the natural landscape evolution are highlighted.

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Sustainable Land Management of the agro-pastoral plateaus, Atlantic Morocco

LAOUINA A.
UNESCO-GN Chair, Univ. Mohamed V, Faculty of Human sciences, RABAT, MOROCCO

The research made in the framework of the DESIRE project concerns the marginal lands in the Atlantic plateaus of Morocco, where farming has as main objective to feed the livestock. Many constraints are responsible of the current spreading of land degradation mechanisms. Direct overgrazing and indirect effect related to mismanagement of land for fodder production, operate massive damages to the vegetation cover and to the soil.

Scenarios were built, based on various rates of land management inside the fragile environments, vulnerable to degradation by runoff and erosion. These scenarios try to integrate the concept of SLM into the current system of livestock to make it progressively evolve towards intensification, more income and less degradation.

The proposed changes are not easy to apply. At first, at the level of the farms, we must consider the private character of property, the dispersion of the plots and the various state and forms of degradation. At the level of the whole territory, many agro-sylvo-pastoral combinations are possible. But it’s difficult to recommend a specialization of certain lands in grazing and others in farming, without rethinking the restructuring of the fragmented plots. This calls agreements between farmers and new landowners, coming from the city.

The choice for planting gullied plots with shrubs, like atriplex halimus demonstrated, during 2 years of monitoring, its effective potential for land rehabilitation, fodder supply of the cattle and for evolution towards a new semi-intensive breeding. But it is not easy to encourage the farmers to invest in this effort of planting, while the cost is much higher than the expected outputs during the 5 first years.

The role of the domanial forest must also be re-defined, because, in this perspective, the forest could become less used for grazing and devoted for new activities.

Human impact on slopes and valley bottoms in iron ore exploitation areas in Minas Gerais - Brazil

SILVA C.F.A.(1), VALADÃO R.C.(2), SILVA J.R.(1), SILVEIRA J.S.(3)
(1) Instituto Federal de Minas Gerais - IFMG, OURO PRETO - MG, BRAZIL ; (2) Institute of Geosciences - IGC Universidade Federal de Minas Gerais - UFMG, BELO HORIZONTE, BRAZIL ; (3) Centro Universitário de Sete Lagoas - UNIFEMM, SETE LAGOAS, BRAZIL

Brazil iscurrently one of the world's leading exporters of iron ore, specially the production from the Quadrilátero Ferrífero region, located in Minas Gerais. The exploitation of iron in open pit mines in the Itabira Complex has resulted in significant impact on landformand hence on changes in geomorphological dynamics beyond the exploited areas. This impact results from the combination of two processes: (i) the removal of soil and rock opening large hollows on the slopes, and **(ii) the** accumulation of material in the form of tailings and mine dumps. Relief transformation processes were extremely fast compared to the speed of change that occurs in natural conditions. The anthropogenic landforms evolution in the area investigated was reconstructed from 1946 to 2008; the landscape along this period was obtained from interpreting and processing topographic maps and from remote sensing products. Along 62 years of mining activity landforms and their dynamics were greatly impacted withinversions of relief, in which ridge lines and interfluves now are configured as depressions up to 250 meters deep; low areas, which had their surface increased up to 150 meters; decapitation of 106 drainage headwaters with the localized extinction of springs in them; redefinition of surface and subsurface hydrological flows, and heavysilting ofvalley bottoms. In Brazil after closing mining activities the environmental legislation requires the investigated area to be environmentally recovered by deploying the Recovery Plan of Degraded Areas (PRAD). However, we argue there is no possibility of reversing much of the geomorphological damage resulting from the exploitation of iron ore.

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Landform change due to airport building

PIJET-MIGON E.
High School of Banking, WROCLAW, POLAND

Along with an increasing popularity of air transportation the number and size of airports and landing sites for commercial aircraft has grown. Local relief, site hydrology, and the presence of natural obstacles potentially affecting flights, were among factors considered at the planning stage and, if feasible and necessary, modified to suit the purpose. Hence, substantial topography and landform change has been associated with airport building, especially in recent times.

Among the most common examples of interference with natural topography are ground levelling and land reclamation. The latter has concerned wetlands, lakes and marine embayments. At an earlier stage of aviation development, alteration of coastal configuration and dredging were frequent, in order to allow mooring of hydroplanes. The Santos Dumont airport in Rio de Janeiro and the Dąbie airport in Szczecin (Poland) are the examples.

Introduction of larger aircraft required extension of runways, especially at big airports. If topography or land use rendered options of inland extension impossible, land reclamation was attempted and man-made solid ground was created to accommodate longer runways. Examples include Gibraltar, Nagoya Centrair, Tokyo-Haneda, Seoul-Incheon, or Malé in the Maldives. In densely populated regions the only option left was to build artificial islands. The most spectacular example is the Kansai airport in Osaka. Building of Hong Kong International, in turn involved levelling of a few hilly islands and filling the marine space between them.

Another type of landform change concerns hilly relief on the landing approach/take-off routes. Hills were completely planted (Tegicugalpa, Honduras) or lowered through removal of the upper part (Mulu, Malaysia). Further examples include construction of earth embankments for noise reduction and, along with an increasing role of airports as tourist attractions, of artificial hills to allow observation of airport traffic.

Active collapse dolines: a geomorphological impact from a high-speed railway tunnel crossing the Cantabrian Mountains (NW Spain)

VALENZUELA P.(1), DOMINGUEZ-CUESTA M.J.(1), JIMENEZ-SANCHEZ M.(1), MELÉNDEZ-ASENSIO M.(2), SÁENZ DE SANTA MARÍA J.A.(3)
(1) University of Oviedo, OVIEDO, SPAIN ; (2) IGME, OVIEDO, SPAIN ; (3) GEHMA, OVIEDO, SPAIN

A 24.9 km-long high speed railway tunnels (Pajares Tunnels) were built between 2005-2009, crossing the Cantabrian Range (NW Spain) and trending NW-SE. The tunnels cross an alternation of paleozoic formations (shales, sandstones, quartzites and limestones) with a complex geological structure resulting from the deformation during Hercinian and Alpine Orogenies. The lithologies show very different mechanical and hydrogeological behaviours, some of which represent important aquifers (fractured and karstic). A section of the tunnels were built below Alcedo Valley (León, N. Spain) at approximately 450m depth.

Alcedo Valley is drained by a mountain stream that was canalized in an artificial channel built in 2008 to enhance river superficial flow and to avoid water infiltration. In the bottom of the valley, some subsidence and collapse evidence have been appearing from 2008 to present, also affecting the artificial channel. Evidence include 2 main scars hollows (5-10m long), 3 circular dolines (3-4m radius) and several minor hollows, which are developed in an area of about 20.000m^2 over quaternary fluvial and coluvial deposits covering karstified limestone bedrock (Láncara Fm.). Some of these active hollows work as sinkholes of surficial water, drying up all the water of Alcedo stream during the summer. The watershed, using as the baseline the collapsed area, is around 4km^2, under pluvio-nival climate with average temperatures below 10ºC and rainfall between 1000-1300mm/yr.

The recent development and active growing of the hollows is consistent with 1) the drop of the groundwater level by the tunnels drainage after the excavation; 2) the increase of groundwater flow across the karstic aquifer and 3) the increase of the river incision as a response to the descent of its base level.

The combination of hydrogeological, geomorphological, climatological studies and GIS management will allow us to establish accurately the role that the tunnels play in the evolution of the valley.

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Erosion processes in flysch: An example from the Istria Peninsula (NE Adriatic)

ZORN M., KOMAC B., FERK M., ERHARTIC B.
Research Centre of the Slovenian Academy of Sciences and Arts, Anton Melik Geographical Institute, LJUBLJANA, SLOVENIA

In recent decades, several investigations of erosion processes in the flysch bedrock and soils of northern Istria have been carried out (NW Croatia, SW Slovenia). Numerous measurements in various environments were gathered in order to establish erosion rates for different types of land use. The presentation gives an overview of the most notable findings.

Two experimental sites for measurements on closed erosion plots were located in Abrami (Croatia) and near the village of Marezige (Slovenia). The rockwall retreat of bare flysch slopes in badlands and soil erosion on different land uses was measured in both locations. Direct measurements at the plots and indirect measurements with terrestrial photogrammetry were used. Measurements nearby suggest that bare slopes retreat at a rate of a few centimeters per year and that the interrill soil erosion on bare soil is up to 90 t/ha.

Recently, measurements of the rockwall retreat of coastal cliffs at Debeli Rtič (Slovenia) were carried out in combination with analyses of historical data on erosion on the Slovenian flysch coast. The photogrammetric measurements indicate an erosion rate of about 1 to 2 mm/yr. However, comparison between the cliffs' current position and submerged Roman artifacts suggests that the cliff retreat rate must be markedly higher, probably around 10 to 20 mm/yr.

Erosion rates in river systems can also be calculated from sedimentation rates. Therefore, sedimentation was measured behind the Letaj Dam (Croatia) and in Lake Butoniga (Croatia). The specific sediment production in the river basin behind the Letaj Dam is estimated to be 803 m^3/km^2 per year, and in the river basin of Lake Butoniga around 2107 m^3/km^2. Furthermore, analysis of historical topographic maps of the mouth of the Raša River (Croatia) revealed that in the last 240 years the river mouth has moved around 4 km towards the sea and that the mouth of the Mirna River (Croatia) has moved some 350 m since the second half of the 19th century.

Early holocene to present fluvial-coastal morphodynamics in the adriatic sector of Central Italy

ARINGOLI D.(1), BUCCOLINI M.(2), DRAMIS F.(3), FARABOLLINI P.(1), GENTILI B.(1), MATERAZZI M.(1), PAMBIANCHI G.(1), SCIARRA N.(2)

(1) University of Camerino, CAMERINO, ITALY ; (2) University of Chieti, CHIETI, ITALY ; (3) Roma Tre University, ROME, ITALY

The Holocene evolution of the Adriatic sector of Central Italy has been characterized by a complex evolution of the fluvial networks and the corresponding mouths with erosion and aggradation phases generally controlled by climate changes and, in the most recent times, also by the impact of human activities.

In the second half of the last century, after a former phase characterized by aggradation, essentially due to a prolonged period of deforestation and subsequent abandonment of slope farmlands, intensive erosive processes occurred as a consequence of widespread gravel quarrying from the river beds.

Using data from several rivers of the Adriatic sector of Central Italy, an empirical relation to quantitative correlate the erosion capacity of rivers consequent to quarrying and the related amount of fluvial deepening has been formulated:

$Fd = 1.5\ GFP^{0.2}$

where Fd is the amount of Fluvial deepening in m and GFP is the *Global Fluvial Power index*, obtained by multiplying the*Fluvial Power index* (mean annual fluvial discharge in m^3/s multiplied by the mean slope of the river channel in %) by the total volume of quarried material in m^3.

The preliminary results seem to be quite encouraging even though, due to the limited number of available data, the relation needs to be further tested.

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River regulation and associated degradation of landscape ecology of flood plain: case study from a subtropical controlled drainage in para-deltaic tract of Southern Bengal, India

CHAKRABORTTY D.

ASSISTANT PROFESSOR OF GEOGRAPHY,BANKURA CHRISTIAN COLLEGE, BANKURA.WEST BENGAL,INDIA, SURI, INDIA

Since the earliest civilization, rivers have been a vital resource in the landscape. Various social, cultural and economic activities are related to rivers, which are exemplified from growth and development of hydraulic civilization in flat fertile lands adjacent to rivers, but through the river uses human civilization had significant direct and indirect impact on fluvial environmental system in terms of river regulation. Impact of river regulation in the river regime is evitable through three processes: these are *first,* on channel modification included widening, dredging and straightening of channel*, second*, modification in river corridor and flood plain involves in construction of levees or flood embankments, downstream storage, and *third,* changes in catchment area included deforestation in basin, construction of large dams *etc*. The major processes of river regulation are dam construction, river diversion, canal construction, local channelization, irrigation, embankments, river basin planning and agricultural land reclamation. The present study proposes to analyze the impact of river regulation in the fluviomorphological structure and flood plain ecological setting in parts of lower Babla river basin, West Bengal, India using remote sensing and GIS techniques. Babla is a Yazoo drainage system which flows parallel to the mega floodplain complex of Bhagirathi- Ganga-Bramhaputra delta in North West to south and south easterly direction. The information generated would be immensely helpful in hydrological modeling and providing necessary inputs for constructing suitable developmental management plans for restoring landscape ecological setting of the Babla river basin.

Importance of Slope in City Planning Case Study: Southwestern Suburban Area of Kolkata, India

JOARDAR R.
Vivekananda College for Women, KOLKATA, INDIA

Settlement on deltaic plains always develops on river levee, which being the highest point in the site and having slopes on both sides is naturally free from waterlogging. The future growth of settlement also follows the levee crest along the river, the result being an elongated pattern of settlement. Originally the city of Kolkata also grew over the natural levee of the river Bhagirathi for over a length of 50 km in a north-south direction following the same trend. But due to enormous population pressure it has encroached into the backswamp and marshy lands to the east and southwest by way of filling up extensive areas in unplanned manner. The physical features of the area have been dominated by surface water systems, the proximity of the sea in the south, and the human induced influence on the entire hydro-geophysical characteristics of the region. However, the latter has been the most dominant influence of all in recent decades, leading to profound subsequent implications on social and economic aspects of the inhabitants. The filling up of backswamp in a haphazard way leads to frequent waterlogging in the area paralyzing the daily chores of life in the rainy season. As the land was low, individual developers filled the land without caring to maintain the general slope of land, which is very necessary for easy draining of accumulated rain or waste water. Thus over period on the imperceptible slope of the delta, an anthropocene micro relief developed due to such reckless landuse leading to distortion of natural slope. The paper presents a glimpse of the severity of the waterlogging problem in the southwest part of Kolkata megalopolis where every individual distorts the micro-relief and natural slope of the area in the absence of any master plan.

Keywords: river levee, backswamp, waterlogging, anthropocene micro relief.

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The effects of land use changes and morphometric parameters in the gullies erosion, São Paulo, Brazil

VIEIRA GOMES R.
University of S_o Paulo, S_O PAULO, BRAZIL

This research discussed the contribution of land use changes and the morphometric settings in gullies erosion evolution in the basin, one of the areas that are most affected by erosion processes, located in São Pedro, São Paulo, Brazil. The methodology involves the following steps: (i) aerial photointerpretation of the years, in 1972 (1:25.000) and in 2006 (1:30.000) and field trip observation; (ii) scanning and vectorization of photographs, topographic maps and digital elevation model (DEM) (resolution 4cm², grid 2X2 m); (iii) mapping of gullies erosion (in 1972 and 2006), morphometric parameters (slope and curvature) and land use (in 1972 and 2006); (iv) quantitative and qualitative analyzes of the of gullies erosion. In the quantitative analysis we used the Erosion Potential (EP) which is the ratio between the number of cells with gullies, in each class, and the total number of cells of that same class. Using the EP indexes we observed the dirty pasture, soil exposed (land use classes), slope between 20% and 40% (5.22%) and concave slopes, (4.89%) which were the most affected by gullies erosion. The analysis of evolution, from 1972 to 2006, shows that there was a reduction of the gullies due to the reduction of pastures and the increase of vegetation and the urbanization in northwestern basin. In conclusion, the suitable land use may contribute to the reduction of erosion volume (e.g controlling runoff). Furthermore, the method applied in this study showed the importance of the aerial photointerpretation and DEM highest resolution in the gullies erosion research.

The distortion of alluvial plains by the mining of gravel sand

SMOLOVA I., DUSKOVA M., MACHACEK J.
Palacky University Olomouc, Faculty of Science, Department of Geography, OLOMOUC, CZECH REPUBLIC

Disruption to a natural flow regime is a serious problem, even in consideration of the mounting risk of floods which menace human lives and property. An example of human interference in a hydrological system is the distortion of alluvial plains by the mining of gravel sand.

In the period of transformation of the Czech economy after 1989 some crucial changes were made in the mining of minerals. Those changes have been reflected at the legislative level in relation to landscape care and one area they have influenced is in the use of flooded regions.

Though mining of gravel sand is still one of the most important aspects of mineral mining in the Czech republic despite the fact that it is situated mostly in areas of alluvial plains and gravel sand alluvial terraces.

During the extraction of large volumes of stone, changes happen to the hydrological regime. This is manifested in floods. The fact that the capacity for the accumulation of subterranean waters is affected means an enhanced risk of natural hazards for inhabited areas in the neighbourhood of the flooded areas.

The phenomenon can be mathematically expressed as the relation between a certain cubage of mined gravelous sand, the hydro physical characteristics of the alluvial sediments and the volume of flood water which passes through alluvial plains as floods.

The poster chronicles the development of the exploitation of alluvial plains for sand and gravel mining in selected basins in the Czech republic over the last twenty years (1990-2010) and compares risk indexes of intervation in alluvial plains during floods.

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Rapid assessment of floodplain storage of contaminant metals using high-resolution XRF core scanning

JONES A.F.(1), TURNER J.N.(1), DALY J.S.(1), GOODHUE R.(2), EDWARDS R.J.(2), FRANCUS P.(3), REID I.(1)
(1) University College Dublin, DUBLIN, IRELAND ; (2) Trinity College Dublin, DUBLIN, IRELAND ; (3) Institut National de la Recherche Scientifique, QUEBEC CITY, CANADA

Effective management of the hazards caused by the contamination of river systems resulting from historical metal mining requires assessment of contaminated sediment storage within river floodplains. In Ireland, to date, few attempts have been made to assess the extent of Pb, Zn and Cu storage in floodplain sediments, even in catchments severely affected by historical metal mining. The development of high-resolution XRF core scanners provides a new tool to assist in the quantification of contaminant metals currently stored within floodplains and, in particular, to rapidly evaluate variations in contaminant concentrations with depth within the sediment profile. The aim of this study is to test the utility of high-resolution XRF analysis for the rapid assessment of contaminant metal storage within floodplain sediments and to elucidate the extent and severity of floodplain Pb, Zn and Cu contamination in Irish catchments affected by historical metal mining. The selected catchments include the Avoca and the Kilmastulla, which contain two of the three most contaminated mine districts in Ireland. XRF scans of floodplain sediment cores at resolutions of 1 mm or finer are calibrated using ED-XRF analysis of subsamples. Heavy metal concentrations are evaluated with respect to depth within the floodplain, increasing distance from the active channel and distance downstream of the mine sites. The significance of catchment-scale floodplain storage of Pb, Zn and Cu and the likelihood of reworking of the floodplain sediments are assessed in the context of the other hazards (e.g. AMD, contaminated channel sediments) presented by unremediated historical mine sites.

Land-use changes and geomorphological development during the last millenium in the Campine area, north-eastern Belgium

BEERTEN K.(1), VANDERSMISSEN N.(2), DEFORCE K.(3), LETERME B.(1), MALLANTS D.(4), VANDENBERGHE N.(2)
(1) Institute Environment-Health-Safety, SCK-CEN, MOL, BELGIUM ; (2) Department of Earth and Environmental Sciences, KU Leuven, LEUVEN, BELGIUM ; (3) Onroerend Erfgoed, BRUSSELS, BELGIUM ; (4) CSIRO Land and Water, ADELAIDE, AUSTRALIA

We present the results of an interdisciplinary study on the human-induced transformation of a late Holocene landscape in a ca. 6 km² large interfluve between the rivers Kleine Nete and Grote Nete (Campine area, north-eastern Belgium). Descriptions of cross-sections and hand-drillings, soil profile analyses, palynology, optically stimulated luminescence (OSL) dating, historical archives and GIS-data were used to establish a chronology of land-use changes and their impact on the landscape during the last millennium. The first evidence of geomorphological changes in the slightly undulating deforested late Holocene sandy landscape is a thin layer of drift sand dated to between 1200-1500 AD. For the period between 1500-1750 AD, evidence of strong land-use intensification is found, including further destruction of the heather vegetation due to grazing and the use of plaggen, wind-enhanced erosion of podzol soils and the intensive use of paths for sheep drift. This phase has caused the complete reshaping of the landscape with the creation of large deflation areas of ca. 1 m deep, and the development of drift sand dunes up to 2 m in height. Between 1850-1900 AD the interfluve became completely reforested and stabilized with ca. 85 % of the area being occupied by pine trees. The first signs of the existence of large-scale infrastructure and industrial activity is the construction of the Bocholt-Herentals canal between the Meuse and Scheldt basins, and the exploitation of quartz sand around the end of the 19th century. Further enlargement of the newly formed excavation pits, vegetation clearing, and the development of new industries around 1950 AD has led to an open landscape with only ca. 25% of the 19th century pine trees left. It is anticipated that the changes described here have induced a progressive lowering of the water-table in an already relatively dry landscape.

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Types of badlands and earth pyramids in the republic of macedonia

MILEVSKI I.
University "Ss. Cyril and Methodius" Skopje, SKOPJE, MACEDONIA

As a consequence of accelerated erosion which affects large areas in the Republic of Macedonia (25713 km^2), there are numerous erosion and denudation landforms in the landscape, and badlands are one of more distinguished. Field researches and analyses of satellite imagery, digital elevation models, topographic maps etc., show that badlands in the Republic of Macedonia occupies significant area. In most cases, they were created with excess erosion of erodible rocks and soils on steep slope hilly terrains. Aside of suitable natural factors, the main trigger of their formation usually is severe human impact on susceptible landscape (deforestation, overgrazing, extensive cultivation etc.). Because various factors affecting their genesis and evolution, analysed badlands shows significant morphological differences. Thus, most of the badlands in upper Bregalnica catchment created in Pliocene lacustrine sands and sandstones has particular amphitheatric shape, with 150-300 m in length and 30-100 m in height. Other badlands like those created in tuffs of Kratovo-Zletovo palaeovolcanic area has ribbed-shaped morphology with almost parallel and sometimes very long system of rills and gullies. There is another type of badlands appeared in both mentioned areas, characterized with numerous earth pyramids on the sides. Such kind of badlands is near village of Kuklica or “village of stone dolls”, formed by decomposition of andesites and subsequent intensive erosion of tuffs bellows them. As a result, more than 150 human-like pillars are shaped, according to which this phenomenon is known as “jolly wedding”. Similar morphology has some of the badlands in Bregalnica, Bosava and Pcinja catchments. Aside of the negative impact on land use, in recent times some badlands and earth pyramids sites are recognized as natural rarities and each year attract more tourists with potential to improve even local economies.

Erosion vulnerability evolution processes associated with the deforestation settlements in Western Amazon

GOMES F.(1), MANIESI V.(2), BASTOS A.(1)
(1) CENTRO DE ESTUDOS RIOTERRA, PORTO VELHO, BRAZIL ; (2) Universidade Federal de Rondônia, PORTO VELHO, BRAZIL

The study aims to present and analyze the contents of vulnerability to erosion through thematic maps and study of the occupation modes in the area of Machadinho do Oeste municipality located in the western Amazonia portion, where there are several settlements with large deforested areas related to this kind of occupation. Were conducted literature surveys, visual interpretation of satellite images in an integrated view of climate, geology, geomorphology, soils, dynamics changes in land use and land cover and deforestation advance. The erosion vulnerability map preparation was based on the methods proposed by Crepani et al. (1996) and Tricart (1977) ecodynamic concept, using techniques that integrated thematic aspects assigning values to vulnerability based on soil loss processes. The region occupation occurred through governments colonization programs. As a result of this process, many settlements were created without adequate technical support and without knowledge about the area. There has been a gradual increase in the county's area related to unfertile soils susceptible to erosion when the vegetation is removed to intensify pasture use. The vulnerability class of erosion most representative was “moderately stable” (64.8%). The presence of moderately stable class is preserved by maintaining the natural vegetation. On the other hand, where there are great anthrop impacted areas, it shows “averagely stable vulnerable” class (30%), an intermediate index for the current conditions. This areas needs to be conserved for not change the vulnerability class for a lower one. These areas of settlement projects that no longer have natural vegetation present in proportions smaller classes “moderately vulnerable” and “vulnerable” associated principally by its soils.

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Human activities and changes in flow, width and depth in cross sections at the top, middle and lower course of the river Peixe - Western Plateau Paulista (Brazil), 1906 and 2012

TRIVELLATO F., PEREZ FILHO A.
Unicamp, CAMPINAS, BRAZIL

This research points to changes in flow, width and depth in five cross sections along the upper, middle and lower course of the Peixe, located between parallels 21º 20' S to 22º 30' S and meridians 49º 36' W to 52° 02' W. Two moments in time are taken as parameters: 1906 and 2012. At first the watershed had its entire natural vegetation preserved and, in the second, deforestation for agricultural crops and pastures occupy about 87% of the basin area and urbanization 10%, leaving only about 3% of natural vegetation areas.

Data for 1906 were collected and mapped by the extinct Comissão Geográfica e Geológica do Estado de São Paulo (Brazil) in reconnaissance expedition to the unknown valley of the Peixe river. We emphasize that this material is the only source of environmental data from the early 20th century for the region.

In fieldwork, we return to the five cross sections, in the same climatic period characterized as dry, corresponding to the months from June to September for the study area.

Through manual ratchet counter with depth, winch and flow meter coupled to a boat anchored by a steel cable graduated in meters, it was possible to calculate flow and width of the sections.

The results show significant increase in the variables of each of the five cross sections. The discharge (m^3/s) rates of 2012 are 10 times bigger than in 1906, doubled the width of the sections, the depth increased by about 50% and the average velocity of the flow tripled.

We highlight the problem of variables that interfere in such data, which were considered: publications indicate negligible increase in the area of the average annual rainfall in the past 30 years, reports from 1906 indicate dry weather and some rain episode over river valley during the expedition; operation in the trickle small hydropower plant since 1940 in the middle course of the river; studies estimate 24 m^3 / s water withdrawal from aquifers.

Evaluation about the use and human occupancy in the west edge's geomorphologic unit of Potiguar Basin, Northeast of Brazil, CE

SILVA R., BRITO É.
Universidade Estadual do Ceara, LIMOEIRO DO NORTE, BRAZIL

Throughout time man has transformed natural elements into resources to satisfy his needs. Man significantly alters the landscape and cause imbalances in the process of interaction among the elements of nature, having intensified it even further with technological advances. The goal is to examine ways of uses in the Chapada do Apodi, collecting data that can support environmental and policy management. The area covers the western portion of Potiguar Basin, located on the northeastern Brazil, which receives the name of Chapada do Apodi (Apodi Plateau). Its formation took place in the Cretaceous period of the Mesozoic era, suffering action tectonic and subsidence. The formations present in the West Edge are: Jandaíra (top) and Acu (lower), their soils are Cambisoils and Vertisoils. The place has potential for irrigated agriculture by high soil fertility and groundwater, but with shortcomings regarding the use, irregular rainfall, because the rainy season is short, and water deep underground, making it difficult to uptake. After the 30s, the area has suffered from the exploitation of limestone and the withdrawal of vegetation, erosion and great terrain transformation, as well as the launching of effluents. The methodology is based on the geomorphologic concepts of Casseti (2005), IPECE (2012), Maia (2005) and Souza (1988 and 2000). The research procedures were reading literature and data collection, mapping and use of satellite images, field visits, analysis and synthesis. It is noticed that the activities performed in the Chapada do Apodi are inadequate for this geomorphologic unit and have caused weaknesses that intensified may cause environmental degradation, modification of the original forms of terrain through the exacerbated removal of limestone and vegetation, leading to a decreasing in infiltration capacity, as well as accelerating the overland flow and the loss of support capacity.
KEYWORDS: environmental degradation, Chapada do Apodi, geomorphologic forms.

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The landscape concept in studies or the transformations of the land surface: reading geomorphologic and biogeographyc

MATOS_FIERZ M.(1), REZENDE S.(2), ROSS J.(1)
(1) UNIVERSITY OF SAO PAULO, SAO PAULO, BRAZIL ; (2) UNIVERSITY OF SAO PAULO, SÃO PAULO, BRAZIL

The landscape concept is present in Geography since the beginning of modern geographical science, prioritizing descriptive and narrative aspects of the natural environment, having pioneered the naturalist Alexander von Humboldt who developed and operationalized the concept of landscape as a geographical category of natural organization of Earth's surface. Since then, this concept is present in Geomorphology, in Biogeography in Pedology in many other sciences and continues to gain strength before its holistic potential. In Geomorphology this concept is very peculiar characteristics directly related to the material composition and its origin and forms. While in biogeography is directly linked to different types of vegetation in its various stages of development. However the landscape is not only described by biogeographical and geomorphological characteristics, but rather as a spatial structure that results from the interaction between natural processes and human activities, which acts with strong processing capacity of these natural spaces. Emphasis in the transformation of landscapes the processes resulting from human action also will act strongly in the genesis of the landscape. The transformation of modes of land use and production systems modifies the arrangement of habitats, the distribution of agro and forest physiognomy. The landscape structure is important for the maintenance of biological diversity, but also to human populations due to their dependence on natural resource use. Thus landscape can be understood as a result of the interconnection of natural and human history. Given this context the objective is to portray the evolution of the landscape in an area that portrays well the points raised, the region Bertioga coast of the state of São Paulo emphasizing the various methods of analysis supported the concepts of geomorphology and biogeography, and human participation this transformation.

Understanding erosion better in a data scarce catchment in NW Jordan - A multiple response approach

KRAUSHAAR S.(1), WILKINSON S.(2), OLLESCH G.(3), SIEBERT C.(4), VOGEL H.J.(1)
(1) Helmholtz Centre for Environmental Research - UFZ & University of Halle-Wittenberg, HALLE, GERMANY ; (2) CSIRO, Land and Water, CANBERRA, AUSTRALIA ; (3) Elbe River Catchment Community - Liaison Office, MAGDEBURG, GERMANY ; (4) Helmholtz Centre for Environmental Research - UFZ, HALLE, GERMANY

Around 65% of the freshwater used in Jordan is derived from surface waters and reservoirs. Sediment pollution harms the quality of this scarce resource in the region and plans for mitigation have to be developed. In the framework of an Integrated Water Resource Management it is therefore aspired that more rain infiltrates on the spot and recharges groundwater resources and less runoff occurs delivering sediment loads to the surface waters. Soil and it's physical integrity play an important role in these tasks and erosion needs to be better understood in this context.

The catchment Wadi Al-Arab (263,5km2) in the north of Jordan was therefore focus of a multiple response analysis to serve as a transferable approach in erosion hot spot detection for the region. As many catchments in the region Wadi Al-Arab lays in the transition zone from the Mediterranean to the semi-arid. Carbonatic bedrocks of the Upper Cretaceous and younger dominate the catchment's geology and olive cultivation plays a major part.

Field measurements in defined land units as well as a chemical fingerprint served to get first insights into soil erosion on the slope and the deposition into the catchment's reservoir. The methods cover different spatial and temporal scales of erosion and are used to calibrate and validate the setup of the SedNet model for the catchment. It's implementation helps to cultivate more sophisticated questions to the research focus and allows a conceptual scenario development for mitigation strategies.

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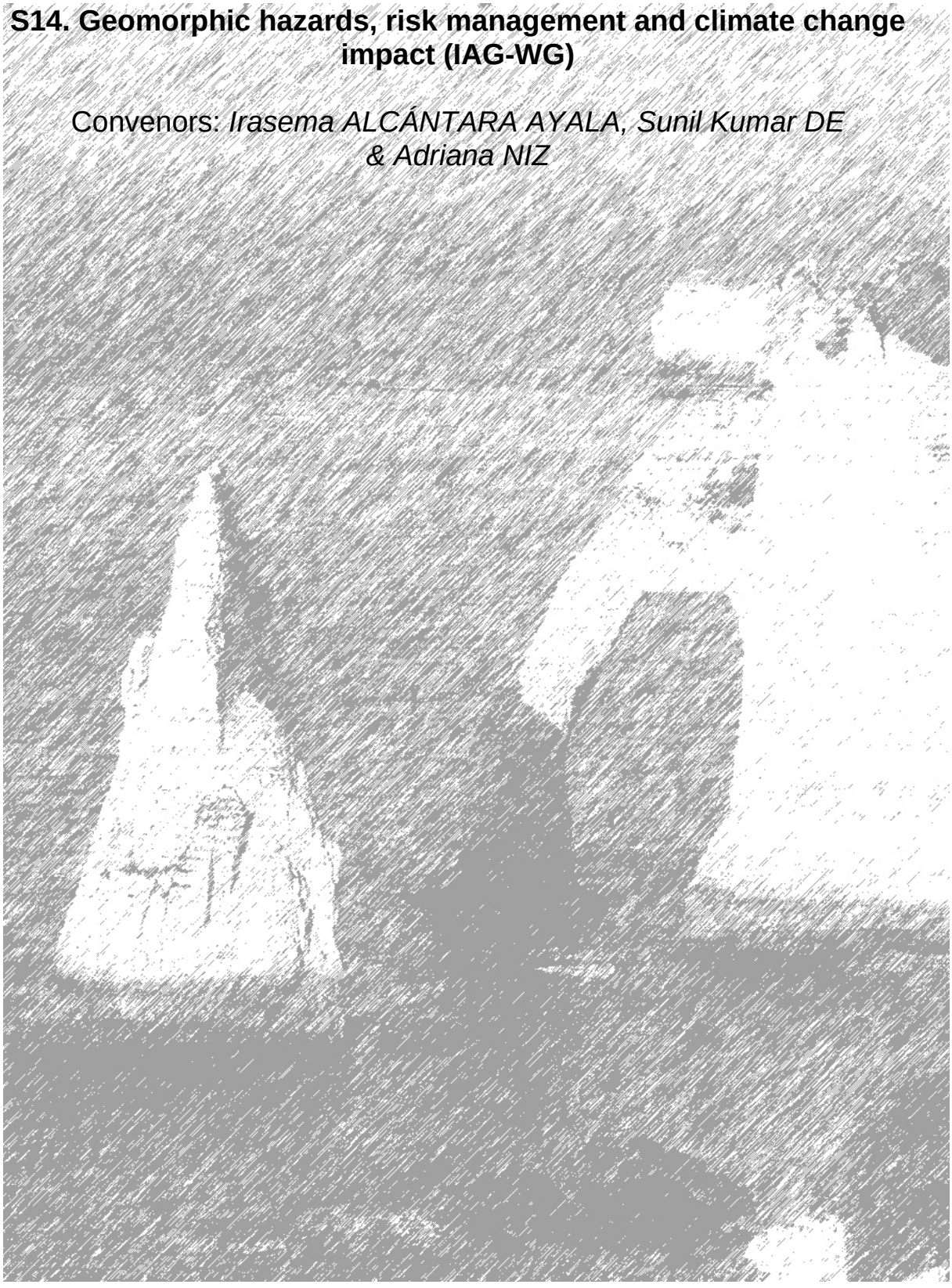
S14. Geomorphic hazards, risk management and climate change impact (IAG-WG)

Convenors: *Irasema ALCÁNTARA AYALA, Sunil Kumar DE & Adriana NIZ*



Oral presentations:

Rockfalls triggered from a rock-glacier front as a mirror of multi-centennial permafrost dynamics in the Valais Alps?

STOFFEL M.(1), STOFFEL M.(2), TRAPPMANN D.(1), CORONA C.(1)
(1) University of Berne, Institute of Geological Sciences, BERNE, SWITZERLAND ; (2) University of Geneva, Institute of Environmental Sciences, CAROUGE-GENEVA, SWITZERLAND

Trees have been demonstrated repeatedly to be excellent recorders of rockfall activity on forested talus slopes, both in terms of their spatial and temporal activity and possible changes thereof. Rockfalls have also been described to depend, among others, on freeze-thaw cycles and the melting of winter ice in clefts, and that their temporal frequency and magnitude will likely be altered at higher elevations dominated by permafrost environments as a result of ongoing climatic changes.
This study focuses on rockfalls triggered from the frontal area of rock glacier in the Saas Valley (Valais, Switzerland) which is located above a steep cliff. It is anticipated that changes in rock glacier movements at this site will affect the production of rockfall which would in turn be recorded in the vegetation growing on the steep slopes below the cliff. Based on the study of almost 400 time series of century-old *Larix decidua* Mill. trees, we demonstrate that rockfall activity and therefore rock glacier movements have been modified significantly at the study site between the end of the Little Ice Age and today, and that such changes can be considered reflective of changing climatic conditions in general and of recent increases in temperatures in particular.

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Predicting Massmovement Processes induced in Periglacial Areas

TOBLER D.(1), MANI P.(2)
(1) GEOTEST SA, ZOLLIKOFEN, SWITZERLAND ; (2) GEO 7 SA, BERN, SWITZERLAND

Based on glacier retreat and degrading permafrost in high alpine regions across the Bernese Oberland (central Switzerland), several new hazardous source areas for debris flows became evident within the last years. The evaluation of susceptible periglacial areas and the assignment of resulting processes by modelling will be one of the major tasks to be solved in near future. The prediction of those processes and their consequences is an interdisciplinary question. Meteorological scenarios for the next 30 to 50 years derived from climate change scenarios stand at the beginning of the decision chain. Based on those, susceptible periglacial areas which act as starting zones for debris flows or new sediment sources can be calculated through sophisticated permafrost and glacier retreat models. The bedload characterisation is based on extensive field investigation and laboratory testing subsequent to the October 2011 events in Switzerland. There many debris flows originated in periglacial areas; deep gully erosion phenomena in permafrost induced debris fans at the foot of steep rock faces have been evident. A vast basic monitoring of the permafrost by BTS measurements helps understanding on-going processes and is fundamental for the bedload calculation in in the periglacial area. This is measured by monitoring systems at representative and characteristic locations within the study area (e.g. Spreitgraben near Guttannen, Switzerland).
Dealing with large investigation areas of several 100 km^2 it is important to use adequate models. Well established simulation tools like dfwalk and RAMMS have been used within the project. The result is a so called periglacial hazard indication map visualizing endangered areas for debris flow processes as well as other natural hazards like rockfall, landslides and floods.

Understanding geoenvironmental dynamics and hazards of high mountains: the Geo-Morpho-Structural assessment of Veny Valley (W-Alps, Italy)

GIARDINO M., PEROTTI L., BACENETTI M.
University of Turin, TURIN, ITALY

Mountain regions have geological and geomorphological features that make them attractive for leisure and tourism activities; land occupation and seasonal population in many mountain areas are consequently increasing, together with impacts on the natural environment and geomorphological risks for human activities and infrastructures. We aims to understand the present and past geomorphologic processes in the periglacial environment of the Veny valley (Courmayeur, Ao), and to study their interaction with the morpho-structural setting, by using geomatics techniques.

First, the field data have been collected using pocket-PC and integrated GPS whit mobile GIS, in order to create an ESRI-GIS based geodatabase. Considering the alpine context of the area, stereoscopic models from the '97 and '03 flights with a 4 m precision were built to map geomorphological features in inaccessible area. Contemporaneously, to support these data, LiDAR '08 images were processed to include hillshade, slope, and aspect maps.

Two areas of keen geomatics interest were iidentified: the potential failure surfaces of the Mont Rouge de Peuterey and the Miage glacial basin. Using the Coltop 3D software, kinematic analysis of the data were performed using the Markland test. MIVIS '99 images analysis allowed to classify the debris cover of Miage Glacier and detected the potential rock instability using the Principal Component Analysis (PCA). On the same slopes close range photogrammetry was performed to measure joint sets setting.

Data interpretation yielded to obtain three geotematics layers: a) geomorphologic, within mapped landforms b) morpho-structural, concerning the structural evolution c) debris cover of Miage glacier, for the multitemporal analysis.

The remote sensing technologies showed to be more affordable than the usual field-based approaches, in the perspective of a safe analysis of stability conditions in mountainous areas.

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The impact of debris flows on the transport infrastructure in NW-Norway

MEYER N.K.(1), SCHWANGHART W.(2), KORUP O.(2), ROMSTAD B.(3), ETZELMÜLLER B.(1)
(1) University of Oslo, OSLO, NORWAY ; (2) University of Potsdam, POTSDAM, GERMANY ; (3) CICERO, OSLO, NORWAY

Norwegian's transport infrastructure is frequently affected by rapid mass movements. Aside from snow avalanches and rock falls, debris flows account for high economical costs related to road damages. However, studies investigating debris flow initiation conditions at a regional scale are rarely available for Norway. Thus, we aim to identify a set of terrain attributes as predictor variables for critical topographic conditions of debris flow initiation and to develop a statistical model to obtain a regional susceptibility map for NW-Norway. A debris flow inventory and the terrain variables slope, curvature and flow accumulation derived from a DEM with a resolution of 20 m x 20 m serve as input to a weights of evidence model (WofE) that we use to estimate posterior probabilities of debris flow occurrence on a pixel basis. Thereby, we address three topics related to model quality: model adequacy, model robustness and model accuracy. Beside the susceptibility map itself, WofE offers the possibility to conduct an uncertainty map related to the posterior probabilities. This map is used for spatial error quantification. Finally, the obtained susceptibility map is generalized to the scale of terrain segments, so-called mean curvature watersheds, for the sake of comprehensibility and practicability to the end-users. Identified susceptible areas serve as input to a simple run-out model to identify transport route sections at risk. A network analysis is conducted to estimate the effects of potential road/railway closures and the related costs are quantified.

Changing nature of riverine hazards in Brahmaputra Valley, India

DAS A.K., HAZARIKA N., SAH R.K.
Deptt. of Environmental Science, Tezpur University, TEZPUR, INDIA

Brahmaputra valley, Assam, India, is one of the most flood affected areas in the world. The authors in this paper present a factual overview of the nature of riverine hazards in Brahmaputra valley based on RS-GIS studies of selected parameters of river dynamics, field based information on human response and reports on hydro-geomorphic aspects of floods. The purpose is to re-emphasize the need for behavioural adjustment to be up in the policy agenda for flood management in Brahmaputra Valley. Such an objective overview is not only important but also becomes an urgent requirement when considered in the light of changes in precipitation pattern that have been observe and documented by scientist for this region.

Available reports on flood situation for this region show occurrence of repeated breaches in embankments that are meant to control floods during the period of rainfall maxima. Breaches leads to large scale inundation and deposition of sediments over land. This has been the most striking feature in the nature of riverine hazards of Brahmaputra valley for the last couple of decades. RS-GIS and field based studies undertaken for this work suggest that inundation and damage caused by breaches are far more damaging than normal floods.

All documentary evidences available in the form of research publications show that there is an increase in number and intensity of extremerainfall events over Indian region. An analysis of the causes of breaches indicates that these are the results of rivers' response to heavy precipitation. With the observed change in the precipitation pattern, these events are likely to increase.

Integrating the understanding of the nature of riverine hazards and probable changes in it in light of changing precipitation pattern, and the studied dynamic nature of the rivers and socioeconomic factors, this work urges that behavioral adjustments should up in the policy agenda for managing riverine hazards in Brahmaputra Valley.

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Flood hazard maps of ephemeral streams (NE Spain): the Multibasin-Multifunction approach

FURDADA G., MARQUES M.A., MASCAREñAS P.
Dpt. Geodynamics and Geophysics; University of Barcelona, BARCELONA, SPAIN

This presentation deals with hazard maps for the ephemeral streams of North Cap de Creus (NE Spain) based on the Integrated Geomorphological Method and the Multibasin-Multifunction analysis. The streams drain 11 small basins (surfaces: 0.125-28.5 km^2; lengths: 14.5-0.8 km; very high medium slopes: 0.241-0.052 m/m). Flash floods are very frequent.

The Integrated Geomorphological Method is based on oriented geomorphological maps where all kind of data related to the hydrologic behaviour of the basin are integrated. From these maps, the flood hazard maps are derived. Flood frequencies and discharge calculations were impossible to obtain with classical methods: discharge data are inexistent and there are only 3 meteorological stations inside the basins (incomplete series). This led us to develop the Multibasin-Multifunction analysis. It consists of: a) to analyze and select the variables that provide information about flood frequency (including historical and field data); b) to compile, for each variable and basin, all the data (including meteorological data from surrounding areas); c) to analyze every variable; d) to compare the results; e) to establish the frequency flood. This approach allowed us to obtain the channel overflowing frequency of 2.3 years, which reaches the inhabited floodplains. These floodplains contain all the floods, from 2.3 to 500 years return period, just increasing the flow depth. With these results we obtained the hazard maps. However, it was impossible to adapt the streams real dynamics to the flood typologies indicated in the EU 2007/60/CE Directive.

Ephemeral streams flash flood dynamics and data limitations are very frequent all along the Mediterranean coast. The Multibasin-Multifunction analysis represents a good alternative to estimate the overflow frequency of such streams. The EU 2007/60/CE Directive should be modified in a way that legislation could adapt and describe the dynamics and nature of these ephemeral streams and flash floods.

A Proposed Method of Bank Erosion Hazard Zonation and Its Application on the River Haora, Tripura, India

BANDYOPADHYAY S., DE S.K.
Tripura University, AGARTALA, INDIA

Estimation of bank erosion is usually carried out through the Bank Erosion Hazard Index (BEHI) and Erosivity Index methods, but in practice these methods have been found complicated. In this article an attempt has been made to propose a GIS based method of bank erosion hazard zonation considering 7 parameters, such as, bank slope, meander index, river gradient, river velocity, soil erosivity, vegetation cover and anthropogenic impact. LISS III (30m resolution) and Google Images have been used to determine bank slope, meander index, river gradient, vegetation cover and anthropogenic impact; Soil map of the NBSSLP, India has been used for assessing Soil Erosivity index and river velocity has been measured from the field by water current meter.

Out of those seven parameters, bank slope and meander index are given weightage of 20% each and the rest five parameters are given 12% each. Bank slope of <15° is considered as gentle and >45° as very steep. Meander index has been calculated as the ratio between actual meander length and axial length. The entire river has been divided into 500m stretches and the river gradient of each stretch has been calculated as the areal percentage. Soil Erosivity has been calculated on the basis of Soil Nomograph of USLE. A composite buffer map of anthropogenic activity has been prepared by superimposing individual buffer layers of different activities.

By integrating the individual values of those seven parameters a bank erosion hazard zonation map of the River Haora, Tripura, India (23˚37´- 23˚53´N and 91˚15´-91˚37´E),has been prepared. The values have been compared with the field data of 30 cross sections taken along 56 km stretch of the river in Indian Territory and found that the estimated values are matching with the field data. The whole stretch has been divided into 5 hazard zones, i.e. Very High, High, Moderate, Low and Very Low Hazard Zones and they are covering 4.82 km, 17.07 km, 21.95 km, 9.22 km and 2.94 km respectively.

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Flood hazard mapping as a risk mitigation tool in a Moroccan urban catchment

WERREN G.
Universit_ de Lausanne, LAUSANNE, SWITZERLAND

Severe rainfall events are thought to be occuring more frequently in semi-arid areas. In Morocco, flood hazard has become an important topic, notably as rapid economic development and high urbanization rates have increased the exposure of people and assets in hazard-prone areas. The Swiss Agency for Development and Cooperation (SADC) is active in natural hazard mitigation in Morocco. As hazard mapping for urban planning is thought to be a sound tool for vulnerability reduction, the SADC has financed a project aimed at adapting the Swiss approach for hazard mapping to the case of Morocco. The Swiss method was adapted to semi-arid environments, and to other constraints specific to the study site. Following the Swiss guidelines, a hydro-geomorphological map was established, containing all geomorphic elements related to known past floods. Next, rainfall/runoff modelling for reference events and hydraulic routing of the obtained hydrographs were carried out. Finally, a hazard map was calculated using the Swiss hazard mapping matrix that convolves flood intensity with its recurrence probability. Hazard maps become effective when implemented in urban planning. We focus on how local authorities are involved in the management process. Therefore, an institutional vulnerability “map” was established, based on individual interviews held with the main institutional actors in flood management. Results show that flood hazard management is defined by uneven actions and relationships, it is based on top-down decision-making patterns, and focus is maintained on active mitigation measures.

Estimation of flooding potential for Chakrood catchment by SCS method

GHANBARI H.
University of Payam Nour, TEHRAN, IRAN

Flood usually occurs based on natural conditions predominated in an environment and human activities like felling trees or deforestations. So physiographical and geomorphological conditions of a catchment such as form, area, slope and river bed combined with climatological conditions like 24 hrs. precipitation can cause a place to have flooding potential. This research was done in Guilan province north of Iran. According to UTM coordinate system it is located from 445096 - 449858 ms. E to 402967 – 408374ms. N in zone 39. The highest point is 3601 meter high and the lowest point is -29 meter below sea level. Total area of the catchment is 11066 hectares and perimeter of 313047ms. The annual average temperature is 10 centigrade and has 662 mms. Annual precipitation. In order to obtain geomorphological condition, from a raster data layer(DEM) of catchment, elevation, slope, area and form was extracted from arcgis10.1 and then other layers like vegetation, soil and water source were added to the base map. With regard to 1:25000 topographic map, the catchment was divided into 34 sub-catchments (26 hydrological H and 8 non hydrological N). to calculate flooding potential cases like rainfall excess, time base, time of concentration, peak flood , annual peak flood, CN and unit hydrograph were calculated through the SCS method. The result shows that CN in all sub-catchments varies from at least 79 to 86 hours, time of concentration 2.2 hours, peak flood 1.2 hour and flood coefficient 0.6 . because CN factors are near to 100 and smaller time of concentration and finally refer to unit hydrograph this catchment is in risk of flooding and need to be considered as a flooding potential.
Keywords: flooding potential, Chakrood catchment, SCS method

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Flood Risk Management - A Case Study of Savitri River Basin, Maharashtra (India)

NAGARALE V., MORE P.
S.N.D.T.Women's University, PUNE, INDIA

Flooding is predominantly a natural event that becomes a problem when it has an impact on people. We can't stop flooding; however, we can do more to help reduce the impacts of floods when they happen. Making better use of science and information, we can plan and target our investment to protect and prepare communities and businesses more effectively. Risk is the combination of vulnerability, cost of the elements at risk and the probability of occurrence of the event, and can be expressed as follows:

Risk = Vulnerability * Costs * Probability

Flood risk is defined as the expected number of lives lost, persons injured, damage to property, or disruption of economic activity due to flood phenomenon. India is the worst flood affected country in the world after Bangladesh. Flood prone area of this country is 40-45 million hectares. Therefore, various problems like ecological degradation, land use changes (upstream/ downstream) and urban floods etc. arise due to increasing flood risks.

In this paper, flood problems in Savitri Basin, present status of flood risk management, measures, their effectiveness and future needs in flood risk management are covered. River Savitri is one of the major river in Konkan Coastal Belt of Maharashtra (India). A subset area was selected along the river which measured 150 km^2 (10 km by 5 km) and was used as the area of interest for inundation mapping. This subset was large enough to represent the river and surrounding areas. In the present paper, flood inundation map for 2005 and 2007 flood events have been prepared and analysed. For this all HFL markings of 2005 and 2007 events were recorded. The total inundated area, total villages submerged and spatial extent of respective flood events have been computed. For this purpose ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) data has been utilized for the preparation of the digital elevation model of the Savitri River basin.

Flood Recurrence Analysis of River Bhima at Pandharpur in Part of Maharashtra

UNDE M., JAWARE D.
PG Department of Geography, Ahmednagar college, AHMEDNAGAR, INDIA

When hydrologicevents are random, it is helpful to represent their frequency as an average time between past events. Therefore, the frequency analysis is important to understand Paleoflood characteristics of the river. Identifying the magnitude and frequency of potential future floods is an essential component of any river flood study. Flood frequency analysis provides an estimate of the probability of future flood events.

Present paper aims to attempt the flood recurrence interval of river Bhima at Pandharpur. The River Bhima is flowing north to south direction near Pandharpur. The river channel takes the curvature position near the city. The several high floods recorded and demarked different locations at the river side settlements. Data for the flood recurrence interval of this site is taken into consideration to understand hydrologic characteristics of the river.

The effects of development on peak flows are generally much greater for low-recurrence interval floods than for high-recurrence interval floods. HEC-RAS model is applied to find out the probable flood recurrence interval. The 30 years discharge data is used for the analysis through Gumbel's distribution. Gumbel's extreme value distribution is based on the theory that the extreme event is unlimited and therefore the most suitable distribution to the extreme value data is double exponential type. Flood frequency is the statistical method of frequency analysis for computing the magnitude frequency relationship of the event. Flood peaks corresponding to return periods of 2, 5, 10, 25, 50 and 100 years have been considered for present study. The average flood recurrence up to 12-13 times. 10 years flood recurrence is observed is only once and 25-26 interval also found one time that is in the year 2006. It is given the previous record that the maximum flood in 1956, 1961 it has recurrence interval more than 40 years.

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Vulnerability to natural hazards in the city of Bamenda

SAHA F., TCHINDJANG M.
University of Yaoundé I, YAOUNDE, CAMEROON

In the early 21st century, about 300,000 people on average each year are affected by natural hazards and nearly 78,000 people are killed. At the forefront of these natural hazards, cyclones, droughts, earthquakes and storms are the most deadly and particularly affect Asian American and European continents. Africa suffers mainly droughts, floods and mass movements. In Cameroon, the abundant rainfall, the dramatic topography in some areas are at the origin of some hazards such as floods and mass movements. Bamenda is a city in the highlands of western Cameroon with a population of 496,931 inhabitants. The city is crossed by an escarpment whose slopes are now colonized by squatter particularly at risk of landslides. The occupation of the lowlands is the cause floods every year causing significant damage. Between 1995 and 2012 floods killed at least 20 people in the city of Bamenda and extensive damage. The situation of the city of Bamenda is also compounded by many other factors, including socio-economic, cultural, institutional, political, functional and even climate. After a diagnosis of the various natural hazards that affect the city of Bamenda, we present a spatial assessment of the vulnerability by combining a number of variables at once physical, social and cultural, demographic and economic, to highlight areas that have several vulnerabilities and the consequences of damaging phenomena are likely to be higher. This vulnerability assessment leading to the realization of the risk map by the superposition of three variables: slope, land use and the various hazards.

Climatic and anthropogenic mechanisms of the desertification process in the Santa Maria Valley, Northwestern Argentina

COLLANTES M., GONZALEZ L.M.
Institute of Geosciences and Environment, National University of Tucuman, SAN MIGUEL DE TUCUMAN, ARGENTINA

Desertificationis the greatest environmental challenge facing dry regions, mainly in relation to their productive potential. In this regard, the Santa Maria valley, located in the north-western quadrant of the province of Tucumán and north-eastern of Catamarca province (Argentina), presents a severe picture of land deterioration, with a highly degraded anthrophic-environmental system, standing out among causal factors, the heterogeneity of the relief, an arid-semiarid seasonally contrasting climate (with permanent hydric deficit and seasonal rainfall), surface materials highly susceptible to removal by wind and water, loss or marked decrease in vegetation cover, because of logging or diverse extractive activities,overgrazing and improper management of soil and water throughout several centuries.

In that sense, in regions such as the study area, seasonal climate variability and current multiyear oscillations occurred during the Holocene, coupled with anthropic pressure for several centuries (mainly linked to over use of the land), has generated a long chain of desertification processes, leading to the destruction of the capacity for regeneration of vegetation cover necessary or sufficient to protect the soil surface from erosion, producing a "metamorphosis" in the primitive landscape, currently restricted to a sparse shrub layer and monotonous surrounded by highly degraded soils, with few trees in areas with some moisture availability

Taking into account this geoenvironmental and anthropogenic context, this investigation analyzes the influence of current and past climate variability and human occupation, as factors of desertification. We study also, the processes linked to the geomorphological mechanisms of desertification hazard, such as water erosion, salinization of soils, wind erosion and sedimentation, stoniness (pavement), etc., and its influence in the spatial heterogeneity of vegetation and soil.

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The socialization of threat information in hazardous areas: a method for the representation of susceptibility to landslides at landholder parcel scale

COUTURIER S.(1), HUERTA-LUNA R.(2), GARNICA R.(2), ALCÁNTARA-AYALA I.(2), HERNÁNDEZ G.(2), OSORNO J.(2)
(1) Instituto de Geograf_a UNAM, MEXICO CITY, MEXICO ; (2) Instituto de Geograf?a UNAM, MEXICO CITY, MEXICO

Risk management in highly hazardous areas involves preventive steps such as the socialization of threat / vulnerability information to the local population.

Specifically in less industrialized countries, disaster prevention organisms face multiple difficulties for socializing threat-vulnerability-risk information. A key component is the attempt to implement a participatory process in which information stem from different actors (at local, regional and national levels). In this process, a usual input of academic and governmental institutions for threat and vulnerability representation has been national level cartography and local level statistics. Threat representations which may be delivered to the local population involve the GIS modeling of continuous, regional scale maps. We propose an enhancement of existing spatial modeling methods using a segmented representation of land use / land cover, allowing for the representation of objects relevant to local landholders. Our method includes the segmentation of satellite imagery to produce a vegetation density classification map as an input of the landslide-risk modeling chain. The segmentation was then used to partition the continuous expression of the threat product into parcel objects instead of the traditional natural breaks partition.

This method was applied to the Chichonal area, including the Chichon volcanoe in the state of Chiapas, South-East of Mexico. This area has been the object of interests to create the first Geopark in Mexico. An expression of susceptibility to landslide was obtained at landholder parcel scale in the highly fragmented grazing pasture landscape. This product is meant as one of the tools of a participatory process leading to the Geopark project.

How to evaluate the extreme vulnerability of human exposure to sea flood risks? The example of Noirmoutier island (Vendée, France)

CREACH A.
LETG Nantes-G_olittomer / Universit_ Nantes, NANTES, FRANCE

Storm Xynthia (February 2010) was responsible for an important sea flood. 41 people died by drowning in the flooding of low lands. Xynthia was a violent storm; it has been generated by a rare combination of different factors, even if those one were not exceptional in themselves. However the number of deaths can not been explained only by the storm in itself. Human exposure on coastal areas was also an important factor. This exposure is due to the evolution of society and to political choices: coastal areas have become attractive for tourism. This phenomenon is responsible for the development of many residential areas, increasing the pressure on unoccupied areas in coastal cities. In order to meet the new demand, many low lands formerly used for agriculture were urbanized. Moreover, many constructions were built according in a traditional architecture which is not adapted to flooding. These factors led to an important vulnerability.The relationship between architecture and the location of houses is an interesting issue. The present lecture intends discuss it.

A research is at the moment in progress on Noirmoutier island (Vendée). This low-lying island is particulary concerned with the development of urbanization for tourism activities. Although Noirmoutier was not very impacted by Xynthia, it is interesting to study the potential effect of such a storm on the island. To do so, we propose creating an indicator of "exposure to extreme vulnerability". Its aim is to make the link between architecture and the potential flooding in order to identify houses in which death by drowning may be possible.

Easy to use, this tool could be applied in many places and it could have many applications, notably for decision makers. For example it could be useful in order to locate priority interventions areas or to recommend architecture adaptations.

With sea-level rise due to climate change, such matters are becoming crucially important.

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DISASTER: a GIS database on hydro-geomorphologic disasters in Portugal

ZEZERE J.(1), PEREIRA S.(1), QUARESMA I.(1), SANTOS P.(2), SANTOS M.(3), VERDE J.(1)
(1) Centre for Geographical Studies, IGOT, University of Lisbon, LISBOA, PORTUGAL ; (2) Centre for Social Studies, University of Coimbra, COIMBRA, PORTUGAL ; (3) Dynat, CEGOT, University of Oporto, OPORTO, PORTUGAL

In the last century Portugal was affected by several natural disasters of hydro-geomorphologic origin with high levels of destruction. However, data on past events related to floods and landslides is scattered, increasing the difficulty associated with the implementation of effective disaster mitigation measures. The Disaster project aims to bridge the gap on the availability of a consistent and validated hydro-geomorphologic database for Portugal, by creating, disseminating and exploiting a GIS database on disastrous floods and landslides for the period 1865 - 2010.

Data collection is steered by the concept of disaster adapted to Portugal. Therefore, any hydro-geomorphologic event is stored in the database if the occurrence led to casualties or injuries, and missing, evacuated or homeless people, independently of the number of people affected and the value of the damages, using national, regional and local newspapers as sources. Sixteen newspapers were used and 145 344 individual newspaper were analysed. All the news about hydro-geomorphologic occurrences which fulfil the adopted disaster concept was converted to digital support and stored in the database.

The database contains two major parts: (i) the characteristics of the occurrences and (ii) the damages. The first part includes data on type, subtype, date, location, triggering factor, information source and reliability of source. The second part records social damages: number of casualties, injuries, evacuated and homeless people.

In this work the main results of the Disaster data base are presented. 1622 disastrous floods and 281 disastrous landslides were recorded and registered in the database. These occurrences generated 1310 dead people. The obtained results do not show any exponential increase of events in time. Floods were more frequent during the period 1936-1967and occurred mostly from November to February. Landslides were more frequent in the period 1947-1969 and occurred mostly from December to March.

Assessment of direct and indirect vulnerabilities of transportation networks impacted by debris flows in the French Alps

UTASSE M.(1), JOMELLI V.(1), LEONE F.(2), BRUNSTEIN D.(1), GRANCHER D.(1)
(1) Laboratoire de Geographie Physique, UMR 8591, CNRS, MEUDON, FRANCE ; (2) Gouvernance, Risque, Environnement, Développement, UMR - IRD, MONTPELLIER, FRANCE

The Alps are highly impacted by debris-flows triggered by heavy rainfalls and snowmelt. Such events have important consequences on societies and communication networks located in the valley floors. If most studies focus on understanding the natural process, the concept of vulnerability defined as the propensity of an exposed element to suffer damages due to natural hazards, is still unexplored and its evaluation needs to be standardized.

This study focused on different aspects of vulnerability:structural, institutional, functional and territorial on roads at local and regional scales. Owing to many landlocked valleys in the Alps, disruption of transportation networks does not only affect damaged area, but extends to all reliant areas and activities. On a territory where the economy relies mainly on tourism activity, such indirect damages represent the major economic loss for these regions.

We selected two catchments located in very touristic valleys of the French Alps that have been affected by many Debris flows over the last decades which frequently impacted transportation networks.

A method based on a feedback scenario allowed estimating direct and indirect damages in order to provide a quantitative evaluation of drawbacks due to disruptions of the network.

We analyzed physical damages on infrastructures such as road obstruction or bridge collapse. Using numerical simulation tools, we evaluated the functional disturbances beyond the impacted area in order to highlight the territorial dysfunction of activities related to the network characteristics such as temporary breaks of traffic, bypass roads. Thus, an investigation conducted among the actors of the crisis management has led to a better understanding of both the decision-making process and the risk perception.

This approach allowed us to identify the strategic value, the vulnerability of the network and possible losses of accessibility of the territory impacted by the Debris flows at different spatial scales.

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A methodological framework to assess landslide vulnerability and resilience across different temporal and spatial scales

SOLDATI M.(1), GHINOI A.(1), MENONI S.(2), PATTUZZI E.(1)
(1) Universita' di Modena e Reggio Emilia, MODENA, ITALY ; (2) Politecnico di Milano, MILANO, ITALY

Current research on global change and related impacts is also dealing with the effects of climate changes on geomorphic hazards, including landslides. It is clear that climate changes will cause a series of consequences on the environment as a result of variations in temperature and precipitation, and landslide hazard is expected to undergo a significant increase under these changing conditions. Therefore policies of risk management and adaptation to climate variations should increasingly focus on reducing exposure and vulnerability, and on increasing resilience to the potential adverse effects of climate extremes that is fundamental to prevent disasters.

The current state-of-the-art in landslide hazard assessment offers a wide variety of methods, suitable for different landslide types and for different scales of analysis. However, the ongoing changes in climate patterns require multiple-scenario analyses of landslide hazard, taking into account the most probable precipitation patterns that may occur. In recent years, an ever-growing attention has been raised in Europe, also by the geomorphological community, towards vulnerability assessment methods and also towards the assessment of resilience, i.e. the capacity of a certain community of people to face and positively react to the occurrence of a certain hazardous phenomenon. Vulnerability and resilience issues related to landslide hazard have been extensively explored by the EC-funded ENSURE Project that aimed at elaborating a methodological framework to assess, across different temporal and spatial scales, vulnerability and resilience of natural, built, social and economic systems. In addressing such a variety of systems, the framework created a bridge between the natural sciences (responsible for identifying parameters and indicators related to the natural and the built environments) and the social sciences (necessary to tackle social and economic systems' vulnerability and resilience).

Spatial Distribution of Slope Failures, Grand Teton National Park, Wyoming, USA

MARSTON R., BUTLER W.
Kansas State University, MANHATTAN, UNITED STATES

Slope failures pose a significant hazard to campgrounds and hiking trails in deglaciated mountain canyons of Grand Teton National Park, Wyoming, USA. However, few detailed maps and statistical analyses of slope failures as hazards exist for park officials and visitors. The purpose of this study is to produce a comprehensive map of slope failures in five of the most accessible and commonly used canyons of the park: Cascade, Death, Garnet, Granite, and Paintbrush.

This project combined field surveys, LiDAR imagery, aerial photography, and GIS analyses to document four primary categories of slope failures: rock slides, rock/debris flows, rock falls, snow avalanches. The frequency of each category of slope failures was examined as a function of slope gradient, slope aspect, slope curvature. Snow avalanche source areas where debris flows were not readily present occurred most commonly on slightly convex, north- and northeast-facing slopes, with a gradient of approximately 40% gradient. Debris flow source areas occurred most commonly on slightly convex, south- and southeast-facing slopes, with a gradient 42% gradient, and on slightly convex slopes. Rock fall source areas were most common on flat, north-facing slopes, with an average 55% gradient. Rock slide source points were most common on flat to slightly concave, north-facing slopes, with an average 54% gradient. Rock Mass Strength (RMS) values were sampled at a rate of every 0.5 kilometers on the hiking trail of each canyon to provide an introductory insight into rock stability conditions in each canyon. The vast majority of slope failures originate at or near the trimline/berm created during the Pinedale age glaciation. Fault-shattering and variable weathering seems to have also played a role in all five canyons. However, distance to the active Teton Fault and lithology did not provide significant additional explanation for the geographic distribution of slope failures.

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Dynamics of Tsunami Flood related with Evacuation Behavior in the City Area Enclosed with Embankments - Analysis of 'the Tsunami Movie' recorded in Miyako City on 11 March 2011 -

IWAFUNE M.
Shigakukan University, KAGOSHIMA, JAPAN

Dynamics of the tsunami flood in the city area enclosed with embankments was analyzed based on "tsunami movie" recorded in Miyako City on March 11, 2011. Changes in depth of inundation and flow speed of the tsunami flood were measured on the still images taken at intervals of 0.50 seconds of the movie. The result shows important basic information not only for human evacuation behavior from tsunami but also regional planning and education for disaster prevention.

The characteristics of the tsunami overflowed into the city were as follows:

1) The tsunami went ahead for about 50m within 10 seconds after overflowed the embankment. This is faster than the running speed of most people.

2) Tsunami flow of 20cm depth at speed of approximately 4m per second moved cars. If someone stayed in this place, they were probably swept their legs and fell down before the cars moved.

3) The water splashed for about 2 m high in an area about 10 m along the embankment. In this zone, someone might not continue breathing.

4) 28 seconds after, almost the entire ground surface was flooded. In addition, the drifted cars have gathered, and started to push houses and buildings around them.

5) Depth of inundation reached to 1m at about one minute after tsunami overflow. If someone stayed in this place, they must be floated away.

6) Flow speed changed to less than 2m per a second at 2 minutes after the tsunami overflow.

7) The tsunami flow reached on about 3m per a second in speed and more than 300cm in depth at 4 minutes after the tsunami overflow. Many wooden houses were started to drift.

8) For about 1 minute after the peak flow was recorded, drawback flow occurred and its speed was less than 2 m per a second.

9) Stagnant water stayed inside of the embankment after drawback flow occurred, because the embankment did not collapse. At this water condition, somebody could evacuate from tsunami flooded area by swimming.

Resilience of huge earthquake in Taiwan ---12 years after Chi-Chi Earthquake

LIN J.
Department of Geography, National Taiwan University, TAIPEI, FRANCE

It has been 13 years after Chi-Chi earthquake in 1999. The damage of earthquake together with typhoons caused Taiwan huge damage and loss since 1999. This paper try to demonstrate the impacts of earthquake and typhoon and resilience of the study area from earthquake and typhoon damage.

By comparison of satellite images and aerial photos, Tachia river catchment and Chenyeulan river catchment have been demonstrated as these two catchments are most typical examples.

It is found that the evolution of landslides could be traced by different periods of aerial photos and field study. The evolution of landslide could be clearly documented and useful for comparison of hazards.

Landslides caused by earthquake and heavy rainfalls could evolve in three types: type 1 is recovering by vegetation which is hardly to identify previous landslide in five years' time; type 2 is quite unstable. Most of the type 2 landslide could occur at the same site after each heavy rainfall event. Type 2 landslide is still unstable 13 years after Chi-Chi earthquake. Type 3 landslide is new landslide. Most of the size of type 3 landslides are relatively small.

The resilience of impact from earthquakes is still not stable. In comparison with Kobe earthquake, the sedimentation load went back to normal in five year time. However it is still higher than before the earthquake on the study area at the same periods according to the gauging station data

Typhoon together with heavy rainfall is the main factor to cause such unstable situation. This study demonstrates such complicated situations.

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EADaS: A reference system for predicting possible geomorphic disasters in Japan

SUZUKI T.(1), SHIMAMURA M.(2)
(1) Chuo University, TOKYO, JAPAN ; (2) JR East Professor, Department of Civil Engineering, The University of Tokyo, TOKYO, JAPAN

The EADaS is a software to predict possible geomorphic disasters at given site in Japan by examining the combination of Environment, Agent, Disaster mode and Structure at a target site. The main part of the software contains the combinations of the elements of disaster-related environment at a site and the frequency of the 90 disaster agents which possibly occur at the site. On the environment, are listed 225 questions including a total of 1450 choices for the characteristics of environmental elements. The user of the EADaS, however, does not have to answer all the questions. The user chooses one or two answers from 2 to 20 choices for the first question concerning the characteristics of environmental element at the target site, then the next question will be shown automatically according to the previous answer by the EADaS, and so on. The frequency of 20 disaster modes caused by each agent and also the risk of 135 structures caused by each disaster modes are automatically shown by the EADaS. The results of examinations are shown by the total value of the frequency of each of the 90 disaster agents at the site (e.g. from 0 to 2,737 for landslide: The past landslides had occurred at the sites more than 1,000). Since this kind of threshold differs from each agent, such a permissible threshold is determined on the basis of the minimum value in the past disasters records, although the threshold should be carefully revised just like the medical examination. The merit of the EADaS is that the risks of every possible disaster at the target site are predicted by the values for each agent automatically, because various disaster agents are simultaneously triggered by a strong agent at a site. For examples, flood, lateral erosion, landslide and/or debris flow are possibly induced by a big typhoon. The EADaS can be modified for any regions of the world by local geomorphologists.

Earthquake induced landslides susceptibility assessment: Roles of topography, geology and seismology

TAKEZAWA N.(1), UCHIDA T.(2), ISHIZUKA T.(1), HONMA S.(3), KOBAYASHI Y.(3)
(1) Public Works Research Institute, TSUKUBA, JAPAN ; (2) National Institute for Land and Infrastructure Management, TSUKUBA, JAPAN ; (3) Kokusai Kogyo, Co.Ltd, TOKYO, JAPAN

It has been considered that topography, geology and seismic waves gave large impacts on the size and susceptibility of earthquake induced landslide. However, to quantify these effects, we have to analyze landslide maps from a variety of earthquakes, geological settings and topography. Using landslide maps from the epicentral areas of four Japanese earthquakes, Kobe in 1995, western Tottori in 2000, Chuetsu in 2004, and Iwate-Miyagi, 2008, we have investigated the roles of topography, geological settings and seismic waves over the location of earthquake induced landslide.

We found that the slope angles, bedrock geology and the distance from fault controlled the landslide susceptibility. Moreover, relationships between the distance from fault and the ratio of landslide area were not different each slope angle and each bedrock geology. It means, the seismological factors related to landslides susceptibility were depended on slope angles.

Furthermore, we found that there were large differences in landslide area-frequency relationships. In the epicentral areas of Kobe and western Tottori earthquakes, small shallow landslides were dominant, while in the epicentral areas of Chuetsu and Iwate-Miyagi earthquakes, a number of large scale landslides were occurred. This difference cannot explained by slope angle and the distances to fault break. While, we found that the susceptibility of large scale landslide increased with the increase of relief, indicating that topography is one of main control of seismic landslide size.

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Hazard Risk Assessment in North Cyprus: Sheet Floods, Flash Floods and Floods

KUTOGLU S.
Turk Maarif College, NICOSIA, CYPRUS

The intensity and frequency of the hydro-meteorological hazards have been increased in the last two decades in North Cyprus. Together with almost all of the developing countries, North Cyprus is also highly vulnerable to natural disasters. Lack of scientific researches, limited economic resources and widespread improper land-use are the most important reasons for this vulnerability. The purpose of this paper is to present the causes and effects of sheet flood, flash flood and flood disasters and to show the evidences of improper land-use in North Cyprus. There are different factors which affect the formation and the intensity of flooding. In order to specify these factors several maps with different scales and topics such as vegetation, soil, geology, landuse, aspect, dems, slope, topography and geomorphology have been digitized and produced. To determine the degree and zoning of flooding risk in North Cyprus these maps have been overlaid in ArcGIS spatial analysis software program by using raster calculator module. The primary objective of these maps is to identify the hazard prone areas and the distributions of sheet floods, flash floods and floods in North Cyprus. Moreover, these maps are also designed to help the constitutions and corporations of North Cyprus dealing with such geomorphological problems in order to formulate the legal regulations. The implementation of such regulations will directly affect mitigation and will reduce vulnerability rate of such hazards and will increase the capacity to cope with floods. In conclusion, these attempts will contribute to the sustainable development in North Cyprus.

Keywords: Sheet Floods, flash floods, floods, improper landuse, geomorphology, risk assessment, vulnerability, ArcGIS, North Cyprus

Urban risk in the Yaoundé VII district

GHOMSI H.D., TCHINDJANG M.
University of Yaoundé I, YAOUNDE, CAMEROON

In developed countries, measures are taken in terms of prevention, management or forecasting risk. Paradoxically in developing countries, the challenge of a taken official awareness of the presence of the remaining risk to overcome. The evidence is that 90% of victims and 75% of the economic damage resulting from natural and health disasters occur in developing countries and especially in their cities. Indeed, the urban population believes a priceless speed (17% in 1950 and probably 57% by 2025 according to WRI, 1990). The scale of the city of Yaoundé, Cameroon to seen its population increased from 1.8millions in 2005 (RGPH) to 2.5 million in 2012. This growth ignores environmental requirements for the resurgence of the risks (landslides in Oyomabang in 2000 and Mbankolo in 2012; to Nkolbisson flood in 2008 and 2012). However, to develop strategies to reduce the harmful consequences of urban risks in the District of Yaoundé VII, susceptibility to risk is evaluated by a probabilistic bivariate (theory of obviousness) model. This model analyzes the mathematical relationships between environmental factors of predisposition and spatial occurrence of past and present risk. The mapping of the areas a risk was conducted on the basis of an amount associated with the hydro-morphological method. This approach provides a mapping exhaustive and homogeneous of the maximum allowance for potentially vulnerable areas across the borough, allowing to identify areas that may be urbanized without imminent danger, because it relies on visible topographic structures. Thus, the results of this work could contribute to the improvement of land management, urban planning and management of urban risks in Yaoundé.

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Application of digital orthophotos and digital terrain models to investigate of surface evolution in Tsaoling landslides, Taiwan

CHEN R.(1), WU R.Y.(2), KUO C.Y.(2), CHANG K.J.(3)
(1) Chinese Culture University , TAIPEI, TAIWAN ; (2) Research Center for Applied Sciences, Academia Sinica, TAIPEI, TAIWAN ; (3) Department of Civil Engineering and Graduate Institute of Civil and Disaster Prevention Engineering, TAIPEI, TAIWAN

On September 21 1999, a catastrophic earthquake occurred in the mountainous Tsaoling area in Central-Western Taiwan, at epicentral distance of about 35 km. Chi-Chi earthquake (ML=7.3) triggered two huge landslides at Jiufengerhshan and Tsaoling, Killing 39 and 29 persons, respectively. We focus on the Tsaoling landslide, form the point of view of historical landslide event, the occurrence of successive landslides in the Tsaoling area during the last century. Multiple (five) gigantic landslides have been recorded in the Tsaoling landslides since 1862 and the latest landslide was triggered by the 1999 Chi-Chi earthquake. After Chi-Chi earthquake, it is found that the surface process is fast and the rapid topographic change benefits the studies of landslide mechanism, active tectonics and geomorphologic evolution. To understand the impact of earthquake induced landslide on short-lived sediment budgets and suspended sediment transported in the Chingshui River. In this paper, we use aerial orthophotos to generate high-resolution digital terrain models (DTM) are generated for the investigate period. These DTMs are inspected by three ten-year comparisons (1979-1989, 1989-9999, 1999-2009) for long-term geomorphologic evolution and followed by short- term evaluations after Chi-Chi earthquake (1999-2009). Our observations from the Chingshui River near Tsaoling indicate that despite upstream sediment accumulation resulting from landslide damming, landslides undoubtedly facilitate erosion, because disrupted landslide masses are quickly eroded. The study of the Tsaoling landslide suggests that the probability for further major landslide events is high, which deserves consideration in terms of natural hazard mitigation. Topological information in front of the orogenic belt of Taiwan and activity rates are addressed and calculated.

Landslide identification and mapping based on the interpretation of a stereo pair of Very High Resolution satellite images (VHR) for the production of a landslide inventory for the municipality of Pahuatlan, Mexico.

MURILLO GARCIA F.(1), ARDIZZONE F.(2), FIORUCCI F.(2), CARDINALI M.(2), MONDINI A.(2), ROSSI M.(2), GUZZETTI F.(2), ALCÁNTARA AYALA I.(3)

(1) A) Posgrado en Geografía, Universidad Nacional Autónoma de México, MEXICO, MEXICO ; (2) B) Consiglio Nazionale delle Ricerche, Istituto per la Protezione Idrogeologica, PERUGIA, ITALY ; (3) C) Departamento de Geografía Física, Instituto de Geografía, Universidad Nacional Autónoma de México, MEXICO, MEXICO

The Pahuatlan municipality is in the Sierra Norte de Puebla region, Mexico. The landscape is mountainous and is characterized by deep ravines; the highest reliefs correspond to the Sierra Madre Oriental. Mesozoic rocks outcrop in the region: conglomerated, shale, siltstones and limestone. Landslides, which are diffused and frequent in the territory, play an important role in the evolution of landscapes and represent a serious hazard for the population in this area. In this work we present a multi-temporal inventory map for Pahuatlan, which will be essential for geomorphological studies, especially in understanding the evolution of the landscape processes and evaluating landslide hazard and risk.

New remote sensing technologies are proving very useful for detecting and mapping landslides. For this study, pan sharpening fused stereo pairs of images from a Very High Resolution images satellite (VHR) were acquired from the GeoEye 1 sensor from March 2010 and were used to build a stereoscopic 3D digital model. A Planar StereoMirror™ stereoscope system was used to perceive the 3D effect. The 0.5 m spatial resolution of the images was adequate for mapping landslide features. The hardware and software systems simplify the acquisition of morphological information and directly allow the digital mapping of faults. The data obtained by the interpretation of the stereoscopic model were complemented with information from other inventory techniques and tools such as the revision of historical data, field surveys and the analysis of monoscopic images.

We obtained a digital multi-temporal landslide inventory map of the study area that shows 301 recent landslides, 170 old landslides and 22 very old landslides. The data of the landslide inventory were used, together with the Double Pareto function, to obtain the relative size-frequency distribution of landslide area. We, also, analysed the spatial persistence of the recent landslides with respect to the pre-existing landslide areas.

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Geomorphic risk assessment and management in the context of global change

BONACHEA J.(1), FORTE L.M.(2), HURTADO M.(2), BRUSCHI V.M.(1), RIVAS V.(1), GÓMEZ-AROZAMENA J.E.(1), REMONDO J.(1), CENDRERO A.(1)

(1) Universidad de Cantabria, SANTANDER, SPAIN ; (2) Universidad Nacional de La Plata, BUENOS AIRES, ARGENTINA

Natural disasters due to geomorphic processes appear to be growing in most regions of the world. This is often considered to be a consequence of climate change. Geomorphic hazard and risk management are strongly dependent on our ability to appropriately assess future frequency of potentially dangerous geomorphic events. This, in turn, depends on our knowledge of past trends and understanding of factors that determine them.

Global, continental and regional data on the frequency of hydrogeomorphic disasters during the last century are presented and compared with potential natural (rainfall) and human (activities that modify land surface) drivers. Data so far available suggest that there is a marked increase in the frequency of those disasters from around the middle of last century. Of course, there is small doubt that intense rainfall is the main immediate trigger of floods and landslides, but precipitation does not seem to explain their growing frequency. Comparisons and correlations between disaster frequency and potential drivers suggest that climate change plays a minor role in the intensification of geomorphic processes and that the observed increase is caused mainly by the alteration of the surface layer. In other words, they seem to be driven by “global geomorphic change”. This change reduces surface layer resilience and enhances geomorphic processes in general. Indeed, land surface modification and consequent increase in the intensity of geomorphic processes appear to be one of the characteristics of the Anthropocene.

As the magnitude of geomorphic change is directly linked to population and economic growth, it is reasonable to assume that trends observed during the last century will continue during the present one. Therefore, it is important to verify the proposed hypothesis. If it were correct, to find clues for better managing geomorphic hazards in the future we should not look up to the clouds, but down to the ground.

Integrating Environmental Indicators to Diagnose Desertification Risk Zone in Indian Arid Lands using Geo-Spatial Approach

SIDDIQUI A.
Department of Geography, University of Allahabad, ALLAHABAD, INDIA

Desertification is a land degradation problem of major importance in the arid region of the world. It involves long term changes in the floral and faunal characteristics, its biological potential and carrying capacity. The size, remoteness and harsh nature of many of the world's desert make it difficult and expensive to map or monitor these lands as well as to determine the effect of land use on them. Remote sensing has long been suggested as a time and cost efficient method for monitoring change to desert environment, since it can serve both to enhance monitoring efforts as well as provide valuable information on dry land degradation in specific areas. The present study has been undertaken to diagnose the desertification risk area in Churu district (27°24' to 29°0' N and 73° 51'49" to 75°40'20"E) of Western Rajasthan in India covers an area of 13,740.95 km^2. The area encompass nearly 12.40% of Indian arid land, is endemic to desertification by different measure, endangering the sustainability of nearly two million population and a still larger livestock population.

The main objective of present study to develop cumulative index to measure varying intensity of desertification in the study area based on selected indicators of climate, soil and vegetation to identify desertification risk zone using remote sensing and GIS. In order to arrive a cumulative map of desertification various information layers like soil texture, soil depth, organic carbon, aridity indices, land use/land cover, wind erosion susceptibility and water table heterogeneity have been processed. Soil samples have been collected from the field to estimate soil organic concentrations in different land use systems. It has been observed that there is regular gradient of increasing desertification is seen towards western margin and north western margin of the study area due to cumulative impact fragility of ecosystem.

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Methodological approach for mapping landslide risk areas, based on brasilian public policy

CANIL K., MACEDO E.S.D., GRAMANI M.F., MIRANDOLA F.A., SILVA F.C., CORSI A.C.
Instituto de Pesquisas Tecnologicas do Estado de Sao Paulo, SAO PAULO, BRAZIL

Based on the Program of Urbanization, Regularization and Integration of Precarious Dwelling Areas proposed by Brazilian Federal Government, it is presented the guidelines of methodology developed by IPT to map risk areas of landslides processes. It involves the indicators that characterize geological-geotechnical processes related to landslide risk and of the social context exposed to such risk. Landslides are natural processes, triggered or accelerated by intense or prolonged rainfall, leading to sudden changes in groundwater levels; undercutting of a slope or cliff by erosion or excavation; shocks or vibrations resulting from construction; removal of (natural) vegetation; and overburden on steep slopes. The main criteria used to map these areas are: building material (brick, wood, corrugated iron, concrete, etc.); terrain characteristics: natural and man-made slope (height and declivity); top and base distance from dwellings; type of existing deposits on natural or man-made slopes (garbage,landfill); evidences of mass movement (presence of fissures in dwellings and in the terrain; steps of subsidence; curved walls; tilted trees, poles, walls; landslide scars); water action: rainwater concentration on the surface; release of wastewater on the surface, water leaking, piping; surface drainage (enough, precarious or satisfactory); land cover vegetation (presence of trees, underbrush, grass; cultivation area, or deforestation area); kinds of instability processes expected (landslides in natural or man-made slope; landslides in landfill, erosion, debris flow, falling and rolling of blocks).After identifying the risk indicators, it is possible to evaluate the risk level on the basis of the probability of occurrence of landslides (Low, Medium, High and Very High Risk). It is worth mentioning that this mapping is valid for a year only because of the constant changes caused by the weather (in particular the rainy seasons in tropical areas) and human activities.

Hydrogeomorphological mapping: current uses and perspectives for floodplains management

MONTANE A.(1), VINET F.(2), BUFFIN-BELANGER T.(3), VENTO O.(4)
(1) BURGEAP / Université Montpellier 3, AVIGNON, FRANCE ; (2) Université Montpellier 3, MONTPELLIER, FRANCE ; (3) Université du Québec à Rimouski, RIMOUSKI, CANADA ; (4) BURGEAP, AVIGNON, FRANCE

In France, the hydrogeomorphological mapping has been considered for over 20 years as an efficient method of flood mapping contributing to the sustainable development of territories by taking into account the occurrences of extreme events. This communication aims at providing an overview of practices related to their spatial logics, as well as future developments related to the implementation of the European Flood Directive (2007/60/CE), the progressive development of hydrogeomorphological mapping in Quebec and the gradual diffusion of Lidar DEMs. Several examples from rivers in France and Québec are used to illustrate these developments.

The use of hydrogeomorphological mapping has evolved over time from a simple knowledge to its integration in urban planning documents (PPRI). Important regional differences related to the nature of rivers, flood data availability and also to administrative divisions remain when implementing the method. This has led to the development of various hydrogeomorphological mapping.

The hydrogeomorphological mapping has shown great potential. However, many actors are critical because of the lack of quantification of water depth, but also because of the “geomorphological” skills needed for its comprehension that a general audience may not possess.

The current dissemination of Lidar DEMs and the introduction of concepts such as “extreme events” in French law after the Flood Directive caused new interest for the use of that mapping. Medium resolution DEMs have allowed for several years to develop the automatization of hydrological calculations. Lidar DEMs which are high resolution DEMs, set to develop the automatization of geomorphological forms description. The development of Lidar DEMs can also help to produce Digital Model of Flooded Area (DMFA), which represents the heights of water for an extreme flood. It appears to be a useful tool to communicate on extreme floods and to help flood risk management in floodplains.

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Dendrogeomorphological research applied to flood hazard analysis in the 'Caldera de Taburiente' National Park (La Palma, Canary Islands, Spain)

DIEZ-HERRERO A.(1), GENOVA M.(2), MAYER P.(3), BALLESTEROS J.A.(1), RUBIALES J.M.(2), SAZ M.A.(4), BECERRIL L.(1), HERNANDEZ M.(1), GUTIERREZ-PEREZ I.(5), BODOQUE J.M.(6), RUIZ-VILLANUEVA V.(1)
(1) Geological Survey of Spain (IGME), MADRID, SPAIN ; (2) Technic University of Madrid, MADRID, SPAIN ; (3) University of Las Palmas de Gran Canaria, LAS PALMAS DE GRAN CANARIA, SPAIN ; (4) University of Zaragoza, ZARAGOZA, SPAIN ; (5) Ferrovial-Agroman, MADRID, SPAIN ; (6) University of Castilla-La Mancha, TOLEDO, SPAIN

Las Angustias torrent is an ungauged stream located in the **'Caldera de Taburiente' National Park** (La Palma, Canary Islands, Spain), where frequent and intense flash flood events occur, even causing fatalities (such as in November 2001) and important economic damages (over 700,000 euros in the last two years). The **aim** of this research is to analyze the flood hazard atone of the most visited areas of this protected park (more than 60,000 hikers per year).

The classic data sources and methods (hydrological and hydraulic modelling) for flood hazard analysis have important shortcomings regarding the lack of information (i.e., precipitation and flow data) in Las Angustias basin; and due to the low statistical representativity of time series, which normally leads to under- or over-estimated results. So, a detail **dendrogeomorphological study** of the river system was carried out and 65Canarian pine trees located at the stream bed and banks showing external evidence of flash floods damages, as scars or exposed roots, were sampled using Pressler borer. More than 150 tree-ring cores were analyzed and measured using binocular microscope and a LINTAB semi-automatic measuring table, with the TSAPWin and Cofecha softwares, looking for evidences of past flood events. In addition, a detailedtopographical survey using GPS and total station allowed us to obtain the inputs for hydraulic modelling.

As **preliminary results**, tworecent flood events have been well identified, corresponding to the winters 1962-1963 and 1990-1991; and evidence of flood events in other dates has been observed (1920, 1976, 1983, 1993 and 2001). The magnitude reconstruction of these events, using 2D hydraulic models, will improve the flood hazard and risk analyses and will be useful for National Park managers to landuse and visitors planning. These studies are funded by the Spanish Ministry of Agriculture, Food and Environment by means of the research project IDEA-GesPPNN (OAPN 163-2010).

Protective role of planted alder trees in capturing debris flow material, Moxi Basin, Sichuan Province, China

MALIK I.(1), OWCZAREK P.(2), YONGBO T.(3), WISTUBA M.(1), PILORZ W.(1)
(1) University of Silesia, KATOWICE, POLAND ; (2) University of Wroclaw, WROCLAW, POLAND ; (3) Chengdu Center of China Geological Survey, Chengdu University of Technology, CHENGDU, CHINA

In the Moxi Basin, at the foreland of high mountains surrounding Tibetan Plateau, moraines are strongly dissected by debris flows. At mouths of debris flow gullies vast and flat debris flow fans develope. On their surfaces – available for building development and agriculture – villages are located. During monsoon seasons debris flows are triggered by heavy precipitation and can reach inhabited fans. Flows deliver rock material and by this cause destruction of houses and death of people. At mouths of debris flow gullies alder trees (Alnus nepalensis) are planted by local inhabitants in order to protect villages against debris flows. In areas overgrown by alders we have found numerous boulders captured by individual trees. Many trees were injured and tilted by rock material from debris flows. This enabled dendrochronological studies on: (1) tree reaction to stress connected with debris transport and delivery, (2) frequency of debris flow occurrence recorded in tree rings, (3) role of alder planting in protection against debris flows. Dating scars and stem tilting have revealed that small flow events occur every 2-3 year in the study area. Large debris flows, threatening houses built on debris flow fans occurred two times during the last 20 years (1996, 2005), but alder trees were able to capture debris transported, weaken the energy of mass-movement events and protect houses and inhabitants.

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Poster presentations:

Hazard Management in a Debris Flow Affected Area ' Spreitgraben, Switzerland

KULL I., TOBLER D.
GEOTEST SA, ZOLLIKOFEN, SWITZERLAND

Since 2009 several extremely erosive debris flows have occurred in the Spreitgraben near Guttannen (central Switzerland). They were initially triggered by rockfall events and started with small and harmless flows. Within three years they have increased to become destructive events with an enormous hazard potential. Strong erosion along the debris flow channel caused considerable depositions in the receiving stream. A total of 650,000 m^3 bedload has been deposited to date. Due to the scale of the erosion and deposition processes, no constructive protection measure can be implemented to stop the process evolution.

Important infrastructures are increasingly affected; the major gas pipeline between Germany and Italy had to be relocated and two houses had to be abandoned. The main pass-road is endangered in different places and has already been locally destroyed. The only reasonable solution to confront these natural hazard processes is land use planning, in order to avoid any human activity in this increasingly dangerous area.

As a matter of urgency a vast, sophisticated early warning system has been established. A profound knowledge of the ongoing processes is the precondition for reliable hazard and risk management. Scenario-based debris flows have been simulated for the near future in order to estimate the deposit progress of depositions and to define areas at risk. These simulations form the basis for the safety and monitoring concept. A project handbook defines the role, tasks, responsibilities and cooperation among all affected infrastructure owners and public authorities.

The presentation focuses on the hazard management in a highly endangered area with enormous vulnerability. The devastating debris flows are forcing the authorities to adapt yearly to new situations. Due to the high event-frequency in the Spreitgraben, the established system has already been approved after only three years – a unique case in Switzerland.

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The assessment of the risks of gully erosion activisation in urbanized areas

OSINTSEVA N., KWASNIKOWA Z.
Tomsk State University, TOMSK, RUSSIAN FEDERATION

Scientific studies of geographers of Tomsk State University laid the foundation for systematic evaluation of activisation risks of gully-formation in urbanized areas of the western Siberian South-East. The investigations were carried out in sub-taiga zone in the city and suburbs of Tomsk.

Risks factors causing gully erosion on above - mentioned territories are as following: natural and anthropogenic. Under natural conditions active gullies are scarce and are found in separate spots. The total length of gullies in natural sub-taiga landscape does not exceed 100 m/km^2, and gully density is not more than 10 gully heads /100 km^2.

The anthropogenic factors increase the risks of gullying, cause new areas of erosion and activate already existing gullies. It is ploughing, forest clearing, destruction of soil-tree cover, changes in conditions of surface runoff. Gully erosion is progressing more on urbanized territories. So, total lengths of gullies on the territory of Tomsk amounts to 1,6-2,0 km/km^2 on separate spots, and its density - up to 10-30 gully heads/km^2.

The authors suggest evaluating of gully erosion risks in urbanized areas taking into account natural and anthropogenic factors together. As risk criteria we can consider: 1.Gully erosion rate: polygonal and time. Polygonal rate is assessed by means of the indexes of gully damage: total length, density, gully frequency, gullying (the proportion of gully area to total area), total amount of gullies. The time rate of gully erosion is assessed by means of the following indexes: linear velocity of gully increase, increase in its area, volume, anabranching, the change in total amount of gullies. 2. The index of activisation of gully erosion, as a proportion of the amount of active gullies to the total amount of gullies on a certain territory. 3. The potential of developing of gully erosion, that is maximum numbers of gully erosion rate under the conditions set.

Susceptibility to natural hazards in two peri-urban neighborhoods Yaoundé: case study of Akok-Ndoué and Mvog Betsi

MUJIA FOFACK G.G., TCHINDJANG M.
University of Yaoundé I, YAOUNDE, CAMEROON

Natural hazards affect the entire planet. According to a UNDP report in 2004, nearly 75% of the world's population live in areas which recorded at least once a year a risky phenomenon, and 11% of it fits in low income countries, including Cameroon. In general the risks to the natural environment affect many cities of Cameroon (Bafang landslides in 2008, floods in repetitions in North and Far North Cameroon (Benue and Maga in 2012) or more specifically, Douala city floods. Yaoundé is particularly exposed to these risks because of it physical environment and socio-economic factors. Excessive urban growth recorded for more than three decades, is reflected in the spatial plan by humanization of the suburban area of the city mountains with steep slopes on which are piled without management plan, poorest urban population.

What is the effect different degrees exposure of these two peri-urban quarters to floods and landslides? This study aims at the mapping of landslides and floods, thus highlighting the degree of vulnerability to these risks in neighborhoods Akok-Ndoué and Mvog Betsi areas. It will achieve Prevention and Management Risk Plan (PMRP) that can reduce and minimize the level of corporal and structural damage. Choosing the Susceptibility risk approach from Malet et al, 2006, it built a map of the total risk taking in consideration several parameters: slope map after the topographic map of Yaoundé 1/10 000, soil, land occupation, infrastructure by diachronic treatment of satellite images and the population density. Finally, we crossed the results obtained above to get a total risk map with different degrees of exposure of different areas of these two districts. It appears from this study that the different sectors of the peri-urban area of Akok-Ndoué and Mvog Betsi (South-West of Yaoundé) are exposed differently to natural hazards according to the different parameters considered.

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Characterization of natural hazards in peri-urban areas: the case of Mont Febe (Yaoundé)

VOUNDI E., TCHINDJANG M.
University of Yaoundé I, YAOUNDE, CAMEROON

The consequences of natural hazards concerned. The occurrence of disasters to heavy balances raised the problem of security for the population. The floods in West and Central of August 2012 Africa attest to their vulnerability. The city of Yaoundé is not immune to these crises. At the Mont Febe, the loss of 3 lives following a landslide on May 15, 2012 proves it.In fact; sprawl of cities raises the problem of the fragility of the natural environment. In Cameroon, approximately 52% of the population lives in the city with more than 2 million to Yaounde.This study aims to show how the conditions of the natural environment of the Mont Febe; Yaoundé anarchic urbanization and human activities, fit together to make vulnerable residents. The vulnerability assessment is based on a systemic approach that proceeds by steps and field surveys. After making a map of the slopes from the topographic map of Yaoundé, we made a map of deforestation of the slopes, then the soil map. From a Google earth image, found the map of land cover, and have superimposed across to make the map of susceptibility that, combined to the FTAA we informed on the problem of landslides on this site. Human surveys provide information on the history of risk in the sector and the perception of the populations of these phenomena.It is clear that the Mont Febe, heavy precipitation; steep slopes where human activities leave pockets of deforestation; shallow soil; disregard of hazard and the laxity of the authorities enable the landslides.To resolve the problem, we have from the map of susceptibility, proposed a plan of development of the site. In a context where human installation usually precedes urban planning, it is urgent to reverse the trend.

Influence of deforestation and reforestation to landslide occurrences in the granite region－Case in Mt. Ichifusa area, in central Kyusyu, Japan－

MURAKAMI W., DAIMARU H.
FFPRI, TSUKUBA, JAPAN

In this research, the relation among the forest management records, the landslide occurrences and the rainstorm records of about 30 years in the past was examined in the granite region. The study area is located on the north side of Mt.Ichifusa that is on the boundary in Kumamoto Prefecture and Miyazaki Prefecture, in the central Kyusyu, Japan. We interpreted aerial photograph and mapped the vegetation change and the landslides (location of occurrence and area) in 1969, 1976, 1980, 1985, 1990, 1995, 1999, and 2005. And the normalized Soil water Index was calculated from the rainfall record for the period.

Extensive deforestation had begun since around1967, and the forest in the site of about 70 % on the study area had been deforested by 1976. Landslides occurred frequently after the deforestation, such as during periods of 1976-1980, 1980-1985, and 1990-1995. In these periods, many landslides occurred in the deforest area, while few landslides occurred in the non-deforested area. Moreover, in the site that had been afforested after the deforestation, the tendency for the occurrence of the landslides to be suppressed was shown. In the order the normalized Soil water Index, the rainfall during the period that the landslides occurred entered the high rank, however, too much a lot. Therefore, it was suggested that the landslides had occurred by small rainfall relatively, since the deforestation.

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A genetic typology of glacial lakes in regard to their hazard potential in the Cordillera Blanca (Peru)

ITURRIZAGA L.
Institute of Geography / University of Goettingen, GOETTINGEN, GERMANY

The presentation focuses on the environmental conditions of the formation of glacier lakes and their distribution in terms of their specific hazard potential in high mountain regions of the tropical Andes. Glacier lakes are one of the most striking landscape elements of the recent global trend of glacier retreat. Glacial lake outbursts have produced multi-stage, high-magnitude geomorphological events with considerable damage for settlements and their infrastructure located down- and upstream of the glacier lakes. Since the mid of the 20th century in the Tropical Andes proglacial lakes have formed exponentially, generally dammed by Holocene (Neoglacial / Little Ice Ages) morainic arcs. They may attain a size in the range of about several kilometres in length and a volume of up to about 100 Mio. m³. The Cordillera Blanca shows in comparison with other mountain regions extremely homogenous topographical and climatic conditions and therefore a rather systematic distribution of the lakes in their hypsometric and central-peripheral arrangement. A genetic classification of glacier lake types will be presented for the Cordillera Blanca. The environmental conditions of their formation will be discussed as a function of topographical, climatic and sedimentary influences. Glacier recession may be connected with lake formation, but only certain glaciers are prone to the formation of glacial lakes. Apart from the eye-catching and well recognizable proglacial lakes on satellite images, the more “invisible” glacial lakes and other water reservoirs, may pose a latent thread. Their prediction and the technical capabilities of their hazard management are rather limited. The investigations have been financed by the Alexander von Humboldt-Foundation.

Iturrizaga, L. (2011): Glacier lake outburst floods. In: Singh, V.P., Singh, P., Haritashya, U.K. (Eds.), Encyclopedia of Snow, Ice and Glaciers, Springer, 381-399.

Demarcation of landslide risk in highland of Sri Lanka using geomorphological setting, environmental and climatic conditions

WICKRAMASOORIYA A.
South Eastern University of Sri Lanka, SAMMANTHURAI, SRI LANKA

Highland which has an altitude greater than 1200 m is the highest peneplain out of there peneplains in Sri Lanka. Topography and the climatic conditions of this region vary with place to place. There are different geomorphologic features such as very steep slopes, scarp slopes, valleys; etc can be observed in this region. Highland gets the highest rainfall during Southwest monsoons from May to September and during inter-monsoon period from March to April. Although the average annual rainfall of the area varies from 2700 mm to 4200 mm, occasionally at certain places on the Southwest slope record more than 5000 mm. Because of its geomorphological features and recording heavy rainfall during many months of the year, highland has been experiencing severe landslides and floods during last two to three decades. With experiencing such events, many environmental and socioeconomic issues arise in this region. Proper monitoring methods have to be implemented to minimize the impacts created by landslides and floods. Landslide risk areas have to be identified prior to monitor them. Therefore, this study is focus on demarcating the landslide risky areas in the highlands. Five main parameters influence on landslides i.e slope, rainfall, soil type, landuse pattern and population density of the area were considered to demarcate landslide risk areas. Arc GIS software has used to produce five different thematic layers for above parameters. Using Principal Component Analysis method, different weightages (W_i) were assigned for these parameters based on the degree of their influence on creating landslide risk. Different Ranks (R_i) were introduced for different conditions of each parameter based on their effect on creating landslides. Landslide Risk Index (LRI) was introduced based on weightages and ranks. Finally, landslide risk map was prepared based on Landslide Risk Index using Erdas Imagine software. According to the map, 15% of the study area has very high landslide risk.

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High- and low-frequency morphodynamic events and natural risks in mountain catchments of the semi-arid Brazilian 'Nordeste': Crato (Ceará)

DE OLIVEIRA MAGALHEES A.(1), PEULVAST J.P.(2), BETARD F.(3)
(1) Université Paris-Diderot Paris 7, PARIS, FRANCE ; (2) Université Paris-Sorbonne, PARIS, FRANCE ; (3) Université Paris-Diderot Paris 7, PARIS, FRANCE

Usually known as prone to severe droughts, the inner Northeast Brazil(“sertão”) is still hardly considered as an area of hazards and risks related to violent geodynamic events. However, such past or present phenomenaare now recognized in a few humid mountains exposed to the trade-winds, such as the eastern “Chapada do Araripe”, a high tabular sandstone plateau (900-1000 m) located at the border between the Ceará and Pernambuco states. Here, a 400-500 m high cuesta-like scarp covered by a dense forest overlooks drier dissected lowlands. The city of Crato (110,000 inhabitants) is built along one of its short rivers, the Rio Grangeiro, 4 km from the rim. Whereas existing works only bear on current dynamics, flash-floods, gullying, and small-scale mass movements, we consider a wider range of phenomena. So far, only the violent floods that periodically occur along the Grangeiro River have been taken into account in urban management, with the construction of a 2 km long concrete canal through the city. According to our analysis of climate-hydrological data over the last decade, big floods aggravated by this inadequate canalization have devastated the centre almost every year. Our study of landforms and deposits in the city and upstream also evidences largely distributed marks of past large-scale debris flows and landslides, showing that recurrent gravitational dynamics are usual processes in scarp evolution. Since such phenomena induced by favourable climatic and geological factors still might occur in a now densely populated area, and since some of them were catastrophic, they must be included in the list of natural hazards and risks, in spite of their absence in historical records and of the current lack of chronological data. Our results justify further integrated studies of the past and current conditions of occurrence of both high frequency-low magnitude, and low frequency-extreme events identified through short-and long-terms records.

Stability monitoring of high Alpine infrastructure by terrestrial laserscanning

RAVANEL L.(1), DELINE P.(1), LAMBIEL C.(2)
(1) EDYTEM, LE BOURGET DU LAC, FRANCE ; (2) Institut de géographie et durabilité - Université de Lausanne, LAUSANNE, SWITZERLAND

Rock mass movements are dominant in the morphodynamics of high Alpine rock slopes and are at the origin of significant risks for people who attend these areas and for infrastructures that are built on (e.g. mountain huts, cable cars). These risks are increasing because of permafrost degradation and glacier retreat as consequences of the global warming. These two associated factors may affect slope stability by changing mechanical properties of the interstitial ice and modifying the mechanical constraints in these rock slopes. The monitoring of rock slopes is thus an essential element for risk management.

Our study focuses on two particularly active areas of the Western Alps:

- The *lower Arête des Cosmiques* (3613 m a.s.l., Mont Blanc massif, France) on which is located the very popular Refuge des Cosmiques. Since 1998, when a rockfall threatened a part of the refuge, observations allowed to identify 10 detachments (20 $m^3$to > 1000 m^3), especially on the SE face of the ridge. Since 2009, this face is yearly surveyed by terrestrial laserscanning to obtain high-resolution 3D models. Their diachronic comparison shows eight rock detachments (0.7 $m^3$to 256.2 m^3) between 2009 and 2011.
- The *Coldes Gentianes* (2894 m a.s.l., Valais, Switzerland) where is located a triple cable car station. Since the early 1980s the moraine is unstable: its inner slope has retreated for several meters. Since 2007, the moraine is monitored by terrestrial laserscanning: 8 campaigns were conducted between July 2007 and October 2011. The comparison of the high resolution 3D models obtained allowed the detection and quantification of mass movements that have affected the moraine over this period. During the survey period, 7 landslides involved a volume between 87 and 1138 m^3.

Discussed on the base of geophysical and glaciological data, those evolutions probably result from the combination between permafrost activity/degradation and glacier shrinkage.

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The Soil Conservation Service Method (SCS) applied to hydrological modeling: a contribution for urban flooding studies

MORAES I., CONCEIÇÃO F., CUNHA C., MORUZZI R.
UNESP, RIO CLARO, BRAZIL

Brazil is one of the countries most affected by flooding in the world, with more than 18 million people have been affected since 1960. The mainly reason for this problem is the urbanization process, which starts with the removal of vegetation, buildings in the flood plains areas, hillsides' waterproofing and channeling of rivers. The consequences are reduced rates of infiltration and floods. Thus, this work describes the evaluation of land use changes and its interference in urban flooding in the Servidão Creek, Rio Claro, São Paulo State, Brazil. The land use of this watershed was mapped for the scenarios, i.e. 1958, 1972 and 2006. The Soil Conservation Service method - SCS (United States Department of Agriculture) was used, which suggested an empirical model for runoff estimating by the curve number – CN. The CN estimative is based on hydrologic soil group, land use, and initial soil humidity. The CN values can range from 0 to 100. Higher CN indicates a higher runoff potentialand lower CN indicates higher water retention in the soil. The free software IPHS1 was used to get hydrographs whose parameters were: 1 hour of rainfall and Recurrence Time of 50 years. The predominant hydrological soil group was the class C - with a clay mass lower than 40% and without impediment in the subsurface. The results indicated an increase of impermeable areas and output flow values of 32m^3/s in 1958, 43m^3/s in 1972 and 53m^3/s in 2006, due to the growth of Rio Claro city,which was responsible for the first event of urban flooding in the early 1970s. In 2006, an overflow on the street has occurred in the downstream sector, with values of output flow close to 20 m^3/s. The government has been doing some engineering works and transferring most of the urban flooding in areas near the mouth, where today the floods do not occur. Thus, the hydrologic modeling to evaluate the urban flooding in the Servidão Stream was efficient and can be used inurban drainage planning.

Geomorphological hazards in the Tucuman Province, Northwestern Argentina

COLLANTES M.
Institute of Geosciences and Environment, National University of Tucuman, SAN MIGUEL DE TUCUMAN, ARGENTINA

The territory of the Tucumán province, lying between two large morphostructural regions of Argentina, the eastern Chaco plains and western Pre-Andean mountain. Its geomorphological development presents a marked contrast between the eastern plain, the piedmont, mountainous areas and intermountain valleys. Such contrasts also manifest in climate characteristics, occupation of land and the distribution of the population, confirming the interrelationship between physical and human components of the landscape. They join them, high soil fragility, which together with unrestricted and uncontrolled land use, determine the severe environmental deterioration box affecting the region, intensifying geomorphological hazards.

In the eastern plain, the influence of soft and long flattened surfaces, loessic soils, sub-humid to semi-arid climatic conditions and lack of conservation management, determine a severe water erosion risk, especially in deforested land. In the foothills, the most slopes and subtropical climate (rainfall seasonal contrasts) increase the landslides hazard and debris flows being generated. It also intensifies the risk of flooding due to seasonal and multi-year rainfall variability and water imbalance promoted by human actions. In the mountainous areas, mass movements are more intense, characterized by landslides on slopes covered by subtropical forest and topples and falls on those without coverage. Seasonally, is possible the generation of catastrophic debris flows during rains with high intensity and short duration. In the intermountain valleys with permanent or temporary hydric deficit the desertification risk is intensified with water and wind erosion and salinization.

As such,in this paper, are described and mapped in each relief unit, the intensity and extent of the main morphodynamic hazards affecting the territory of the province: soil erosion, landslide, flood, salinization and desertification hazard.

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Environmental risks in the Coast: comparative study Brazil-Portugal

MEDEIROS W.D.A., CUNHA L., ALMEIDA A.C.
Universidade de Coimbra - CEGOT, COIMBRA, PORTUGAL

The present study relates the environmental risks in the Coast trough a comparative boarding between towns of the Figueira da Foz (Center of Portugal) and Areia Branca (Northeastern Brazil). The aim was the identification and assessment of environmental risks in an appliance context of territorial planning and management. The methods of study were based on empirical observations in land, contacts with the populations of study areas about the environmental risks and interpretation of satellite images. Most of the identified risks are present in both territories; however their magnitudes and expressions are different. According to the study, it is evident that Areia Branca city shows a better scenario in relation to the environmental risks, probably due to a low occupation throughout the Coast. Nevertheless, as the local tourism is growing, the local coast environment needs must be considered by the occupation planning because it points out some instability. Thus, it is still possible to minimize the future problems reducing the vulnerabilities due to the existing risks. The coast dynamics of Figueira da Foz acts as an important environmental risk specially the South of Mondego's estuary, because its consolidated occupation has been threatened by the coastal retreat, demanding urgent solutions to mitigate local risks and vulnerabilities; the mobility of the population, for example, may be seen as a solution which obliges to a different territorial organization.

Predictive value of the geographical distribution of shrines undamaged by the 2011 Tohoku earthquake and tsunami: Identifying previous maximum disaster ranges from the distribution

UCHIYAMA S., SUZUKI H., HOTTA Y.
National Research Institute for Earth Science and Disaster Prevention, TSUKUBA, JAPAN

Japan's shrines, which are familiar historical heritage sites, exist in regions with a long history of past natural disasters. We identified the shrines that escaped damage from the 2011 Tohoku earthquake and tsunami and compared these sites with areas previously by affected tsunamis. Considering the shrines' location as being indicative of accumulated tsunami disaster experience, we clarified the distribution of their placement. If the previous maximum disaster range is deducible from the geographical distribution of Japan's numerous surviving shrines, this information can be useful for assessing future disasters. The massive earthquake that caused the 2011 tsunami is assumed to be an earthquake of a scale that occurs once in 500 to 1000 years. In this tsunami-stricken area, many shrines with at least 300 years of history, and some with 1000 years (thus having survived previous tsunamis), suffered no direct damage. Therefore, we assume that shrines' location reflects disaster experiences of inhabitants over a period of centuries. We investigated the damage to shrines on the Pacific coast from the Tohoku district's northern region to the Kanto district's eastern region, roughly 800 km that suffered tsunami damage. We conducted a field survey of the shrines near the boundary of the tsunami flood area. Results indicate that shrines adjacent to a tsunami flood area have tended to escape damage, suggesting that shrines are placed in an area's historically safest places. Furthermore, examples of undamaged shrines exist even in low-lying areas. Thus, our findings suggest that previous inhabitants, who built these shrines at safe points identifies after the occurrence of tsunamis, applied their experience of the local geography's effect on decreasing the reach of tsunamis; thus, the shrines' placement can be useful in future disaster planning.

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Dendrochronological dating of debris flow activity in the Minya Konka massif (Sichuan, China)

OWCZAREK P.(1), MALIK I.(2), TIE Y.(3)
(1) University of Wroclaw, Institute of Geography and Regional Development, WROCLAW, POLAND ; (2) University of Silesia, Faculty of Earth Sciences, SOSNOWIEC, POLAND ; (3) Chengdu Center of China Geological Survey, CHENGDU, CHINA

Debris flows are one of the most common processes in the high-mountain areas. Dating of the frequency of these processes in the past is very important, especially in the areas with high population density. Surviving trees and shrubs react to debris flows by abrupt growth reduction. The rock particles often injure the stems. Tilted trees growing in marginal zones of debris flow tracks develop eccentric growth-ring patterns with reaction wood. These signals are very useful to reconstruction past geomorphic events. The aim of this study is to use dendrochronological methods to date debris flow activity in high-mountain areas. The study was carried out in the Daxue Mountains which are adjacent to the eastern edge of the Tibetan Plateau (Western Sichuan province, China). The detailed research site was located at the foot of the Mt. Minya Konka (7,556 m a.s.l.) in the Moxi Basin. This area is inhabited by about 4,000 people and tourists number is increasing rapidly. A combination of several factors, such large amounts of loose moraine material, high precipitations and steep slopes, affects the high risk of catastrophic geomorphic events. 49 debris flow gullies were identified in the research site. Most of the debris flows initiate at high elevation (2000-4500 m). Three of them were chosen to dendrochronological analysis. Total 200 cores and wood pieces were collected from trees (*Abies fabri, Alnus glutinosa, Rhododendron*) growing in marginal zones of the debris flows (gullies and accumulation lobes). Dating scars and abrupt growth reduction showed that small geomorphic events occur every year in the gullies. Large debris flow occur every 10-15 years (e.g. beginning of 80's, 1994-1996, 2005). Using dendrochronological methods is limited by the age of trees growing on the bottoms of the debris flow tracks (150-180 years). These trees often prevent areas located below (e.g. inhabited alluvial fans) and capture large part of the rock particles transported by debris flows.

Climatic trend in Central Calabria (Italy) during the last 100 years

VELLA S.
Sapienza University of Rome, ROMA, ITALY

The aim of this work is to reconstruct the climatic trends of the study area in relation with the morphologic features of the landscape. The study area corresponds to the central part of Calabria region in Italy, where the distance between the Tyrrhenian Sea and the Ionian Sea is only 30 km.

The data set refers to 72 station records, with 2,100,000 daily precipitation and temperature observations for the period 1916–2011. The analysis describes the seasonal and annual distribution of rainfalls, as well as its intensity during the period under study. Statistical methods have been used to estimate the parameters of extreme values distributions and of the return periods. Moreover, data have been analyzed using the spectral decomposition of the overall climatic variability in order to identify possible stochastic trends, seasonality and short-term cycles. In our approach we consider both deterministic and stochastic components in the data set and we use stationarity tests in order to check for possible unit roots in the processes.

Both slopes show similar trend of rainfall decrease in spite of their different climatic conditions depending on the different slope attitudes. As a consequence erosive processes affecting both the drainage basins and beaches are different on the two differently oriented slopes.

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Validating an indicator-based vulnerability assessment methodology for debris flow hazards

PAPATHOMA-KOEHLE M.
Department of Geography and Regional Research, University of Vienna, VIENNA, AUSTRIA

Geomorphic hazards such as debris flows often threaten built-up areas in mountain regions. Physical vulnerability assessment as part of the risk analysis is very important for the development of strategies and structural measures for risk reduction. Physical vulnerability is often presented as a function of the intensity of the process and the degree of loss (vulnerability or fragility curves). These curves are often building type specific and do not consider other characteristics of the buildings that also influence their physical vulnerability. However, a considerable amount of studies argue that vulnerability assessment should focus on the identification of these variables that influence the vulnerability of an element at risk (vulnerability indicators). In this study, an indicator-based vulnerability assessment methodology for mountain hazards including debris flow (Kappes et al., 2012) is being validated. The methodology considers a number of indicators for different types of alpine hazards that are connected to the physical vulnerability of buildings located in hazardous areas. By using damage data and photographic documentation from a debris flow event in the valley of Martell, South Tyrol, Italy, the weighting of the indicators as well as their overall significance in the physical vulnerability of buildings threatened by debris flow will be validated. The photographic documentation of individual buildings provides the necessary information on the physical vulnerability indicators but also on the intensity of the process. Information on the actual monetary damage completes the required data set for the validation of the methodology. The study shows clearly that nearly all the indicators are relevant, however in some cases some indicators may be less important as initially expected.

Kappes M., Papathoma-Köhle M., Keiler M., 2012. Assessing physical vulnerability for multi hazards using an indicator-based methodology. Applied Geography, 32, 2, 577-590.

Spatial and temporal patterns of landslide risk - a case study in Lower Austria

PROMPER C., GASSNER C., GLADE T.
University of Vienna, VIENNA, AUSTRIA

The spatial distribution of future landslide risk will be influenced by several dynamic factors related to global change such as variance in distribution of elements at risk or changes in precipitation patterns. The assessment of future spatial distribution of landslide risk is essential for efficient and sustainable risk management and for the development of adequate adaptation strategies to global change.

The objective of this study is to approximate landslide risk for the two future periods 2030 - 2050 and 2070 - 2100 considering the potential development of land cover and climate change scenarios. In order to link the future potential developments to current conditions and past changes, an analysis of former land use changes is also performed. This leads to a total analysis period of more than 100 years. The collection of the different datasets is based on various methods like remote sensing, field mapping and modelling. The land use is modelled with cellular automata and the climate models are statistically downscaled to 1x1km grids from global models with supplemental input of regional models. These data are part of the susceptibility mapping using logistic regression methods.

The study area is the district of Waidhofen/Ybbs in Lower Austria, Austria. It comprises about 130km^2, thus a regional assessment is required. Within the study area a variety of land use types can be observed such as densely and scarcely populated areas, agricultural areas and forests. The future climate is characterized by dry summers with higher frequency of heavy rainfall events and average wet winters.

The visualization of these landslide risk scenarios can significantly contribute to the awareness of eventual problems that need to be faced in the future. Consequently, the results might contribute to the improvement of future adaption and management strategies.

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Alluvial fan flooding hazard in Southern Apennines: the state of knowledge

SANTANGELO N.(1), DI CRESCENZO G.(2), ROMANO P.(1), SANTO A.(2), SCORPIO V.(1)
(1) Department of Earth Sciences University of Naples Federico II, NAPOLI, ITALY ; (2) Department of Hydraulic, Geotechnical and Environmental Engineering, Applied Geology Division, University of Naples Federico II, NAPOLI, ITALY

The term “alluvial fan flooding” was introduced to indicate a type of flood hazard that occurs only on alluvial fans: flooding on alluvial fans differs from most riverine flooding in that the hazard not only stems from the inundation itself, but is also intimately connected with the possibility of various sedimentation processes occurring. Along the Southern Apennines, piedmont areas made up by coalescent alluvial fans are a widespread geomorphic unit and are generally located at the foot of steep slopes bordering the main carbonate massifs of the region. The alluvial fans are fed by drainage basins with high relief energy which belong to the category of small catchments. In these basins runoff is generally low, occurring mainly during the most heavy rainfall periods. During the last few centuries until now, many of these basin/fan systems have been affected by severe flooding that has produced serious damage and loss of life. Cause to the relatively long time lags between floods and the consequent loss of historical memory, development of urban areas in recent decades has not taken into account the presence of alluvial fans. This great urban expansion makes the problem of defining flooding susceptibility increasingly urgent. Our studies faced the problem both at regional and at a local scale. Recognition of the most critical situations at a regional scale was based on morphometric analysis allowing the evaluation of the susceptibility conditions among different basin/fan systems, discriminating them in terms of the prevailing transport process (debris flow vs. water flood dominated). At local scale we focused our attention on extensively urbanized alluvial fans, trying to check the real hazard conditions. The reconstructed flooding scenarios, showing the fan portions potentially affected by different alluvial processes, may represent a useful tool for subsequent studies aimed at land hazard and risk mapping.

Urban flood hazard assessment model using multi-criteria analysis: the case of Kifissos River (Athens, Greece)

GAKI-PAPANASTASSIOU K.(1), BATHRELLOS G.(1), KARYMBALIS E.(2), SKILODIMOU H.(1)
(1) UNIVERSITY OF ATHENS, ATHENS, GREECE ; (2) HAROKOPEIO UNIVERSITY, ATHENS, GREECE

Flood events have often occurred in the metropolitan urban area of Athens, capital of Greece,causing the loss of property and in many cases human lives. In this study a flood hazard assessment model for urban areas is examined. The Kifissos River flowing through the plain of Athens was the case study of the present work.The length of the main Kifissos channel is 33.7Km, flows from NNE to SSW and discharges into Saronic Gulf. Its drainage basin has an area of 374.6Km^2.

The plain of Athens has been extremely urbanized during the last seventy years. As a result the nature environment has been changed dramatically and has caused several catastrophic phenomena, such as floods.

The major factors affecting urban floods were evaluated. For this purpose the lithology, geomorphological factors such as slope, elevation, hydrographic network along with anthropogenic factors like urban land uses, changes of natural and urban environment were used. Comparative observations of the urban areas from 1878 to 2012 led to the mapping of the environmental changes caused by urban expansion. Recognition and mapping of these alterations was achieved using the first topographic maps of Attica, drawn by Curtious and von Kaupert (1878-1894). In this time period urban fabric area has increased from 3.1% to 60% of the total drainage basin area. Furthermore,the total length of the Kifissos River drainage network consisted of open channel streams as well as totally covered streams were estimated and considered.

A multi-criteria analysis was applied to evaluate these factors, leading to the corresponding urban flood hazard assessment map. The resultant map classified the land surface of the study area according to the degree of actual or potential flood hazard. The major flood events that occurred within the broader area of the plain of Athens were used for the validation of the flood hazardassessment results.

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Recent evolution of the Tiber River delta and future scenarios of coastal vulnerability

TARRAGONI C., BELLOTTI P., DAVOLI L., LUPIA PALMIERI E.
Sapienza University of Rome, ROME, ITALY

Many studies that integrate morphological, stratigraphic, sedimentological and geoarchaeological data, allowed the reconstruction of the Tiber River delta evolution during the Late Pleistocene-Holocene. The post-glacial sea level rise was the main controlling factor of delta changes until ca. 6 ka BP. Afterwards, when the modern sea-level highstand was attained, autocyclic processes prevailed during the last 5-6 ka while in the last 2 ka man activity became more and more important. We used detailed reconstructions of the past history, that reflects hydrodynamic and geomorphologic changes affecting the coastal dynamics, to delineate future scenarios and address predictive searches for the near-future, according to SLR projections and estimated sediment input. These results along with new data, deriving from the ongoing SECOA (Solutions for Environmental contrasts in Coastal Areas) European Project, allowed the evaluation of the coastal vulnerability index (CVI) relevant to storm waves in the area of the Tiber delta (from Fiumicino to Castelporziano). The variables; used to define the CVI assessment are of two different types: the “morphometric” variables, ranked on the basis of present-day measurement (i.e. beach mean elevation) and the “morphodynamic” variable, parameterized according to their changes in time (i.e. changes in the upper shoreface slope). Among the morphometric variables we also included anthropic structures that decrease the natural vulnerability. The CVI was calculated by using a multiple regression equation, in which each variable is scaled by an efficacy coefficient. The methodology was applied both to the short-term and long-term interval (up to 2100). With reference to the latter, we considered the impact of relative sea level rise according to the IPCC (4R, 2007) and Rahmstorf hypotheses (2007).

Key world: Coatal vulnerability, Tiber River, Central Italy, coastal geomorphology

Lake Nyos, a multirisk and vulnerability appraisal

TCHINDJANG M., KAH FANG E.
University of Yaoundé I, YAOUNDE, CAMEROON

Lake Nyos, a crater lake of about 1.5km2 of surface area is located in Menchum Division of the North West Region of Cameroon. It lies along the Cameroon Volcanic Line which stretches from the Atlantic Ocean to the Adamawa plateau taking a SW-NE orientation. Its formation dates back to the quaternary era through a volcanic eruption.

In August 1986, this lake released volumes of carbon dioxide (CO2) that spread across its immediate surroundings killing about 1700 people and much of fauna (wildlife, cattle, goats, sheep, birds etc). The occurrence of this gas explosion attracted a lot of attention especially from the international scientific community who developed a number of hypotheses to be investigated upon. But these seemed insufficient as they were still to settle with a similar occurrence two years before in Lake Monoun which killed 37. After the Lake Nyos catastrophe, those who survived were moved to a new sites and till today, they still express their desire to return to their former villages (Nyos, Tcha and Subum). This study therefore falls within the framework of characterizing the different risk of the Lake Nyos area in order to assess the vulnerability and degree of exposure to different types of risks (volcanic, landslide, floods) that might occur. This will then enable to authorities to relocate the plaguing survivors who are not comfortable in their present sites.

Using satellite images (radar and optical treated with ENVI software) as base data for the mapping and characterization of the landscape as well as empirical methods in data acquisition, the zoning extent of risk have be determined as well as the modeling of the floods trajectory within the area and it surrounding.

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Analyze of shallow-landslide risk and susceptibility in São Paulo city, Brazil

DE LUIZ ROSITO LISTO F.(1), VIEIRA B.C.(2)
(1) University of Sao Paulo, SAO PAULO, BRAZIL ; (2) University of Sao Paulo, SAO PAULO, BRAZIL

In the São Paulo city, where about 11 million inhabitants live, landslides occur frequently, especially during the summer, causing the destruction of houses and urban equipment, economic damage, and the loss of lives. The number of areas threatened by landslides has been increasing each year. The objective of this article is to analyze the probability of risk and susceptibility to shallow landslides in the Limoeiro River basin, which is located at the head of the Aricanduva River basin, one of the main hydrographic basins in the São Paulo city. To map areas of risk, we created a cadastral survey form to evaluate landslide risk in the field. Risk was categorized into four levels based on natural and anthropogenic factors: R1 (low risk), R2 (average risk), R3 (high risk), and R4 (very high risk). To analyze susceptibility to shallow landslides, we used the SHALSTAB (Shallow Landsliding Stability) mathematical model and calculated the Distribution Frequency (DF) of the susceptibility classes for the entire basin. Finally, we performed a joint analysis of the average Risk Concentration (RC) and Risk Potential (RP). We mapped 16 risk sectors containing approximately 1872 at-risk homes and more than half of which presented a very high (R4) probability of risk to the population. In the susceptibility map, 41% of the area was classified as stable and 20% as unconditionally unstable. Although the latter category accounted a smaller proportion of the total area, it contained a concentration (RC) of 40% of the mapped risk areas with a risk potential (RP) of 12%. We found that the locations of areas predicted to be unstable by the model coincided with the risk areas mapped in the field. This combination of methods can be applied to evaluate the risk of shallow landslides in densely populated areas and can assist public managers in defining areas that are unstable and inappropriate for occupation.

Research on the lithology response on the rock falls in the earthquake in the downstream of Yuzixi River, Sichuan, China

XIE H.(1), YU B.(2)
(1) Chengdu Institute of Mountain Hazards and Environment, CHENGDU, CHINA ; (2) Chengdu University of Technology, CHENGDU, CHINA

The Wenchuan Earthquake occurred in the Longmen mountain fault belt with a magnitude Ms 8.0 on the Richter scale on May 12, 2008. Numerous landslides and rock falls were triggered in the earthquake-affected area. Abundant co-seismic rock falls were located in the downstream of Yuzixi River, which is a branch of Minjiang River and near the epicenter. There were 99 rock falls triggered by earthquake along the 46-km river valley. The density of rock falls was 2.15 per km.

The lithology response on the rock falls in the earthquake is different in different lithology area. The exposures of lithology in the downstream of research area (about 20 km in length) are hard rock, such as the gabbro, diorite, and quartz diorite. The topographic characteristic of this area is canon geomorphology with steep hill slope. There were 80 rock falls triggered by earthquake, and the density of rock falls was 4.0 per km. The exposures of lithology in the upstream of research area (about 26 km in length) are soft rock, such as the phyllite, quartz schist, phyllite interlated with marble, quartzite sandstone, siltstone, marl, slate, and the deposits of Quaternary. The topographic characteristic of this area is river valley geomorphology with gentle hill slope. There were only 19 rock falls triggered by earthquake, and the density of rock falls was only 0.73 per km.

The conclusions are obtained by this research: (1) the hard rock slope is sensitively broken in the earthquake, and form large scale rock falls; it is active response in earthquake; (2) the soft rock slope is broken in some part in the earthquake, and form small scale rock falls; it is weakly active response in earthquake; (3) the slipped landslide is inactive response in earthquake and stability because the energy was released before earthquake.

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Disaster management of regional disasters occured on 9 July 2012 in Samsun City, (North Turkey)

ERSAN A., ÇOSKUNLU E., UÇARLI L., AYSU Y., ÇALISKAN K., TEKIN E., KOPARMAL E.
PROVINCIAL DISASTER AND EMERGENCY MANAGEMENT, SAMSUN, TURKEY

In this study, disaster management of regional disasters caused by heavy rain on July 9th, 2012 in Ayvacık, Çarşamba, Salıpazarı, and Terme districts of Samsun city was reviewed. Operation was carried out by crisis desk established in Governorship of Samsun Crisis Center.

According to the last forecast by the Regional Meteorological Centre of Samsun, it was warned about heavy rain for the eastern districts of Samsun city on the evening of 9 July, 2012. And the search-rescue squads were ready in various areas. Moreover, in crisis desk, digital map of the region for notices and decisions was opened to use, and a real-time meteorological maps created by satellite images for variation of rain were followed minute-by-minute.

With a total number of 70 workers, 12 vehicles, and 2 rescue boats, alarmed AFAD (Disaster and Emergency) teams in the cities such as Samsun, Sivas, Yozgat, Ankara, as well as UMKE (National Medical Rescue Team) in Samsun were sent to the region because of 16 notices that come to News Center from the districts of Ayvacık, Çarşamba, Salıpazarı, and Terme. These notices included subject of flood, overflow, floodbound, and landslide. Additionally, in order to ensure traffic security, Samsun-Ordu highway was closed up for a period of 30 minutes, and 2 rescue helicopters, provided by the Coast Guard Command, were flown to the region.

Heavy rain having started at 7:30 P.M. was decreasingly ended at 10:30 P.M. 1 corpse and 2 injuries were pulled from the landslide wreck in Ayvacık district. Besides, 95 people were transferred to safety zones in four districts.

On 9 July 2012, disaster management of flood and landslide resulted from heavy rain in districts of Ayvacık, Çarşamba, Salıpazarı, and Terme was successfully ended by devoted efforts of the crisis desk. The whole operation and the followed procedures was a correct and reliable sample of coordination, which is worth taking into account for the future disasters.

Society Adaptation for coping with Mountain risks in a global change Context

BERNARDIE S.(1), GRANDJEAN G.(2), PUISSANT A.(3), MALLET J.P.(4), HOUET T.(5), BERGER F.(6), FORT M.(7), PIERRE D.(8)
(1) BRGM, ORL_ANS, FRANCE ; (2) BRGM, ORL?ANS, FRANCE ; (3) LIVE, STRASBOURG, FRANCE ; (4) IPGS, STRASBOURG, FRANCE ; (5) GEODE, TOULOUSE, FRANCE ; (6) IRSTEA, GRENOBLE, FRANCE ; (7) PRODIG, PARIS, FRANCE ; (8) GEO-HYD, OLIVET, FRANCE

The SAMCO project aims to develop a proactive resilience framework enhancing the overall resilience of societies on the impacts of mountain risks. The project aims to elaborate methodological tools to characterize and measure ecosystem and societal resilience from an operative perspective on three mountain representative case studies. To achieve this objective, the methodology is split in several points with (1) the definition of the potential impacts of global environmental changes (climate system, ecosystem e.g. land use, socio-economic system) on landslide hazards, (2) the analysis of these consequences in terms of vulnerability (e.g. changes in the location and characteristics of the impacted areas and level of their perturbation) and (3) the implementation of a methodology for quantitatively investigating and mapping indicators of mountain slope vulnerability exposed to several hazard types, and the development of a GIS-based demonstration platform. The strength and originality of the SAMCO project will be to combine different techniques, methodologies and models (multi-hazard assessment, risk evolution in time, vulnerability functional analysis, and governance strategies) and to gather various interdisciplinary expertises in earth sciences, environmental sciences, and social sciences. The multidisciplinary background of the members could potentially lead to the development of new concepts and emerging strategies for mountain hazard/risk adaptation. Research areas, characterized by a variety of environmental, economical and social settings, are severely affected by landslides, and have experienced significant land use modifications (reforestation, abandonment of traditional agricultural practices) and human interferences (urban expansion, ski resorts construction) over the last century.

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Landslide Susceptibility in the North District of Sikkim, India

DE S.(1), GHOSH G.K.(1), ALCANTARA AYALA I.(2), SENGUPTA A.(3), JOSHI V.(4)
(1) Tripura University, AGARTALA, INDIA ; (2) National Autonomous University of Mexico (UNAM), MEXICO CITY, MEXICO ; (3) Dumkol College, West Bengal, DUMKOL, INDIA ; (4) Indraprastha University, NEW DELHI, INDIA

Landsliding is one of the most frequent hazards taking place in the North district of Sikkim in the Eastern Himalaya. Highly susceptible geological structures, lithology, steep slopes, deforestation, unscientific and unplanned uses of land are the main causative factors for the occurrence of such phenomena, which is further aggravated by heavy and concentrated rainfall and seismicity. In spite of their recurrence, there is a lack of scientific inventories, hazards and risk maps. Therefore, this study aims at preparing a data base landslide inventory and a detailed landslide hazard zonation map, as a contribution for the further development of risk mapping and thus of landslide mitigation and management.
Based on 1963 and 1969 Survey of India topographical maps, images taken in 1997 and 2009 by the LISS III Indian sensor and GPS locations of landslides triggered by the 2011-Sikkim Earthquake, a landslide hazard map has been elaborated. The map was developed based on particular improvements to the methodology elaborated by the Bureau of Indian Standards, which comprises a guideline for using the Landslide Hazard Evaluation Factor (LHEF) rating scheme and total estimated Hazard. A total of nine data layers have been prepared and used for the elaboration of the hazard zonation map.Results indicated that the highest frequency of landslides, 74% occur in the Very High Hazard zone, followed by 9% in the High Hazard zone, 8% in the moderate and 7% and 2% in the Low and Very Low respectively.

An integrated appraisal of flood causes in Xirolaki Torrent, Northen Greece based on geomorphological and meteorological data

TSANAKAS K.(1), GAKI-PAPANASTASSIOU K.(1), MAROUKIAN H.(1), CHALKIAS C.(2), KATSAFADOS P.(2), KALOGEROPOULOS K.(2)
(1) NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS, ATHENS, GREECE ; (2) HAROKOPIO UNIVERSITY, ATHENS, GREECE

In this paper an attempt is made in order to integrally evaluate the natural as well as the human induced factors that cause Xirolaki torrent flash flood events focusing on the analysis of a severe flood event of the torrent which took place on October 25th, 2009. For this purpose we have quantitatively analyzed the geomorphological characteristics of the drainage basin and the drainage network. In addition a numerical simulation was performed using a non-hydrostatic limited area atmospheric model. Geomorphological and atmospheric data were imported into a Geographical Information System in order to estimate the hydrographs throughout the drainage area. The peak discharge, hydrograph, and volume, derived from the analysis of measured hydrographs in a number of non-flood causing rainfall events with operating stage gauge, were used for calibration and verification of the simulated stage-discharge hydrographs. Drainage basin characteristics such as steepness of the relief combined with a relatively short main channel of the drainage network as well as abnormalities in the hierarchical drainage by stream order are the main natural flood causes amplified of course by the intense human interference at the lower part of the drainage network with a series of constructions such as roads inside the main channel and bridges.

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The fortore river mouth: a data processing methodology for quaternary evolution trend interpretation (Puglia Region - Southern Italy)

DI LUDOVICO A., CUCULO F., IZZO M.P., DI NIRO A., SCAPILLATI N.
Molise, ISERNIA, ITALY

A key prerequisite to knowledge of the changes and trends affecting the territory and in particular the surface water bodies is the correct reading and interpretation of forms and the geomorphological processes in place.

The assessment of indirect effects on watercourses by the combined changes in climate and direct human intervention should be a key element in the actions of study and planning of water resources and land.

In particular, this study is to propose a methodology of geomorphological and sedimentological approach to the analysis of the waterways of southern Italy, to assist with the canons and cognitive tools for proper programming of structural assistance and not put outstanding. To this end, the analysis applied to the case of the Fortore River mouth a representative example in that it was possible to establish a sufficiently comprehensive regarding the evolutionary trends that have affected the Fortore, allowing at the same time provide useful information to the discretization and quantization effects due to climate changes and those attributable to direct human impact. From this change is possible to have partial cognizance, even if it refers to a reduced time scale, a comparison of the official map in GIS environment of 1879 produced by the Italian Royal Institute of Military Survey, the mapping Italian Geographic Military Institute of 1957 and the CTR of the Puglia Region in 2008. Fortore River mouth evolutionary trend of the river appears even in the "Proceedings of the Interministerial Commission for the study of hydraulic and soil conservation" of 1974 which states that "*the Fortore river who was a perennial river (at the Norman time was navigable - until the fourteenth century) for the constant flooding has accumulated so many materials removed from the slopes to be forced to re-dug those materials in its course, site very distant from the place of old balance*".

Erosion of slopes and sedimentation in streams due to forest fires Rio Los Puestos basin, Catamarca, Argentina

NIZ A.E., OVIEDO J.A., LAMAS C.A.
NATIONAL UNIVERSITY OF CATAMARCA, SAN FERNANDO DEL VALLE DE CATAMARCA, ARGENTINA

The areais located to the Westof Catamarca (NW Argentina), with a population of 4,525 inhabitants. Farmers usually burn the bushes believing that later they will grow strongly; this practice coincides with the dry season. Temperatures exceed 38° C in the summer; rainfall has a torrential regime and summer winds are from NW reaching 80 km/h. Large forest fires take place when weather conditions are not considered at the start of the bush burning.

The area climate isstrongly semiarid, the vegetation is shrubby-type. Agriculture and livestock are the basis of the economy. In the last decade systematized agricultural activity has increased due tothe high standard agriculture enterprise establishment.

The analysis and digitizing of satellite images were carried out where the fire focuses took place. The partial area and the total area affected by fires in the last five years were measured; the maps of surface hydrology, of slopes and of reservoir affected by degradation in the upper basin were performed.

Panoramic images ofthe most representative areas affected by fires were analyzed, in order to determine the vulnerability of the slopes in front ofthe influence of the erosive agents and the response to the impact of weather events.

The factors that contribute to land degradation presently and the potential degradation in the medium and long term were characterized, to develop recommendations in order to optimize the preservation of natural resources of thearea and its influencing region.

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The advance of the dunes and your influence in the migration of the human settlements in the village of Medanitos Catamarca - Argentina

NIZ A., OVIEDO J.A., LAMAS C.A.
NATIONAL UNIVERSITY OF CATAMARCA, SAN FERNANDO DEL VALLE DE CATAMARCA, ARGENTINA

The Valley of Fiambala, characterized by a semiarid dry environment, is located to the West of Catamarca, in the Northwest of Argentina. It is part of the extensive territory considered by several world organizations as fragile areas with a desertification tendency.

As a result of centuries of unrestricted and uncontrolled human occupation, even highlighted by a strong demographic expansion in the latest decades, the landscape is nowadays vulnerable in front of the impact of diverse degrading processes that affect these regions.

The deforestation that accompanies the urban settlement, and the expansion of the vineyards, produced surfaces sensitive against the eolic activity. On the one hand, the latter has increased the processes of deflation and transport of sediments, destabilizing the dune system as well as causing the dune advance over houses and farming areas. On the other hand, the described process has eroded the fertile layer of the productive soils, what made the settlers gradually move to areas with better subsistence possibilities.

With the objective to assess and mitigate the impact of the dune movement the urban scheme has been characterized through the multitemporal analysis of aerial photographs. LANDSAT 7 satellite images have been digitized in order to produce the thematic cartography. The dune areas, the advance of dunes over productive zones and the deflation surfaces have been mapped. Finally a proposal of dune attachment using autochthonous vegetation has been designed together with a proposal of future urban development to the government authorities.

Cause and consequences of the Seti River disaster (May 5, 2012) and assessment of a possible early warning system

REGMI D.(1), KARGEL J.S.(2), LEONARD G.(2), THAPA B.(3)
(1) The Himalayan Research Expedition (P) Ltd., KATHMANDU, NEPAL ; (2) Department of Hydrology and Water Resources, University of Arizona, TUCSON, UNITED STATES ; (3) Graduate School of Environmental Earth Science, Hokkaido University, SAPPORO, JAPAN

On 5 May 2012 an outburst flood on the Seti River resulted in the loss of life and property and has left terror that a similar catastrophe could occur at any time in Pokhara. Local people and government agencies were looking for the scientific explanation of some key questions, such as: 1. What was the cause of the Seti river disaster? 2. Is another similar flood likely? 3. What role might imprudent habitation have played in raising the death toll? 4. What other types and magnitudes (e.g., peak flows) of floods are possible in the future? 5. How large a population remains vulnerable? With the objective of answering the above questions, a helicopter-borne survey and ground-based field observations were carried out from November 2012 to April 2013.We have tracked down the likely sequence of events, which, in brief, consisted of a rockslide into a gorge and formation of an impounded lake in the gorge; then a huge rock and ice avalanche off Annapurna IV, which violently swept debris into the impounded lake and caused the rupture of the gorge dam, and thus unleashing of the flood. Increasing habitation along the riverbank and lowest terrace is the biggest cause for continuing concern; minor floods that probably happened before with little impact may now happen again on similar scales and cause devastation and sorrow. The possibility of floods and debris flows larger than the 5 May 2012 event cannot be discounted. A cost-effective warning system must be emplaced; this probably would involve resident involvement and use of modern telecommunications now available to most residents.

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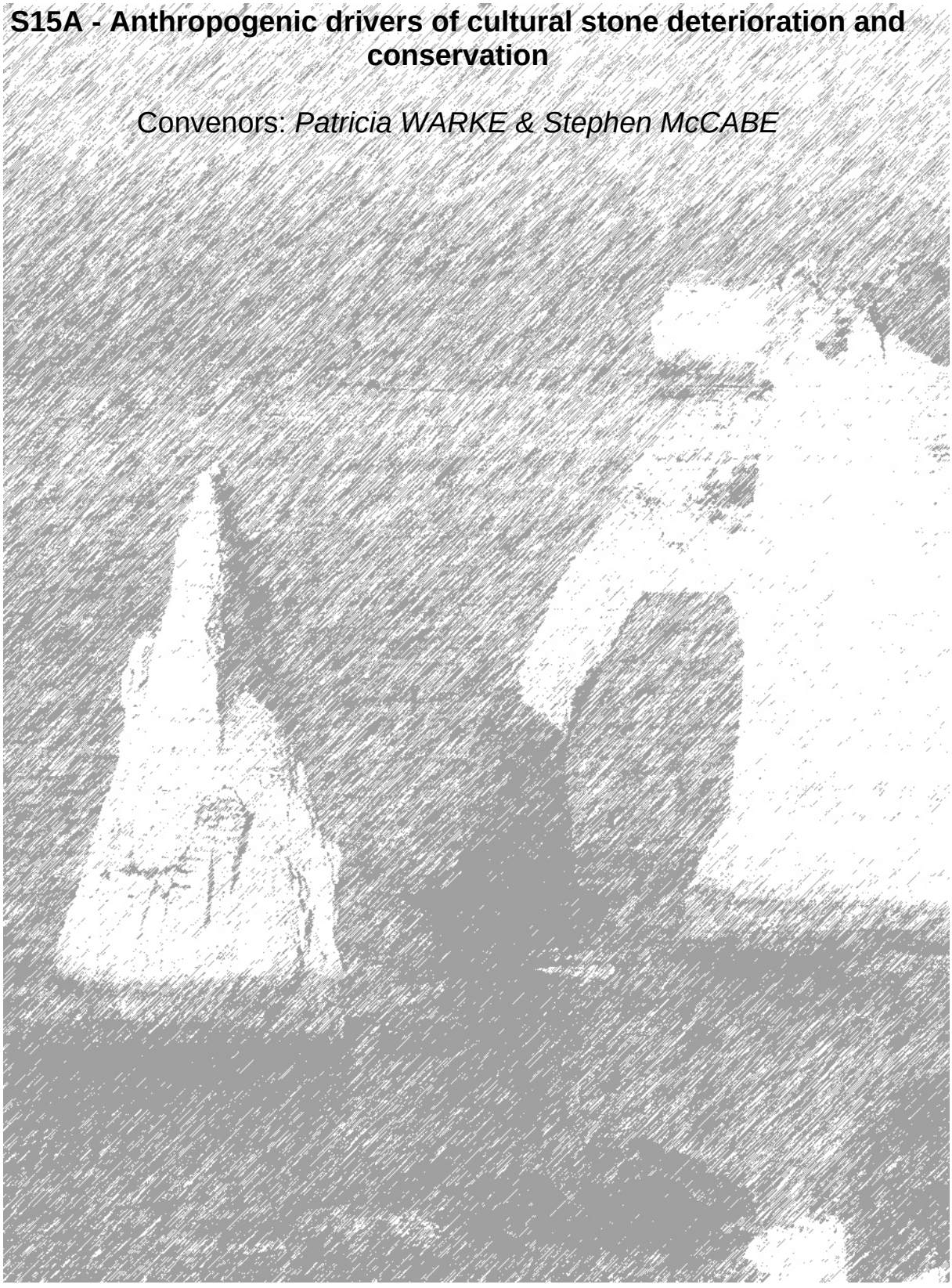
S15A - Anthropogenic drivers of cultural stone deterioration and conservation

Convenors: *Patricia WARKE & Stephen McCABE*



Oral presentations:

Geologic Analysis of Grenada's Carib Stones and Implications for Future Management

ALLEN C.D.(1), GROOM K.M.(2)
(1) University of Colorado Denver, DENVER, UNITED STATES ; (2) University of Arkansas, FAYETTEVILLE, UNITED STATES

This research focuses on analysing rock decay on Grenada's (Caribbean) Carib Stones using the Rock Art Stability Index (RASI, Dorn et al., 2008)—a low-cost, yet effective assessment based on over three-dozen rock decay criteria. Representative of general West Indian rock art (petroglyph) motifs, these priceless cultural heritage resources contain more than 100 individual glyphs between two small sites. Despite this significance, nothing has been done to manage or assess the sites for longevity and geologic stability, aside from their archaeological documentation. As a first step towards a potential cultural heritage management strategy, and to further demonstrate the need for intervention, we employed RASI to assess and document each panel's overall geologic stability. The research assessed two sites in very different locations: Duquesne Bay along the northwest coast and Mt. Rich in the northern rainforest. Overall, the stability of the petroglyphs at Duquesne Bay depends almost entirely on their proximity to water: whether puddles stagnating behind the retaining walls, waves crashing during a storm, or simple residential runoff. Although the rock art site at Mt. Rich receives a considerable amount of precipitation and significantly more impact from vegetation than Duquesne Bay, the panels themselves are much more stable. Analyses show that a few of the 13 total panels exhibit a "Good" status, but the remaining are in poor condition and in danger of disappearing. This research demonstrates the need for further monitoring and lays the groundwork for continued study and assessment of the Carib Stones, while at the same time raising their profile to the international stage in hopes of securing greater recognition that will ultimately entail better management practices.

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Assessing mutual influences of environment and petrography to address the conservation of weathered Maltese stone-built heritage based on interdisciplinary materials characterization

TAPETE D., GIGLI G., MORELLI S., VANNOCCI P., PECCHIONI E., MUGNAI F., CASAGLI N.
University of Florence, Earth Sciences Department, FLORENCE, ITALY

The erosion patterns identifiable over the Upper Coralline Limestone outcrop underneath the stone-built fortifications of Citadel in Gozo (Malta) clearly indicate still active dynamics of geomorphologic evolution of the rock mass. Indeed, the architectural surfaces are subjected to similar weathering processes, as expectable in light of the petrographic properties of the limestones used as building materials from ancient times and nowadays to replace damaged blocks.

To deal with such dual issues, we integrated minero-petrographic (i.e. thin sections under polarized light microscope, X-Ray Diffraction, abrasion tests) and geotechnical investigations (e.g., point load, tilt tests) to characterize differential weathering as represented by several samples collected from historical fortifications, dry-stone walls, restoration masonries and boreholes within the rock mass. Geospatial analysis of the retrieved measurements allowed the exterior erosion and alveolization patterns to be correlated to the inner properties of rocks and stones. Thematic maps of deterioration and related hazard indexes were thereby produced and cross-validated with a kinematic analysis of the instability mechanisms performed by terrestrial laser scanning over the whole Citadel.

The demonstration of a strong control of the inner structure and texture on stone decay led us to assess the impacts that the local microclimate and restoration strategies currently implemented at Citadel might have in the near future, in the broader context of an ever changing natural-anthropogenic environment.

Advantages and limitations of the proposed approach of interdisciplinary materials characterization are here discussed, through the benefits obtained in delivering targeted technical advice to address the consolidation project currently carried out at Citadel by the Restoration Unit, Works Division, Maltese Ministry for Resources and Rural Affairs, and Politecnica Ingegneria e Architettura.

Experimental study on cement mortar deterioration in sulfate environment

OGUCHI C.(1), TAGUCHI N.(2)
(1) Saitama University, SAITAMA, JAPAN ; (2) Department of Civil and Environmental Engineering, Saitama University, SAITAMA, JAPAN

To clarify deterioration processes of sulfate attack on cement mortars, dissolution experiment using sulfate solutions was performed. Two kinds of mortars, high-early-strength Portland cement mortar and the alumina cement mortar, were immersed in different concentration of sodium sulfate and magnesium sulfate solutions. In order to evaluate the total amount of soluble ions dissolved from the mortars, electric conductivity (EC) was monitored until 1440 hours. After the experiment, rock properties of mortar specimens were analyzed The EC values of all cases increased drastically and then decreased rapidly within 140 hours. Then the values decreased extremely slowly until 1440 hours. Higher concentration of the solutions has higher final EC values. The Equotip values of specimens immersed in sodium sulfate solution were lower than to those immersed in magnesium solution. The values gradually decrease with increasing immersion time. From the chemical and mineralogical investigation using, XRD, XRF and SEM-EDS, secondary precipitated minerals were deposited on the surface of the specimen. They are thenardite (Na2SO4) in the case of sodium sulfate solution, and calcite (CaCO3), gypsum (CaSO4. 2H2O) as well as hexahydrate (MgSO4. 6H2O) in the case of magnesium sulfate solution. It is concluded that the sodium sulfate environment affects higher damage to mortar rather than magnesium sulfate environment.

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Chemical analysis of black crust on the Angkor sandstone at the Bayon temple, Cambodia

SONG W.(1), OGUCHI C.T.(2), WARAGAI T.(3)
(1) The University of Tokyo, CHIBA, JAPAN ; (2) Saitama University, SAITAMA, JAPAN ; (3) Nihon University, TOKYO, JAPAN

The Angkor complex is the one of the greatest cultural heritages in the world. It is constructed in the early 12thcentury, designated as a world cultural heritage by UNESCO in 1992. The temples at the Angkor complex are mainly made of sandstone and laterite. However, due to the tropical climate, plants, lichens and various microorganisms are growing well on the rock surface. Black crusts are also easily found on the stone surface. The 21sttechnical session of the International Coordinating Committee for the Safeguarding and Development of the Historic Site of Angkor (ICC-Angkor) held in 2012 recommended that to preserve both the biofilms and the forest cover and to prohibit the biocides (chlorine-based) and organic biocides. However, there are many reports that lichens and microorganisms accelerate rock weathering. It is important to clarify that how the biofilm on the Angkor temples affect Angkor sandstones.

We sampled Angkor sandstonecovered by black crustat the Bayon temple, Angkor complex, and observed the section and the surface of the rock sample by using SEM.Surfaces of the samples are not polished in order to observe the original condition. The samples are coated with gold for 180 seconds. The depth of the black crust is up to 1 mm. Many filamentous materials were found on the black crust. Average energy-dispersive X-ray spectroscopy data of the five areasofca.20 µm × 15 µm in the black crustsshows that over 80 % of the filamentous materials are compounds of carbon. It seems that these materials are hyphae. The shape of the hypha is like a thread and its size is few µm in diameter and up to several centimeters in length. Black crusts are consisted of elements and compounds of carbon, Na, Mg, Al, Si, Cl, K, Ca, and Fe.

Further research has to be done to find out the better and proper way of conservation for the Angkor complex.

Poster presentations:

The formation of hollow of sandstone pillar and heated Angkor Wat temple, Cambodia

WARAGAI T.(1), HIKI Y.(2), HADA A.(1), MORISHIMA W.(1)
(1) College of Humanities and Sciences, Nihon University, TOKYO, JAPAN ; (2) Graduate student of Nihon University, TOKYO, JAPAN

Angkor Wat temple is in a tropical monsoon climate, and the weathering of rocks forming the temple is mainly caused by the wet-dry repetition. Sandstone and laterite blocks have a particularly low durability under the repetition. In addition, it is supposed that due to restoration involving clearing of vegetation, the exposure of building stone has accelerated its. In this study, we notice to a hollow formed on the inside sandstone pillar in the first gallery of the temple which is located most outside from the central sanctuary. The hollow is mainly formed by the wet-dry weathering and it is thought that the depth becomes an index of the weathering intensity. Therefore, environmental condition which provides the depth of hollow is analysed based on the measurement of the depth of hollow and air temperature-humidity environment in the gallery. Besides, the climatic environment at the temple is important to clarify weathering environment. The distribution of air temperature in the precincts which is composed of sandstone blocks and vegetation is observed in August 2010 and March 2011.

As a result, the depth of hollow on pillar facing to the outside which is placed in a highly wet-dry repeat situation is deeper than the inside of pillar about three times. In addition, the depth depends on the position of the gallery. Namely, the depth is deep at the eastern gallery with a rapid humidity change, is shallow at the northern gallery with high humidity and low air temperature through the year. Regarding to the distribution of air temperature, the surroundings of gallery is placed in the hot environment which is more than 2°C higher than the vegetation area in summer. Consequently, the raised temperature of the temple causes a sandstone block desiccation and the wet and dry change becomes big if the rapid moistening due to the rainfall is added. It is supposed that the clearing of vegetation is possible to accelerate the weathering of sandstone.

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Reconstructing Past Pollution Environments Using Gravestones

INKPEN R.
University of Portsmouth, PORTSMOUTH, UNITED KINGDOM

Past levels of atmospheric pollution are difficult to quantify as standard and regular monitoring urban atmospheric compositions did not begin until the early to mid twentieth century. Atmospheric pollution in Victorian and Edwardian cities provided the aggressive erosional environment experienced by many historic buildings and monuments. Gravestone erosion rates have been measured since the Victorian period but their potential as quantifiable surrogates of historic atmospheric pollution levels has been relatively poorly explored. This presentation uses erosion rates within a modified version of Lipfert's (1989) dose response equation to calculate sulphur dioxide levels at locations across the southern UK. The limitations of this method are discussed as well as the spatial variability in historic atmospheric pollution levels its application implies.

Impact of cement repointing on rates of sandstone deterioration in medieval churches of the French Massif Central

ANDRÉ M.F.(1), PHALIP B.(2), ROUSSEL E.(3), VAUTIER F.(3), VOLDOIRE O.(1)
(1) GEOLAB - CNRS / Université Blaise Pascal / IUF, CLERMONT-FERRAND, FRANCE ; (2) CHEC - Université Blaise Pascal, CLERMONT-FERRAND, FRANCE ; (3) IntelEspace /MSH, CLERMONT-FERRAND, FRANCE

Six Romanesque churches of the Auvergne region in the French Massif Central have been investigated. These are built of various sandstones and have been partially cement-repointed in the mid-20th century. Methods used to quantitatively assess weathering damage both since the Middle Ages and since the repointing operations combine terrestrial LiDAR and stone-by-stone surveys, dating of reference surfaces ('zero datum levels') based on stone-dressing marks, and petrographical analyses.

Between the 12th century and the mid-20th century, intrinsic geological factors have been the key control on sandstone weathering. Stone recession has proceeded on average 500 times faster in the poorly-cemented white sandstone compared to the iron-cemented red sandstone (4 mm per century against 0.008 mm per century). Since the mid-20th century repointing operations, a marked increase in weathering damage and resulting stone recession has affected the poorly-cemented white sandstone. This increase is up to tenfold where hard Portland cement has been applied, which confirms the deleterious effects of cement repointing on susceptible stone masonries.

Comparison with previous studies indicate that the maximum pre-repointing recession rates are similar to the ones provided by previous authors for similar temperate inland and rural areas of western Europe. As to the maximum post-repointing recession rates, they are of the same order of magnitude as the values provided for tourist sites such as Petra and Angkor which are significantly affected by human impacts.

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A study on anthropogenic and climatic induced deterioration of some stone built churches in the Transylvanian Depression

ILIES M.(1), IRIMUS I.A.(2), ROSU C.(2), RUS M.(2)
(1) Universitatea "Babes-Bolyai", Cluj-Napoca, CLUJ-NAPOCA, ROMANIA ; (2) Universitatea "Babes-Bolyai", Cluj-Napoca, CLUJ-NAPOCA, ROMANIA

The stone built churches of Transylvania are an important part of the Romanian religious and cultural heritage. Their aesthetic and historic integrity is constantly put at risk due to the weathering processes. For the purpose of this study, the chosen religious monuments are spread throughout the wide region of Transylvania. They are located in areas with specific local climatic conditions, therefore they are being subjected to different weathering factors.

The objective of this study is twofold. First, to investigate the climatic and anthropogenic factors that favour stone deterioration. Second, the aim is to link these to a specific type of damage found on the monument.

The study is based on an analysis of the climatic data such as humidity, temperature, rainfall, wind-speed as well as an investigation of the human interventions that have influenced the monument's state of conservation. The deterioration forms were recorded using *in situ* mapping.

Results show different levels of weathering - induced damage on the studied monuments, thus demonstrating that climatic nuances play an important role in determining the forms and severity of deterioration. This study is part of a wider project that stands to develop suitable preventive and curative conservation treatments for each of the churches.

Linear expansion and thermal cycling of sandstones: key factors of weathering

TOROK A., TURI N.
Budapest Technical University, Dept. of Construction Materials and Engineering Geology, BUDAPEST, HUNGARY

The paper describes laboratory experiments where sandstones that are used in monumets were subjected to three different thermal cycles that aimed to model natural conditions: i) annual cycle (temperatures: -15°C to +40°C), ii) winter cycle (-15°C to +5°C), and iii) summer cycle (+5°C to +50°C). Three sandstone types a fine grained ferruginous, a carbonate cemented and clayey quartz sandstones were tested. For each experimental setup 80 cycles were made by using air dry and water saturated conditions. The following parameters were measured after each 10 cycles: mass, density, water absorption, ultrasonic pulse velocity and linear thermal expansion. Compressive strength and three point load strength of samples were also recorded before and after the cycles. The largest loss in mass (11.5%) is recorded in the clayey sandstone during winter cycles, with nearly same values (11.4%) in annual cycles. The ultrasonic pulse velocities show a decrease due to the cyclic load, which is more than 27% for the clayey sandstone when it is exposed to winter cycles. It is much higher than that of the other two sandstones. The liner thermal expansion coefficients of the three studied sandstones were nearly the same before the cyclic loading (α=13.1-13.9 1/°C*10^{-6}). After applying dry winter cycles it became less for most sandstones but when saturated samples were tested under simulated winter conditions major differences were found, with increasing linear expansion coefficient for carbonate-containing sandstone and decreasing for clay-containing one. Summer cycles decreased the linear expansion coefficient of all studied sandstones, but in various rate. The highest strength loss was recorded after winter cycles, as it was expected. The tests demonstrate that liner thermal expansion coefficient show some changes when the sandstone is exposed to different climatic conditions, thus could be used as a good indicator of weathering susceptibility of sandstone monuments.

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Quantitative assessment of decay in Mayan cultural limestone

GENET P.E.
Geolab - Laboratoire de géographie physique et environnementale - UMR 6042 CNRS/Université Blaise Pascal, CLERMONT-FERRAND, FRANCE

Mayan cultural heritage is affected by deterioration due to tropical bioclimatic conditions and low durability of built limestone. Quantitative assessment of this decay has been conducted in the Rio Bec region (state of Campeche, Mexico), on the archeological sites of Becan, Chicanna, Xpuhil and Rio Bec, using photogrammetric modeling and GIS. The obtained amounts of decay have been linked to controlling factors, such as petrographical properties of built limestone, bioclimatic conditions from regional to microlocal scale, and direct or indirect human interventions. Deterioration has been quantified at different spatial and temporal scales, from the whole monument to individualized stones, and the chronology of human interventions has been taken into account. First results show that biocolonization by microorganisms and anthropogenic impacts such as restorations or forest clearing are influencing the geography of decay, being either protective or aggressive factors. Perspectives include the extension of the quantitative assessment of decay to other stylistic regions, such as the Puuc zone, characterized by drier bioclimatic conditions and better quality of built limestone. This study is conducted in collaboration with geologists, microbiologists, archeologists and conservators in order to provide a complete diagnosis regarding the causes of decay that can lead to conservation recommendations.
Key Words: stone decay, limestone weathering, cultural heritage, quantification of decay, Mayan temples, Yucatan.

The geomorphological Units of Mount Bambouto Caldera (Cameroon Volcanic Line): an asset for geoeducation and geotourism

TEFOGOUM G.Z.(1), DONGMO A.K.(2), NKOUATHIO G.D.(2), WANDJI P.(3), DEDZO M.G.(4)

(1) Department of Hydraulics and Water Management, Higher Institute of the Sahel, University of Maroua & Department of Earth Sciences, Faculty of Sciences, University of Dschang, MAROUA & DSCHANG, CAMEROON ; (2) Department of Earth Sciences, Faculty of Sciences, University of Dschang, DSCHANG, CAMEROON ; (3) Laboratory of Geology, High Teacher Training School, University of Yaoundé, YAOUNDÉ, CAMEROON ; (4) Department of Life and Earth Science, High Teacher Training College, University of Maroua, MAROUA, CAMEROON

The major tectonic events in Cameroun are found in the Cameroon Volcanic Line; which is constituted of volcanic and plutonic complexes. Among volcanic complexes, the mount Bambouto appears one of the most affected by tectonic events. These events gave rise to the formation of a caldera at summit of the volcano. This caldera is sub-elliptical in shape (16x8 km). Various gemormophological units are found in the caldera and they are related to the outcrops of rocks like trachytes, basalts, ignimbrites and phonolites whom eruptions ruled the formation of caldera (Tchoua, 1972; Youmen, 1994). Thus, the landscape of the caldera is characterized by domes (Babadjou Tooth, Mount Meletan, Mount Maga, Mount Mekwop, Mount Nkon'hon etc…) and cliffs. Several valleys are found in the caldera around the deepest "V" shaped valley with altitudes ranging between 1300 m and 570 m. The dissymmetry of these geological units gave to the whole caldera, a stair-like morphology from the crest line to the bottom. The main directions of these features are N-S, N35° and N145° (Zangmo Tefogoum et al., 2011). Since many decades, the wonders the geomorphological features in the Mount Bambouto caldera foster several field trainings of students (from secondary schools and universities), tourism and recreational activities (by local and foreign people). These activities have an impact in the development of the region through local cost-effective activities led by craftsmen.

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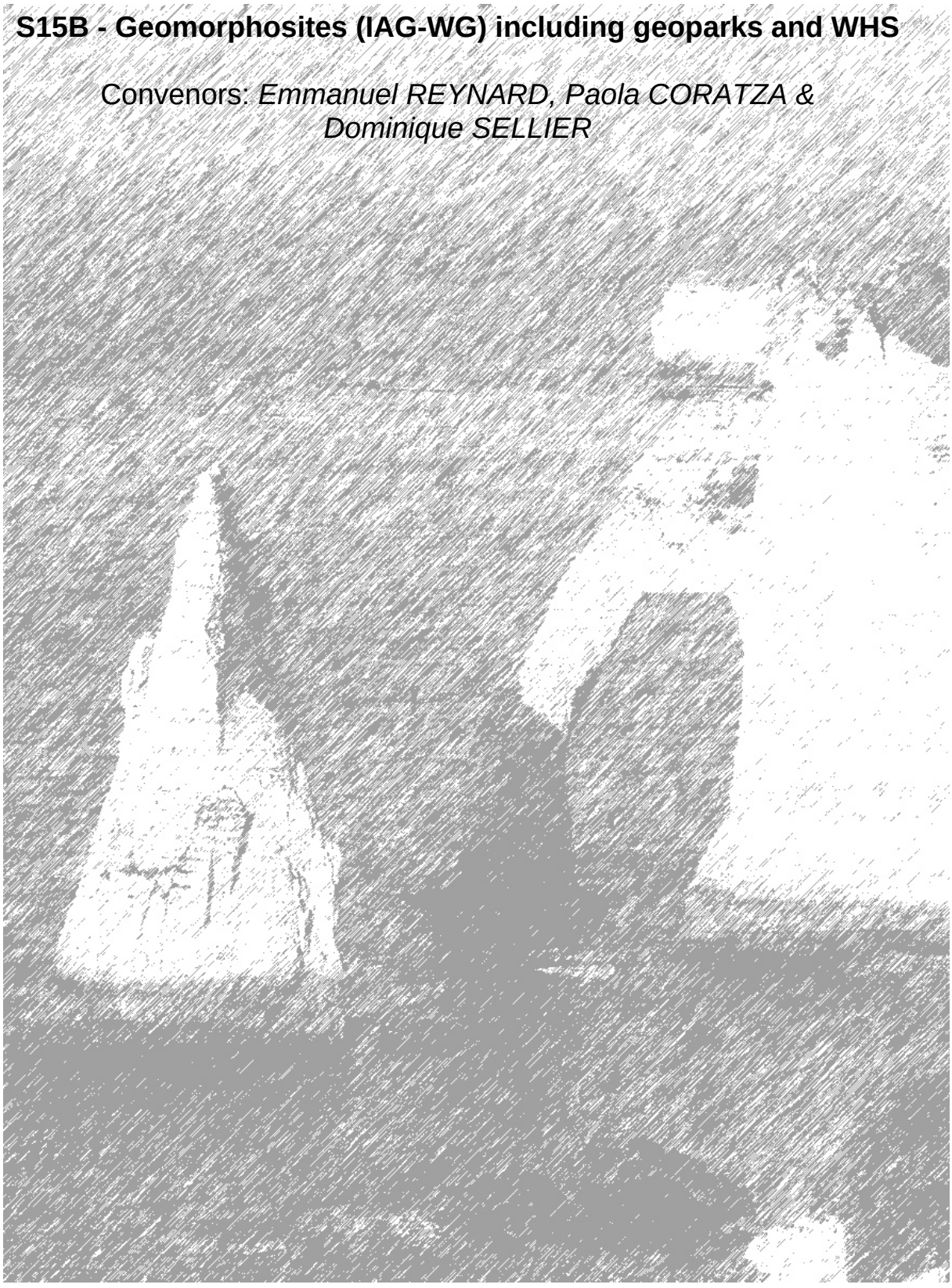
S15B - Geomorphosites (IAG-WG) including geoparks and WHS

Convenors: *Emmanuel REYNARD, Paola CORATZA & Dominique SELLIER*



Oral presentations:

Drawing the Line: Boundary Issues at the National Parks of the SW USA

GRAY M.
Queen Mary, University of London, LONDON, UNITED KINGDOM

Delimiting appropriate boundaries for protected geosites and areas is very important. If the boundaries are poorly drawn, important features of a landform assemblage or important parts of a functioning geomorphological system may be excluded from protection thus diminishing the value of the site and effectiveness of its conservation. Factors involved in drawing protected area boundaries may include administrative boundary issues, land ownership issues, historical factors or lack of understanding of the local geoscience. In this presentation, examples of appropriate and inappropriate boundaries will be discussed at National Park units in the SW USA, including Capulin Volcano National Monument (New Mexico), Sunset Crater National Monument (Arizona), Great Sand Dunes National Park (Colorado) and Petrified Forest National Park (Arizona).

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Geomorphosites: Individual landforms or areas of geomorphological heritage

ERHARTIC B., ZORN M., FERK M., KOMAC B.
Research Centre of the Slovenian Academy of Sciences and Arts, Anton Melik Geographical Institute, LJUBLJANA, SLOVENIA

This article discusses the bases for studying and evaluating geomorphological heritage and presents an example of this evaluation in the Triglav Lakes Valley (Julian Alps, Slovenia).

Studying the high-mountain karst surface revealed that this type of relief has gone through diverse development. In the Triglav Lakes Valley, the high-mountain solid-rock surface gradually entered the process of rock-base corrosion in various stages of the Holocene. A potential question that can arise in this regard is which development phase, or which phenomenon in a particular development phase, is more important or typical in terms of nature conservation. The development and character of high-mountain karst or the abundance and formation of surface phenomena always depends on local factors, including the limestone's physical and chemical properties, the elevation, location, and exposure of the surface, climate, and vegetation, and, finally, potential human impacts. Due to a multitude of relief forms that are often at various development stages, areas with a higher concentration of exceptional, rare, and typical forms connected in a complex way are deemed more important from the viewpoint of nature conservation and geomorphological heritage; these forms have great research and informative value, and have special ecological and cultural importance. Combining forms into logical units with a high density and great diversity also increases the area's importance in terms of nature protection. These units are referred to as geomorphological complexes because they represent specifically defined and typical complexes of karst and other relief forms. Based on the morphogenetic landscape and relief factors, the study area of the Triglav Lakes Valley was divided into seventeen geomorphological complexes. Following the evaluation of these units, the geomorphosites of this area were also defined.

A deductive method for selection of geomorphosites

SELLIER D.
Universite de Nantes, NANTES CEDEX 3, FRANCE

The aim of popularization is to communicate scientific knowledge to a public at large. Popularization of geomorphology can have two targets: to explain landforms to the public (visitors, students) and to provide to this public the basic principles to understand landforms. These objectives require to select *geomorphosites* (sites of scientific interests).

The method set out here to select such sites includes an *integrated analysis of landforms* and a *deductive selection of geomorphosites*, previously tested as part of scientific programs or master memoirs in different fieldworks in Europe.The first stage includes three parts: characterisation of the general geomorphic properties of the *concerned area*, identification of *major geomorphological components* of equal size but different properties, definition of basic geomorphological units, called *geomorphotypes*. The second stage includes two parts: selection of *geomorphosites* connected with each observed *geomorphotype* (what to see) using scientific references (general meaning, pedagogic value), choice of *points of view* related to each geomorphosite (from where to see) using touristic references. This second stage can use assessment methods worked out by the Lausanne school of geography (scientific and additional values).

This method involves scientific and pedagogic competence of popularizer. It depends of the public, institutional framework and available media too. It uses a systemic process from scientific knowledge to geomorphosite determination. It is in accordance with the concept of *geomorphodiversity* because the complementary properties of *geomorphotypes* selected inside the *concerned area*. It allows to choose sites to be visited but also to be conserved, which are two scopes of *geoheritage* making.

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Assessment of geomorphosites: methodological approach on examples of the Moravia (eastern part of the Czech Republic)

KIRCHNER K.(1), KUBALIKOVA L.(2)
(1) Institute of Geonics, Academy of Sciences of the Czech Republic, Branch Brno, BRNO, CZECH REPUBLIC ; (2) Department of Geography, Faculty of Education, Technical University of Liberec, LIBEREC, CZECH REPUBLIC

For the first time in the Czech Republic, the concept of geomorphosites was used for assessment of geomorphological localities. The authors excerpted methods for the assessment of geomorphosites, which are used in some West and South European countries and have elaborated the special methodology for Czech ambient. Traditionally, in the Czech Republic, there is a wide spectrum of geomorphologic information including geomorphological maps. This geomorphological data obtained in geomorphological field research will serve as a basis for evaluation of the selected sites. The authors define geomorphosites traditionally as geomorphological landform that have acquired certain values due to human perception.

Presented methodical approach consists of four main stages: i) identification of the significant geomorphologic sites (based on the literature, maps and field survey), ii) detailed geomorphological inventory of selected sites (general information, geology, geomorphological data - morphology and genesis, environmental conditions, a description of the cultural components of the site, aesthetic aspect, availability, background, presence of touristic infrastructure, current state of the site, potential threats and risks), iii) numerical evaluation of sites (scientific and additional values, economical potential, threat and risk assessment), iv) final synthesis (classification of the sites, management proposals, possible use of the site, proposed legislative protection). The authors propose to include the presented approach in a part of the environmental geomorphology.

This concept was used for evaluating of selected geomorphological sites in the various relief types and different categories of protected areas in the Moravia: Podyjí National Park, Protected Landscape Area Zďárské vrchy (Bohemian Massif). Results of the assessment can serve as a base for proposals for rational use and management and other perspectives of the use of the geomorphologic assessment are outlined.

Bridging Malta and Sicily through geoheritage exploitation: Identification and assessment of geosites for territorial enhancement

CAPPADONIA C.(1), AGNESI V.(1), ANGILERI S.E.(1), CORATZA P.(2), COSTANZO D.(1), DI PATTI C.(1), SOLDATI M.(2), TONELLI C.(2)
(1) Universita di Palermo, PALERMO, ITALY ; (2) Universita di Modena e Reggio Emilia, MODENA, ITALY

Malta and Sicily show common geological and geomorphological features, having been also physically linked not later than the Last Glacial Maximum. At present both islands have a high tourist vocation, but their environmental potential is not fully exploited for attracting tourists and visitors. In the framework of an international research project, “Ecological Cross-border Networks Malta-Sicily” (RE.MA.SI.), a multidisciplinary study for the identification, selection and enhancement of geosites in the Maltese and Sicilian islands was carried out.

A number of sites both in Malta and Sicily have been identified and qualitatively and quantitatively assessed applying a methodology already tested in previous studies. The aim was to see whether any of these sites could be considered as geosites of geomorphological interest (geomorphosites) according to scientific, additional and use values.

In order to create a common geomorphosite inventory and a GIS-database, the standard forms of the Italian Institute for Environmental Protection and Research (ISPRA) were used. The recognised and assessed geomorphosites mainly include coastal and kart features, but also landslides, badlands and mud volcanoes are encountered due to their scientific interest and scenic value.

The research enabled us to highlight that geomorphosites can become a relevant resource for social and economic development in Malta and Sicily, and can provide the ground for bridging these islands through a new integrated approach with foresees common methods and actions for geoheritage exploitation and enforcement of conservation strategies.

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Assessment of geomorphosites for recreational purposes: Case of Nalychevo Nature Park (Kamchatka, Russia)

BLINOVA I., BREDIKHIN A.
Moscow State Lomonosov University, MOSCOW, RUSSIAN FEDERATION

Creation of a new tourism cluster or expantion of natural recreation resource, along with other scientific and applied problems of recreation, requires precise assessment of the territory. Relief often determines technological peculiarities of land use such as location and territory zoning, means of transport, safety for recreational system and people involved in recreational activity.

Attractiveness of relief, diversity and rareness were always the basic features of overall recreational attractiveness of a territory. Unique relief forms, commonly referred to natural sites, make the natural functional kernel for a recreation system which is created and exists around them.

Geomorphosites are particularly vulnerable to dangerous occurrence of endogenous and exogenous processes as guarantee of environmental stability is an essential condition for a proper system functioning. This requires a comprehensive study of relief dynamics, monitoring and forecasting its evolution in protected areas.

There are two general domains of relief and recreation mutual influence: recreational and geomorphic (RG) risk (treat) and RG attractiveness.

The impact of the various relief characteristics is determined by the objectives of holidaymakers. However, various types of recreation require different values of relief parameters. Numerical approach allows to conduct the assessment procedure impartially and to establish the ranking based on final scores.

After estimating recreational and geomorphic potential of a certain area we can analyse its structure, i.e. the set of presented or potentially possible recreational activities.

Such assessment is particularly important for prospective recreational regions. In spite of general fame of Far East recreational resources there are still areas not affected by human activities in immediate proximity to the regional center. One of them is Nalychevo Nature Park which is included in the “Volcanoes of Kamchatka” UNESCO’s World Heritage List.

Quantitative Geodiversity Index: GIS & spatial analysis for assessment and selection of geomorphosites

MELELLI L.
Department of Earth Sciences, University of Perugia, PERUGIA, ITALY

The research centered on geoconservation and geotourism stressed qualitative methods focusing on the definition, identification, study and development of geosites. Although the excellent results achieved by scientific international research, the topic of quantitative evaluation of geodiversity is still an open field.

To define a quantitative index of geodiversity is the next step required in order to quantify this parameter. Geographical Information Systems (GIS), Digital Elevation Models (DEM) and remote sensing imageries are the new instruments available to develop specific tools in order to obtain quantitative indexes.

The formula proposed in this abstract takes into account abiotic factors, contributing to the geodiversity definition, with intrinsic characteristics of spatial continuity (geological substrate, soil cover, land use) or spatial discontinuity (morphogenetic processes). Moreover the topographic parameter is strongly stressed out, modeled through the roughness or an index that measures how irregular an area is from a topographic point of view. The relevance of topography is a consequence of two points:

1. the roughness is strictly related to efficiency of geomorphological processes and generally is corresponding to a greater variability of the abiotic component.
2. The great availability of new DEMs with advanced characteristics of vertical accuracy and horizontal resolution. These models allow to manage the topographic attributes obtaining promising results and highlighting the energy relief role in the geodiversity comprehension.

The study area is the Umbria region (central Italy) and covers many lithological and morphological units, becoming an ideal representation of the conditions of geodiversity in central Italy.

The results of this approach could be not only an advance in the quantitative approach of geodiversity assessment but also a valid instrument for landscape management and geotourism and geoparks evaluation, promotion and management.

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Assessment of Mainland Portugal geodiversity

PEREIRA P.(1), PEREIRA D.(1), BRILHA J.(1), SANTOS L.(2), HENRIQUES R.(1)
(1) Geology Centre of University of Porto / University of Minho, BRAGA, PORTUGAL ; (2) Geography Department, Federal University of Paraná, CURITIBA, BRAZIL

A methodology applied in the quantitative assessment and mapping of Mainland Portugal geodiversity (89,015 km^2) is presented. The geodiversity concept considers the diversity of rocks, minerals, fossils, landforms and soil features and usually is being considered only as a theoretical approach with no particular use or application. GIS procedures were performed to assess all features of Mainland Portugal geodiversity and to avoid overrating any particular one, such as lithology or relief, which is a common weakness in other methods. The Geodiversity Index resulted from the combination of five partial indexes: geological, geomorphological, palaeontological, pedological and mineral occurrences. Each one of the five indexes was obtained by counting different occurrences in a 16x10 km grid cell in maps at scales between 1:500 000 and 1:1 000 000: geological, geomorphological units, hydrography, soils, precious stones and metals, energy and industrial minerals, mineral waters and springs. GIS software was used to convert vector data to raster for these spatial analysis procedures. The geodiversity map of Mainland Portugal is expressed as an isolines map joining the central points of cells sharing the same Geodiversity Index. The highest geodiversity values are related with larger diversity of stratigraphical and palaeontological Mesozoic units and mainly with rich geological and geomorphological diversity. The geomorphological diversity in connection with a lithological control seems to have an important role in the geodiversity map. This cartography is intended to have an easy interpretation by non-specialists as a tool for land-use planning, particularly in the identification of priority areas for conservation, and for the use and management of natural resources.

The geomorphosites of Madre de Dios island (Patagonia, Chile): "marble glaciers", painting caves and hydro-aeolian karst landforms. A singular heritage unique in the world

HOBLEA F.(1), JAILLET S.(1), MAIRE R.(2), MALARD A.(3), MOREL L.(4), FAGE L.H.(5), MARBACH G.(6), TOURTE B.(7)
(1) UMR EDYTEM CNRS-University of Savoie/Centre Terre, LE BOURGET DU LAC, FRANCE ; (2) UMR ADES CNRS-University of Bordeaux/Centre Terre, TALENCE, FRANCE ; (3) Swiss Institute for Speleology and karst Studies (SISKA)/Centre Terre, LA CHAUX DE FONDS, SWITZERLAND ; (4) UMR 5005, Lab AMPERE/Centre Terre, LYON, FRANCE ; (5) Centre Terre, CAYLUS, FRANCE ; (6) Centre Terre, CHORANCHE, FRANCE ; (7) Centre Terre, TOULOUSE, FRANCE

After four expeditions organised by “Centre Terre” (2000, 2006, 2008, 2010), the karstic desert island of Madre de Dios (50° S, Magellan channels, Chilean Patagonia) revealed natural and cultural treasures interesting several scientific fields: archeology, ethnography, botanic, zoology, and especially geosciences and geomorphology through the study of a new karst environment in subpolar wet conditions. Unknown landforms and processes have been discovered, generating an outstanding landscape, called “marble glaciers”, a new kind of mega-karrenfield marked by very active hybrid hydro-aeolian processes and glacial inheritance interfering with differential weathering involving both soluble and non-soluble rocks. Criss-crossed processes give unexpected landforms as “rock comets”, “rock rams”, micro/mega “rock mushrooms”, perched dunes and “sand firns” in cliffs… The endokarst is also well developed. The presence of big caves networks allowed some of them to record glacial deposits as well as paleo-tsunamis or human occupations from different periods (evidences of the past presence of Kawesqar nomad people).
These expeditions revealed the high natural-cultural heritage value of Madre de Dios island, presently desert excepted a quarry of limestone located for sixty years in Guarello, a nearby small island. Thanks to the work of Centre Terre, Madre de Dios is officially protected by the Chilean State since 2007. The current assessment of the heritage value of the island interests the Chilean Authorities thinking to the promotion of the site through its inscription on the WHS list and the development of eco and geotourist visits. In this frame, we present the assessment of the geoheritage and the geosites of Madre de Dios island, focusing on the numerous geomorphosites that present a relevant potential heritage regarding as well the scientific than the additional cultural-aesthetic-biotic values.

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Geomorphological heritage of Samobor karst area (Croatia)

BUZJAK N.(1), PAHERNIK M.(2)
(1) University of Zagreb, Faculty of Science, Dept. of Geography, ZAGREB, CROATIA ; (2) Croatian Military Academy Petar Zrinski, ZAGREB, CROATIA

Samobor karst area is the most eastern unit of Samoborsko gorje-Zumberak Mt. geomorphological region in NW Croatia. It is developed in a well karstified Upper Triassic and Neogen carbonate beds with numerous karst phenomena: dolines, blind valleys, caves, springs and ponors. Some of them are recognized as important geomorphosites and protected or the formal protection process is in progress. Due to the intense urbanization this fragile karst environment is under strong anthropogenic pressure with negative environmental impacts. It is reflected in geoheritage, landscape and natural resources degradation. Therefore whole area is an object of systematic geoecological study that involves geomorphological, speleological and hydrological research performed in a cooperation of scientists, researchers, authorities dealing with nature protection and water resources management and local community. The result of researches is the GIS geodatabase aimed for preparing reports, professional studies and specialized maps used in spatial analysis, planning and nature protection. It consists of two main components, general geomorphological database and speleological database, and is a part of the larger geodatabase developing inside the project of Geomorphological mapping of Croatia. Owing to its object-oriented structure and high operability such database is an effective system for geoheritage identification, evaluation, vulnerability estimation and protection. One of the recent projects example is the research of Bistrac creek valley and preparing of documentation for its protection as a geomorphological nature monument. Such system also has a goal to provide a tool for geomorphosites implementation into the education process and nature protection awareness among local population. It is partially realized in the form of workshops with school children, public presentations and projecting of educational trails with accent on geomorphosites and its role in nature system of karst.

Geoconservation of caves in Fiji: a case study from Volivoli Cave, SW Viti Levu Island

STEPHENS M.(1), HODGE S.(2), PAQUETTE J.(1)
(1) School of Geography, Earth Science and Environment, The University of the South Pacific, SUVA, FIJI ; (2) School of Biological and Chemical Sciences, The University of the South Pacific, SUVA, FIJI

Caves in Fiji often contain unique ecological and hydrogeological features and archives of human, faunal and climate history. These caves therefore provide good opportunities for education, research and sustainable tourism. However, due to their unique setting several caves in Fiji are very sensitive to environmental disturbances from nearby human activities that include quarrying and logging and other impacts such as dumping of rubbish and graffiti. Volivoli Cave, SW Viti Levu Island, is a site of national importance as it contains prehistoric animal remains although in recent years the environment of Volivoli Cave has become degraded. The slopes leading down to the cave entrance have been farmed which has led to increased overland flow of water in to the cave. The result is that areas of stratified archaeological deposits have been removed from the cave entrance. In addition, significant numbers of bats once lived in Volivoli Cave but have now disappeared. A conservation plan to protect and provide sustainable use of the cave involved installation of a drainage system to divert water away from important archaeological deposits, implementation of a walkway to allow safe access and the production of a notice board displaying accurate scientific information. A preliminary survey of the invertebrate fauna was performed and recorded very few individuals and species and probably due to the lack of bat guano. The effects of large groups of people entering the cave on CO2 levels were also measured. Standardized cave sensitivity and disturbance indices were applied to Volivoli Cave and the preliminary results were compared to other caves in Fiji and elsewhere in the world; providing implications for future management strategies and research. This type of study is the first in the tropical South Pacific region and it is envisaged that the methodology and approach employed here may be developed and applied to other similar caves in Fiji and the South Pacific.

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Understanding the geo-heritage value of Dwejra (Gozo) as a geomorphosite

GAUCI R.(1), CORATZA P.(2), SCHEMBRI J.A.(3), SOLDATI M.(2), TONELLI C.(2)
(1) University of Malta , MSIDA, MALTA ; (2) Università di Modena e Reggio Emilia, MODENA, ITALY ; (3) University of Malta, MSIDA, MALTA

Over the last decade, the geo-heritage aspect of geomorphological sites has received unprecedented research attention, with significant scientific initiatives in landscape research undertaken in order to define, assess and map geomorphosites.

The coast of the Maltese Islands, with a series of occupiers over the last ten millennia, has led to the development of a high density of coastal uses that superimpose on both a diverse range of aesthetic natural qualities and different cultural properties that have changed over time. Low sloping limestone coast provided an ideal geological setting for salt panning production, whereas today these are main areas for swimming off-the-rocks. *Rdum* (scree slopes) are areas where fertile agricultural practices were possible and today they are zones for which their aesthetic and ecological qualities are highly prized. Sinkholes were a source of shelter on rectilinear coasts and are now areas of outstanding natural beauty.

This paper examines the bridging of the cultural landscape with the geomorphological features of a sinkhole system at Dwejra in Gozo. Dwejra area is characterised by a highly scenic landscape and a very rich natural and cultural heritage. On the other hand, the impact and pressure of diverse human activities on this area have been growing significantly, often leading to conflicting interests and resultant landscape damage. As a result, geo-conservation aspects of this site have often been at the centre of national debates. The aim of this work is to provide a better understanding of the value of Dwejra as a geomorphosite, increase sensitivity to the geomorphological value of this area and highlight which geo-conservation aspects best fit the protection measures for this site.

KEYWORDS: geomorphosite, geo-conservation, sinkhole, Dwejra, Gozo; Maltese Islands

Geopark's Activities and the Role of Geomorphology in South Korea

KIM C.
Dept. of Geography Education, Kangwon National University, CHUNCHEON-SI, GANGWON-DO, SOUTH KOREA

The main aim of this paper is to introduce activities and the role of geomorphology in establishing (a global or national) geopark in South Korea.

In South Korea, the project on establishing Gangwon Peace Geopark was launched in 2010 by the Ministry of Knowledge & Economy, Gangwon Province and 5 local authorities of the Korean DMZ's (demilitarized zone) adjacent areas. The DMZ and its adjacent areas (cross-border regions) in Gangwon province, South Korea, have comprehensive and academic geo-scientific sites. Their historical assets, cultural uniqueness and ecological resources have still remained intact and unexplored due to the Korean War in the early 1950s and the tension between the South and North during about 60 years. Gangwon Peace Geopark has geomorphological and geological resources which are created by processes of the formation of Korean peninsula. In the geopark, there are three types of petrographical and gemorphogical features such as basalt, metamorphic rocks and granites.

Within these contexts, this paper can be divided into 3 sections. Firstly, in terms of geopark's activities, the relationship between geomorphology and geology is examined. Secondly, efforts on establishing geopark by geographers are reviewed. Finally, the role of geomorphology in making and managing geopark is discussed in the South Korean Context.

It shall be argued that the geopark has aspects of the conservation of geomorphological heritage as well as geological one. Within this context, in South Korea where is in the quickening period of geopark, the discussion and agreement with the Korean name of geopark are absolutely imperative. And nowadays, discussion about using "geopark" rather than "Geological Park" is suggested to organize South Korea Geopark Network (KGN) with geographers, geomorphologist, geologists and other geoscientists. It is expected that geopark and geotourism play an important role in improving the status of geomorphology in South Korea.

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An online atlas as a collaborative and visualization tool for the geopark proposal of the Chichonal volcano area

OSORNO J.(1), ALCÁNTARA-AYALA I.(1), RAMOS S.(2), COUTURIER S.(1), GARNICA R.(1), LOPEZ J.(1)
(1) Instituto de Geografia, UNAM, MEXICO, MEXICO ; (2) UNICACH, TUXTLA, MEXICO

One of the most important elements of a Geopark proposal is the inclusion of local actors in the management plan of the cultural and geological heritage. The risk assessment and other key features of the project usually are expressed through a cartographic printed Atlas. In the context of the collaborative process among local and academic actors, the use of free software and spatial data offers the opportunity of a wider access and sharing of the results.

In this work an on-line atlas is developed as a tool to enhance the participatory process leading to a Geopark proposal for the Chichon Volcano zone in the state of Chiapas, Mexico. A set of information services was implemented using open standards, which allows the use of a variety of free and/or open client applications. The benefits of this digital replica over the printed version are discussed. Particularly the advantages of using multimedia resources such as geo-referenced photographs, spherical panoramas, videos and time series.

Finally, we propose a scheme for the training of local actors in basic editing, visualization and analysis skills using geographic information technologies, in support of administrative tasks, sustainable management and touristic promotion.

The appraisal of geoheritage through different approaches: the lesson from the Salse di Nirano Nature Reserve (Italy)

CORATZA P.(1), CASTALDINI D.(2), CONVENTI M.(3), LIBERATOSCIOLI E.(2)
(1) Dipartimento di Scienze Chimiche e Geologiche, University of Modena and Reggio Emilia, MODENA, ITALY ; (2) Universita di Modena e Reggio Emilia, MODENA, ITALY ; (3) Riserva Naturale Regionale delle Salse di Nirano, FIORANO MODENESE, ITALY

The Regional Nature Reserve of Salse di Nirano is located in the low hills of the Northern Apennines, about 30 kilometres south of the city of Modena. The Reserve was established in 1982 and its characteristic features are mud volcanoes, locally called “Salse”. They are emissions of cold mud up to the surface through faults and fractures, due to the ascent of salty and muddy water mainly mixed with gaseous (methane) and secondarily with fluid (petroleum veils) hydrocarbons. Depending on the density of the mud, these emissions can form either cones or pools at ground level. Since its establishment, the Reserve has promoted initiatives to appraise the area from the tourism viewpoint, welcoming individual visitors and school groups with a full programme of activities. In the last decade, visitors have increased from 30,000 to 70,000 per year. The numerous facilities – excursion and educational footpaths with panels, equipped trails (one for the disabled), two visitor centres – make the area accessible to all, supporting environmental education initiatives. A good variety of educational and information materials regarding the Nirano mud volcanoes and the territory of the Reserve has been published in the last decade, representing a successful example of environmental and tourism appraisal and improvement. Among the most recent products, particularly worthy of note are geotourism and tourism-environmental maps, books in hard copy and digital format, videos, virtual flights, multimedia and audio CDs. In the present study a critical overview of all the products elaborated in recent time is presented, highlighting strengths and gaps, and also taking into account the target of visitors they are addressed to.

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Collecting and sharing geoheritage information in the digital Age

GHIRALDI L.(1), BALESTRO G.(2), PEROTTI L.(2), GIORDANO E.(2), GIARDINO M.(2)
(1) Natural Sciences Museum of Torino, TORINO, ITALY ; (2) Uninversity of Torino - Earth Sciences Department, TORINO, ITALY

Over the last few years mobile technologies and interactive Web tools have become basic needs, allowing extensive exchange of accessible and permanent information. They have acquired increasing diffusion, and todoy they can be considered one of main means of communication and at the same time sources of information. In this new technologial and cultural environment, an important field of application is can be represented by collection and dissemination of geoscientic information, and particularly data concerning geological heritage.

Since 2008 a multidisciplinary group (the Earth Sciences Department of the University of Torino and the Natural Sciences Museum of Torino) is active in defining a method to collect and share geoheritage information of the most representative geological sites of the Piemonte region (NW of Italy). A review of inventoried geosites, collection and dissemination of new geoheritage information are carrying out in the frame the PROGEO-Piemonte (PROactive management of GEOlogical heritage in the PIEMONTE region) project, as well as in others specific works.

The proposed method involves the use of:

- Mobile tools for data collection;
- Relational database for inventory activities;
- Web-Mapping tools and mobile applications for data dissemination.

The aim of this methodology is to identify a standardized approach which allows the use of mobile devices in each step of the process. A basic inventory form has been specifically developed and imported in an open source application, which allows to collect data directly from mobile devices. Structured information are in this way sent to a relational database purposely set-up, or stored in local (e.g. in a phone card).

The database is the core of the proposed method, because it is a source of information for Web and mobile applications too. A graphical interface purposely set-up allows the user to browse data of his interest through specific queries and accessing to an easy-to-use GPS-based mapping tool.

In search of the cultural geomorphosites of Wales: evidence from medieval poetry

GRIFFITHS H.(1), SALISBURY E.(2)
(1) Aberystwyth University, ABERYSTWYTH, UNITED KINGDOM ; (2) Centre for Advanced Welsh and Celtic Studies, University of Wales, ABERYSTWYTH, UNITED KINGDOM

The landscape of Wales is characterised by glacial valleys, dramatic coastlines and fluvial forms ranging from narrow upland valleys to wide floodplains, active and stable meandering reaches and wandering, entrenched and mixed bedrock-alluvial rivers. Some landforms (eg. picturesque waterfalls) have assumed a cultural significance due to their aesthetic qualities, are important sites for tourism, and are recognised by geomorphologists and artists as inspirational features. In general, however, conservation of these landscapes is based on ecological, geological and purely geomorphological characteristics. Landscapes where geomorphology and culture intersect are less frequently recognised, studied or presented to the public. Sources such as historical literature and art can provide clues to sites that were geomorphologically significant, but whose cultural importance has been lost over time due to a lack of awareness of the sources and/or modification of the landscape itself and the context in which it was lived. This paper focuses on four case studies from medieval Welsh poetry to identify cultural geomorphosites on Welsh floodplains. Selected poems by four 14th and 15th century poets–Guto'r Glyn, Dafydd ap Gwilym, Lewys Glyn Cothi and Dafydd Llwyd o Fathafarn–were analysed. We present the geomorphosites identified in these poems. These include sites where rivers in flood either prevented these travelling *troubadours* from reaching their destinations, or were used as metaphorical tools in satirical, elegiac or love poetry. The poetry presents the geomorphological features vividly, and provides glimpses of the nature and perception of floodplains in medieval Wales. These sites have now been modified either by anthropogenic activities (channelisation and drainage) or geomorphological processes. We argue that these sources should be systematically analysed in order to fully appreciate the influence of geomorphology on both historical and contemporary culture.

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The Da Vinci Landscape Code; Exploring the Panorama behind La Gioconda

NESCI O.(1), BORCHIA R.(2)
(1) University of Urbino, URBINO , ITALY ; (2) MVR -Montefeltro Vedute Rinascimentali, URBINO, ITALY

This research, which identifies landscapes and panoramic views painted by Da Vinci in La Gioconda (Mona Lisa), uses both quantitative and comparative methods including digital terrain models, geomorphological mapping, image analysis, and detailed study of historical documents. The methods and research are an extension of a highly successful project to document the landscapes in the paintings of Piero della Francesca. The precise representation of Renaissance landscapes is important not only for cultural and historical studies, but also permits a comparison of forms of features with the present day, a type of repeat photography database that has already suggested strong hydrological contrasts. The landscapes of La Gioconda and Madonna Litta center in the high Val Marecchia area (Central Italy). The identification of these landscapes permits and enables a new dimension in cultural, historical, and geomorphological studies.

The geological characterization of the Landscape in movies and fictions: a suggestion to involve the society in the WHS sustainable development

FARABOLLINI P.(1), LUGERI F.R (2), GRECO R.(3), BOCCI C.(4)
(1) Scuola di Scienze Ambientali - Universit_ degli Studi di Camerino, CAMERINO (MC), ITALY ; (2) Istituto Superiore Protezione e Ricerca Ambientale ? Servizio Geologico d?Italia, ROMA, ITALY ; (3) Departamento de Geociências Aplicadas ao Ensino Instituto de Geociências - Unicamp, CAMPINAS - SP, BRAZIL ; (4) Scuola di Scienze Ambientali - Universit? degli Studi di Camerino, CAMERINO (MC), ITALY

The characterization of natural and cultural heritage, using some popular entertainment products, such as TV movies and fiction, can become an effective and original way to involve the society in protecting the territory and enhancing the local development, thanks to the dissemination of knowledge.

The aim is to make understandable to the society the complex aspects of the landscape related to its geological and ecological assessment.

The tools here proposed are the episodes of the TV series "Il Commissario Montalbano" filmed in Sicily. The stories, written by Andrea Camilleri, are located in Sicily (the biggest Italian island in the South of Mediterranean Sea), particularly in some World Heritage Sites.

One of the most important interpreters in the fiction, Cesare Bocci (co-author of this paper) is a geologist: this combination suggested us the potential of the filmic communication in the popularization of the natural and cultural heritage.

For example, the “clou scene” of the episode “Par condicio”, is located in the so called “Latomie” in Ragusa. Latomia means “cut stone”. These ancient quarries are lithologically composed of Tyrrhenian Calcarenites: in the SE of Sicily this kind of stones are very soft and friable: in the local dialect are called "giuggiulena" ("sesame seeds").

The natural and cultural landscapes, giving a fascinating scenery to the films, represent a meaning in the representation of history. At the same time, if recognized and understood, they become part of the cultural heritage of each component of the local community, and the society. The cognitive process activates a virtuous circle, revitalizing the links between humanity and environment. Moreover, it promotes a creative participation of the society in new policies, oriented to a sustainable development, and the tourism -especially geotourism and ecotourism- becomes an important resource, especially in these times of crisis.

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The Aeterna Urbs geomorphological heritage (Rome, Italy)

PICA A., VERGARI F., DEL MONTE M., FREDI P.
La Sapienza University of Rome Earth Sciences Department, ROME, ITALY

The biggest European cities are characterized by millennia of urbanization. The "man-made layering" over the time modified the original setting on which the cities developed, but the geomorphological survey in the urban environment can still recognize the ancient features. We show an example of recognizing the original paleogeographical conditions by means the results of the geomorphological survey conducted within Rome. The aim of the analysis is the geotourist enhancement of the city center, telling about the paleogeography of the ancient Rome through the landforms still visibles. The geomorphological survey led to the geosites inventory and to the identification of three geosites (two geomorphosites and a geosite of stratigraphical interest). We developed an evaluation model of the Geosite Geotourist Value (GGV index) that consists of the quantification of five attributes for each geosite. The attributes evaluated are significant characterestics of scientific and geotourist interest. The GGV allowed to give a priority order for the geosites enhancement. The proposal for the tourism is a geotourist itinerary along which the geosites are joined and related to the historical and cultural features of the city. It is described in a text explaining both the geomorphological and the historical and cultural heritage of Rome city center. It is also represented on a geotourist map, set as a scientific and popularizing device. In this way we supplement the proposal for the historical and cultural tourism of the *Aeterna Urbs* with natural environment features.

Keywords: Urban Geomorphology, Rome, Geomorphosites, Geosite Geotourist Value, Geotourism.

Towards holistic landscape conservation within urban area: a case study of klang gate geoheritage site in Kuala Lumpur, Malaysia

UNJAH T.(1), CHOUN SIAN L.(2), ALI C.A.(1), KOMOO I.(2), LEMAN M.S.(3)
(1) Institute for Environment and Development (LESTARI), BANGI, SELANGOR, MALAYSIA ; (2) Southeast Asia Disaster Prevention Research Institute (SEADPRI-UKM), BANGI, SELANGOR, MALAYSIA ; (3) School of Environmental Science and Natural Resources Faculty of Science and Technology, UKM, BANGI, SELANGOR, MALAYSIA

Conservation of natural heritage within city area is very challenging, particularly in developing countries, due to rapid development and conflict arising from needs to balance economic and protection of natural environment. An attempt to protect natural heritage within the urban area in the country have been initialized by gazetting part of the Quartz Ridge area as a State Park. This ridge is known as Klang Gates Quartz Ridge, located on the northern part of Kuala Lumpur city centre. The ridge is made up of quartz mineral is by far the longest and largest in the country. In addition,the forested area provide important ecological functions; a green lung with endemic flora and fauna, and a crucial water catchment area for the surrounding urbanized areas. The urban sprawl has resulted more housing development toward the quart ridge surroundings, some lands located on the surface expression this quartz ridge have been least-hold to private owner. Four issues were addressed in coming up with the framework of protecting and conserving the important geoheritage: integrated research; establishing mutually acceptable boundary; continuous education and awareness campaign; and stakeholder participation. Integrated research is based on the need for scientific evidence as well as identifying heritage values. Meanwhile, the establishing of mutually acceptable boundary for conservation includes understanding of the nature of the landscape and recognizing the sensitive area contributes to the integrity of the proposed site and reasonable zone for development and vice-versa. The continuous education and awareness programme for this initiative includes collaborative work with the local authorities, NGO's and other stakeholders in disseminating the knowledge towards understanding and praising their common heritage. Stakeholders' involvement is crucial in the protection and conservation of geoheritage, not just because of their proximity and association with the protected area.

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Poster presentations:

Geoheritage of Fluvial Geomorphology in the Middle and Lower Reaches of the Yellow River: A Survey by Means of Remote Sensing

LIU X.P.(1), DONG Y.(2), ZHOU L.P.(1), DONG X.C.(3), ZHU X.Z.(1), QIU F.Y.(1), CAO X.J.(2), CHEN Z.H.(2), ZHOU H.Y.(1)
(1) College of Urban and Environmental Sciences,Peking University, BEIJING, CHINA ; (2) China Institute of Geo-Environment Monitoring, BEIJING, CHINA ; (3) School of Urban Planning and Design, Peking University,, BEIJING, CHINA

Yellow River is China's second largest river with a total length of 5464km. The middle and lower reaches of the Yellow River were formed during the Cenozoic and the tectonic uplift and climate change are the two key factors to shape the river's morphology and its evolution. Throughout the geological time of several million years, various forms of fluvial geomorphology were developed along the Yellow River that record the history of this river and the environmental processes of its basin evolution. Some of these landscapes form geoheritage of fluvial geomorphology. In this study, remote sensing technique is used to investigate these geoheritage landscapes. With the combined use of satellite images and field investigation,we have identified geoheritage landforms at 20 sites in different fluvial geomorphology units in the middle and lower reaches of the Yellow River, which include mountain meander, plain free meander, braider river, delta, river bed, floodplain, terrace, and anthropogenic landforms.We present detailed analysis for two geoheritage sites and show how the remote sensing approach can be used to identify the features andtypes of the geoheritage and to evaluate theirconservation status.

Geopark potential in the plateaus of Parana sedimentary basin, Uberaba City (Minas Gerais), Brazil: geodiversity and geoconservation

GODOY L.H.(1), SARDINHA D.S.(2), CONCEIÇÃO F.T.(1)
(1) UNESP - Paulista State University, RIO CLARO, BRAZIL ; (2) UNIFAL - Alfenas Federal University, POÇOS DE CALDAS, BRAZIL

Uberaba City is located in the Plateaus Geomorphologic Unit of the Paraná Sedimentary Basin, more specifically at the Septentrional Plateau sub-unit. The topography is characterized by flat or slightly undulated surfaces, formed by sedimentary and igneous rocks from the Cretaceous period (145.5 a 65.5 m.a.), with a moderately dissected relief and leveled tops between 750 and 900 m. These characteristics provide to the city a great geotouristic potential regarding its geological and geomorphological heritage.The igneous rocks from Serra Geral Formation are found in 12 points, between 650 m and 802 m of altitude, in which Ponte Alta (40 meters) and Peirópolis III (7 meters) waterfalls can be highlighted.The sedimentary rocks from Uberaba Formation were described in 11 points, ranging from 733 m to 807 m of altitude, where Giovane Cave and Waterfall (12 meters) stands out. In Marilia Formation sedimentary rocks, occurring between 874 m and 918 m of altitude, the Caieira outcrop (three-meter cave with stalactites and stalagmites) and Vale Encantado Waterfall (8 meters) can be pointed out, among 8 other attractions. Furthermore, a point located on a gas station at 1020 m of altitude, has a panoramic view to the local geomorphology, constituted by tabular sierras (cuestas). After the geodiversity assessment, an environmental diagnosis was conducted throughout the geotouristic attractions, by using the Visitor Impact Management Method. The results indicate that only Vale Encantado Waterfall presents a moderate impact, the least when compared to 22 other attractions, exhibiting high or worrisome impact, and 7 with very high impact. In addition to setting the management strategies, and monitoring the environmental impact indicators, this work provides the basis so that activities in the potential Geopark of Uberaba (MG) can be conducted with environmental responsibility and geoconservation.

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Assessment of geomorphosites in the Celil Gorge (Cihanbeyli Plateau, Turkey)

EKINCI D., DOGANER S.
ISTANBUL UNIVERSITY, ISTANBUL, TURKEY

Geomorphosite is a segment of tourism that has developed worldwide and emerging as a new global phenomenon in recent years. It is a form of special interest tourism and focuses on geomorphological features and the types of landscapes. In addition, Geomorphosite is sustainable tourism with a primary focus on experiencing the landform types in a way that fosters geomorphological and cultural understanding, appreciation and preservation, and is locally advantageous. As it state Geomorphosite is landforms to which the society confers a certain value for scientific, but also cultural, ecological, aesthetic or economic reasons. Many natural landscapes are preserved throughout Turkey due to their cultural and historical values as well as for their environmental importance. As it is state, tourism is the largest economic sector in terms of earnings and in number of people employed among Turkey. This paper aims at assessment of geomorphosites on the Celil Gorge where located central Anatolia. There are semi-arid morphoclimatic region. Celil Gorge is a large range of geomorphosites which were formed by the action of the winds. In this gorge, there are many different types of geomorphosites however zeugens are the best example. This site offers a landscape that affects and excites people. The occurrence of zeugens implies immense variations in the rates of degradational activity on the land surface. In zeugens landscapes, the active erosional processes are confined to valley sides and valley floors. These geomorphosites are at different stages of development some are established tourism destinations and some are working towards this goal. As a result, this area has important resources concerning geomorphologic heritage so ıt has a big geomorphotourism potential and has a unique position in the world.

Conservation, management and valorization of geomorphological heritage in 'geological' nature reserves: the case of the Vigny quarry (Vexin, France)

BETARD F.
Univ Paris-Diderot, PARIS, FRANCE

Located in the French Vexin to the NW of Paris, the Vigny quarry is a geosite of international relevance, recently classified as a Regional Nature Reserve (RNR) of geological interest (in 2009). Exposing reefal and peri-reefal limestones of Palaeocene age, the site was considered by E. Desor (1846) as the co-stratotype – together with the Danish series of the Fakse quarries – of the Danian stage. Furthermore, the Vigny limestones contain the richest Danian molluscan fauna in Europe and are the only known reefal complex of Tertiary age from the Paris Basin. As a whole, the Vigny quarry exhibits various aspects of geoheritage of great scientific and educative value: stratigraphy, palaeontology, sedimentology, tectonics… Geomorphological heritage is one of the major interests of the geological nature reserve. The site is a veritable open-air museum of palaeolandforms of various types, including palaeo-fault scarps with well-conserved tectoglyphs (striation features, coatings), palaeo-submarine landslides (slumping with olistoliths of reefal limestones, debris- and mud-flows of fluidized chalk), Pleistocene palaeosols with cryoturbation features, etc. The development of lookouts and scenic vantage points along a “geomorphological” trail still increases the interest of the site for geomorphology. Protection of geomorphological heritage and other geological features was made possible by 2003 with the land acquisition by the Val d’Oise Departemental Council, which developed an exemplary strategy of conservation, management and valorization of the geoheritage (security setting, pedagogic facilities and tools, information panels, website for school education, museography, mainstream publications…). With its recent classification as a Regional Nature Reserve, this reinforces the protection status of the Vigny quarry and extends the program of conservation, management and valorization of this unique geoheritage of the Paris Basin.

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Geosites of the Al Madinah Volcanic Geopark as the first geopark proposed to develop in the Kingdom of Saudi Arabia

NEMETH K.(1), MOUFTI M.(2)
(1) Massey University, CS-INR, PALMERSTON NORTH, NEW ZEALAND ; (2) King Abdul Aziz University, JEDDAH, SAUDI ARABIA

UNESCO promotes conservation of the geological and geomoprhological heritage through promotion of protection of these sites and development of educational programs under the umbrella of geoparks. Here we identify significant volcanic features that could be organized and promote as the first geopark, the Al Madinah Volcanic Geopark in the Kingdom of Saudi Arabia. The Harrat Al Madinah Volcanic Field has numerous volcanic geosites relevant to broaden our understanding of the evolution of volcanic fields dominated by Hawaiian and Strombolian style volcanic cones and lava fields. The proposed geopark includes the location of the last historically erupted volcanoes in the Arabian Peninsula. A major geosite has been selected to demonstrate the diversity of volcanic phenomena associated with the intraplate volcanism of the Harrat Al Madinah, that created lava spatter and scoria cones formed in a 52 days eruption in AD 1256 just 10 km SE of Al Madinah city. The eruption formed a ~2 km long NW-SE-aligned fissure with at least seven vents, which made a chain of nested lava spatter/scoria cones. More violent explosive phases of the eruption formed an extensive ash plain. The well-preserved craters show evidences of dynamic crater formation through lava infill, drainage and cone rafting through side vents fed the major lava fields. The geosite is one of the best accessable places globally to see well-exposed lava spatter and scoria cone complexes. The Harrat Al Madinah is also located in a culturally significant place near to Al Madinah city which is one of the holiest places to Muslims. The proposed geopark is easily accessable through highways (and by train in the near future) and it would provide significant economic benefit to Al Madinah city, which also plays an important role for Muslim pilgrims visiting the holy sites in the city that would open up a cost-effective volcanic geoeducation program that could be offered as alternative geotouristic programs for visitors.

Sinkholes in the Island of Gozo (Malta): Geomorphosites to be protected and enhanced

CORATZA P.(1), GALVE J.P.(2), SOLDATI M.(3), TONELLI C.(4)
(1) Dipartimento di Scienze Chimiche e Geologiche, University of Modena and Reggio Emilia, MODENA, ITALY ; (2) Universidad de Zaragoza, ZARAGOZA, SPAIN ; (3) Universita di Modena e Reggio Emilia, MODENA, ITALY ; (4) Universita' di Modena e Reggio Emilia, MODENA, ITALY

The Island of Gozo is part of the Maltese archipelago which is located in the Mediterranean Sea, about 90 km south of Sicily and 290 km north-east of Tunisia. Karst processes play an important role in the Maltese archipelago due to the extensive presence of limestones, which has favoured the development of an interesting karst system on the islands and the surrounding submarine area. The effects of karst processes through time are particularly evident in Gozo, where 17 sinkholes have been recognised, some of which of notable size and high aesthetic interest. These sinkholes have been assessed applying a methodology which has been specifically set up with the aim of verifying whether any of them could be considered as geosites according to their scientific, additional (ecological, aesthetic, cultural) and use values. The geosite assessment highlighted that 6 out of the 17 investigated sinkholes can be considered as geosites of geomorphological interest (geomorphosites). Finally, issues related to their enhancement and fruition are taken into account in the frame of potential geotourism strategies. The original contribution of this study is to show that sites of geomorphological interest, such as sinkholes, can become part of a culturally accessible and shared heritage, making them a resource for social and economic development in their own territory. Indeed, the sinkholes selected as geomorphosites in Gozo can be considered as new elements that can catalyse the potential of a territory which is often neglected.

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Tufa and Heritage: Geomorphosites as main elements of Cultural and Historical Monuments (High Ebro River, Spain)

SERRANO E.(1), GONZÁLEZ-AMUCHASTEGUI M.J.(2)
(1) University of Valladolid, VALLADOLID, SPAIN ; (2) Basque Country Univesity, VITORIA, SPAIN

The High Ebro River Area is located in the Cantabrian Range in Northern Spain. It is a folded calcareous cover defining a structural relief drained by the Ebro River. In this area there are fifteen tufaceous complexes aged from Pleistocene to Holocene and present day tufas, linked to Cultural and Historical Monuments.

The presence of tufas is the key factor to understand the emplacement of human settlements during different historical periods. The hydraulic resources, linked to springs, the defensive location and baths are the most common land use of tufas.

This area is very frequented by visitors attracted not only because of the landscape, but also of Historical monuments. In spite of the narrow relation between tufas and cultural landscape, the calcareous buildups are no included nor taken in account in touristic information.

In this work four cases have been selected (Frías, Orbaneja del Castillo, Sedano and Tubilla del Agua), two of them are National Monuments located in a Natural Protected Area -NPA-, andin all cases exist a close and valuable relationship between tufas and cultural heritage. The study implies:

- Assessing the intrinsic, extrinsic and use values of the tufas as ~~a~~ geomorphosites following the assessment method used in previous published works.
- Making documents and tools (mapping, dates, analysis) to land managers (municipalities, NPA) focusing on the inclusion of geomorphic values as natural heritage joint to the cultural ones.
- Propose documents (explanatory maps and leaflets, cards) to incorporate the knowledge on tufa (genesis, age, present-day dynamic) and its relationship with cultural heritage.

Inclusion of tufa knowledge as an attractive to visitors and for the touristic or land management in High Ebro river area must be undertaken from the geoconservationism; our proposal for these four examples allows elaborate a model to be applied in a wider area. Moreover, it provides useful tools for managing tourist resources.

Cantona, one of the largest prehispanic cities in the mesoamerican region; relations to geosites and geomorphosites

PALACIO-PRIETO J.
Instituto de Geografia, Unversidad Nacional Autonoma de Mexico, MEXICO CITY, MEXICO

Cantona is located in Central Mexico, about 160 km to the east of Mexico City. This large prehispanic city, culturally located in the Mesoamerican region, covers about 14 km^2, most of the ruins are still to be recovered (only 1% is open to visitors) and few information about its original inhabitants has been gathered so far.

Cantona is contemporary with other great Mesoamerican cities including: Cholula, Teotihuacan and Monte Alban and its height ranges from 2300 to 1300 yBP. Its population has been estimated at about 100 000 inhabitants.

The entire city is located over lava flows generated in the “Los Humeros” caldera about 20-30 K years; the structure of the city is strongly determined by the rough surface of the flows and their configuration, running in a North-South direction. Due to its strategic location (half way between the Gulf of México and Central México), Cantona represented a commercial site of great importance, where obsidian was the main product. Obsidian deposits are located at less than 10 km to the northwest and up to 400 workshops have been found inside the archaeological site.

Geologically, the region corresponds to a transition area were sedimentary rocks (Mesozoic) are covered by volcanic deposits, like the lava flows mentioned above. The presence of nearby maars has also to be pointed out; six maars (locally known as “Axalapazcos”) are distributed along a flat surface, formerly a lake now under a process of progressive dissecation. Other outstanding features include two large stratovolcanoes: “Pico de Orizaba” (the highest mountain in Mexico and the third highest in North America; It rises 5,636 metres) and “La Malinche” (almost 4,000 metres).

The area is under study in order to promote geotourism based on its geological, geomorphological and cultural attractions.

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The enhancement of a geotourist trail in the Adamello Brenta Nature Geopark (Rhaetian Alps)

PICA A.(1), BAZZOLI G.(2), DEL MONTE M.(1), MASÈ V.(2)
(1) La Sapienza University of Rome Earth Sciences Department, ROME, ITALY ; (2) Adamello Brenta Nature Geopark, STREMBO (TN), ITALY

The high geodiversity of the Italian territory has seen, in recent years, the birth of 8 Geoparks, economic resources of the territory on which they insist, through the promotion and protection of geological heritage and culture. Among the Italian Geoparks members of the EGN (European Geoparks Network), the Adamello Brenta Nature Geopark is the only one representative of the Southern Alps geodiversity: in the geopark area we have evidences of the Adria microplate’s continental margin evolution from the late Paleozoic to his involvement in the Alpine orogenesis. The territory is divided by the Giudicarie Line into two geological and geomorphological very different landscapes and it is possibile to see igneous, sedimentary and metamorphic rocks in contact with each other, within a few miles. The Geopark has an action plan full of popularizing and educational activities, conservation actions and research. The geotourist enhancement of some valleys of the Geopark is one of the action plan aim. For this pourpose these valleys have been analyzed with the help of a method proposed by the University La Sapienza of Rome, in order to assess the Geosites Geoturist Value (GGV) of the geosites in the area through data processing in GIS environment. The application of this method allows to choose an itinerary to visit the geological sites with the higher values of GGV. The geoturist itinerary is presented together with the Adamello Brenta Geopark strategies of earth sciences interpretation and popularization, designed to bring students and tourists to the interpretation of the landscape and to the understanding of the geology: guided excursions, educational projects based on the manual ability improvement, promotion of human relationships, and also experiencing innovative technologies, such as the interpretation of LIDAR images on the interactive whiteboard, are used as a tool.

Keywords: Geopark, Geosite Geotourist Value, G.I.S., Geotourist trail, popularization.

Volcanic Geomorphosites within the large Kanawinka Geopark of southeastern Australia; identifying, describing, evaluating and managing Geomorphosites for future use in Geotourism

JOYCE E.B.
Earth Sciences, The University of Melbourne, PARKVILLE, AUSTRALIA

Australia's first Geopark is on the broad Western Plains of Victoria and an adjacent part of southeastern South Australia, with some 100 well-studied volcanoes ranging in age from five million years to just a few thousand years - Mount Gambier maar erupted only 5,000 years ago. The Geopark is part of a larger area known as the Newer Volcanic Province of Southeastern Australia, one of the best studied of the world's young basaltic monogenetic lava fields. Volcanic landforms include numerous scoria cones, and some 40 maar craters with ash deposits, and extensive lava shields have been built up by Strombolian/Hawaiian eruptions, with fluid lava flows travelling for tens of kilometres down river valleys. The indigenous heritage of the Geopark includes a complex aquaculture of Aboriginal fish and eel traps, and the remains of stone houses in the stony rise flow landscapes of Budj Bim (Mount Eccles volcano). Post-contact settlement is evident in historic "bluestone" (basalt) houses and farm buildings, bridges, churches, and the many striking stone walls. Within the Geopark a Volcanoes Discovery Centre has been established at Penshurst, new reserves have been developed at Mount Elephant and Mount Rouse volcanoes, and improvements to interpretation made at other sites. The integration of volcanic research, local history study, and heritage interpretation is the key to developing a greater awareness of the Kanawinka Geopark. Within the area of the new Kanawinka Geopark are many important Geomorphosites including lava caves of International significance, open volcanic vents, major tumuli groups, and springs and waterfalls. Coastal features include limestone cliffs, calcareous dunes, basalt headlands and cliffs, drowned lava flows and a large offshore volcanic island. Since the area was recognised as a Geopark in June 2008, the Geopark has been developing new material for use by Geotourists, Geotourism operators and local government bodies.

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Runoff impact on active geomorphosites in unconsolidated substrate. a comparison between earth pyramids in the swiss alps and badlands in the italian apennines

IRENE B.(1), REYNARD E.(2), LUPIA PALMIERI E.(3), PELFINI M.(1)
(1) Universita degli Studi di Milano, MILANO, ITALY ; (2) Université de Lausanne, LAUSANNE, SWITZERLAND ; (3) Università La Sapienza di Roma, ROMA, ITALY

The cultural value of geomorphological heritage (i.e. geomorphosites) is universally recognized and at the same time the interest on its mutability, as a consequence of both natural-climate and human pressure, is growing. At this scope the focus has been put on *active geomorphosites*, in which it is possible to observe and quantify the geomorphological processes that vary mainly as a response to climate change. In some cases a sudden increase in the velocity of processes can cause irreversible modifications threatening the survival of sites as well as their scientific value in term of integrity.

The runoff derived morphologies on unconsolidated or partially consolidated deposits may form in different geological (e.g. textural and structural) and morphoclimatic conditions, under influence of water runoff action. The study cases are: *calanchi* on marine originated clays in the Italian Apennines in Mediterranean climatic context (i.e. Crete d'Arbia, Tuscany) and earth pyramids formed on glacial heterometric deposits in mid-mountain environment (i.e. Pyramides d'Euseigne, Canton Valais, Switzerland). In both the study cases human activities (e.g. deforestation, grazing and farming, land-use changes, especially cropland abandonment) have strongly contributed to landscape evolution.

In order to investigate erosion rates, dendrogeomorphology investigations (abrupt growth changes and root exposure analysis) have been integrated to traditional quantitative geomorphology techniques, for detailing and extending to the past the direct monitoring results. Dendrogeomorphology indicators reveal stress caused by variation in geomorphic processes involving trees depending on climatic/meteorological conditions. Especially at Crete d'Arbia a correlation between average erosion rates coming from biologic (1.7 cm a^{-1}) and a-biologic techniques (1–1.5 cm a^{-1}) has been found and the results of the comparison between erosion rates in both marine and glacial deposits are presented.

Urban geotourism

RODRIGUES M.
Universidade de Lisboa, Centro de Estudos Geograficos, LISBOA, PORTUGAL

The great majority of the urban centers, including some metropolis, were build in areas providing the inhabitants with natural benefits: rivers or littoral environments (rich in natural resources or transportation routes), good agricultural soils (as volcanic ones), hilly landforms (were castles or fortifications stand), natural springs to fulfill the water needs (as karst springs) and other geomorphologic, geologic, hydrologic or soil features. Although those urban centers have increased in size over the time (occupying the rural surroundings), many of that previous geodiversity still remains perceptible in the urban landscape.

Today most of the world population lives in towns leaving behind the rural landscapes (Rodrigues *et al*., 2011) and the geoheritage that represents the values of its geodiversity. To promote the geoheritage still preserved in urban environments, establishing urban geotourism routes, could be a very good way to stimulate the urban population to fully appreciate the geoheritage and to develop geotourism.

Geotourism can be considered both in broad and in strict senses (Rodrigues, 2009, 2011). In strict sense, geotourism is a tourism segment focused on the sustainable usufruct (by geotourists and local communities) of the geoheritage fruition. In broad sense, geotourism can be considered as a tourism segment mainly focused on the sustainable usufruct (by geotourists and local communities) of the geoheritage fruition, which can be added the cultural heritage (material and immaterial) of the areas. In this sense geoheritage is the driving force of the geotourism itineraries, but the cultural heritage it is also added to increase the value of the visited regions.

This broad sense of geotourism applies perfectly to urban geotourism. In the cities we can establish geotourism routes were geoheritage can be linked with cultural heritage as we can demonstrate with examples from Lisbon city or, in a more large scale, from the Metropolitan Area of Lisbon.

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Evaluation of a geotope of exceptional importance within the Cameroon coast: the Lobe Falls

TCHINDJANG M.
University of Yaoundé I, YAOUNDE, CAMEROON

According to Strasser et al., (1995), "Geotopes are portions of territory with a value for the Earth Sciences. This term therefore includes mountains, hills, valleys, ravines, caves, riverbanks and shorelines, quarries, gravel pits, ... sites that provide information and compelling features on a situation or event that the Earth has experienced over geologic time or the history of life and climate. The geotopes help to understand the spatio-temporal evolution of a region, the significance of surface processes and the importance of rocks as part of the construction of landscape. The geotopes, in this sense, are natural monuments of great importance, even essential, for both the public and the science »

This definition is consistent with the observations made in the Lobe Falls, a geotope or geosite located along the Cameroon coast. The definition adopted for the evaluation of the geological site for tourism is broad, because it takes into account the cultural aspect and the three-dimensional representation of the communities (Batanga, Mabi and Pygmies) living around. This system of representation seems to be the element that allowed the preservation of this geotope.

In fact, geosite being any geological or geomorphological object having a certain value, whether scientific, historical-cultural, aesthetic or socio-economic, the actual value of Lobe Falls depends as much on its scientific characteristics and contextual location, its use, its historical value and its beauty. These are the criteria that will allow me to assess the importance of the Lobe Falls for tourism development and its patrimonial value in a context where the site is threatened by the management of the deepwater seaport of Kribi as well as oil and gas exploitation.

The adopted approach draw upon the environmental assessment process that will take in account sensitivity, aesthetic and ecological criteria to identify and highlight its intrinsic value.

Geomorphic context and active processes influencing a cultural heritage: irrigation channels in Valais, Switzerland

REYNARD E.
Institute of Geography and Sustainability, University of Lausanne, LAUSANNE, SWITZERLAND

The Canton of Valais (Switzerland) is characterised by dry climatic conditions that explain the presence of an important network (about 800 km) of irrigation channels – called *Bisses* or *Suonen* – dating back to the Middle Ages. During the last 30 years these agricultural infrastructures have sparked a renewed interest for tourist and cultural reasons. Indeed, the paths along the channels are used as tourist trails and several abandoned channels have been renovated for tourist use. Based on an inventory of the *Bisses/Suonen* of Valais, the proposed poster has three aims: (1) to analyse the geomorphological context (morphometric analysis, structural geomorphology, main processes) of each *Bisse/Suon* and to show the impact of the geomorphological context on the building techniques; (2) to identify particularly active processes along the channels; (3) to classify the *Bisses/Suonen* according to their geomorphological value and to their geomorphological sensitivity. The proposed ranking will be used to prepare the candidature of the *Bisses/Suonen* network for the World Heritage List.

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A new network on mountain geomorphosites

REYNARD E.(1), BOLLATI I.(2), CAYLA N.(3), CORATZA P.(4), GIUSTI C.(5), HOBLÉA F.(3), ILIES D.(6), MARTIN S.(1), MEGERLE H.(7), PELFINI M.(2), REGOLINI G.(1), SELLIER D.(8), ZORN M.(9)
(1) Institute of Geography and Sustainability, University of Lausanne, LAUSANNE, SWITZERLAND ; (2) Department of Earth Sciences, University of Milan, MILANO, ITALY ; (3) Laboratory EDYTEM, University of Savoie, CHAMBÉRY, FRANCE ; (4) Department of Chemical and Earth Sciences, University of Modena and Reggio Emilia, MODENA, ITALY ; (5) Institute of Geography, University of Paris-Sorbonne, PARIS, FRANCE ; (6) Department of Geography, Tourism and Territorial Planning, University of Oradea, ORADEA, ROMANIA ; (7) University of Applied Forest Sciences, ROTTENBURG AM NECKAR, GERMANY ; (8) Institute of Geography and Regional Planning, University of Nantes, NANTES, FRANCE ; (9) Anton Melik Geographical Institute, Slovenian Academy of Sciences and Arts, LJUBLJANA, SLOVENIA

As mountains are recognized to be natural areas with a very high geodiversity, and at the same time as areas with a great potential for the development of soft tourism, a new Network on Mountain Geomorphosites was created in October 2012 in Lausanne (Switzerland). The Network is open to all researchers active in geoheritage, geoconservation and geotourism studies in mountain areas. Research will focus on three main issues: (1) Geoheritage and natural processes: because mountains are very sensitive to climate change it is hypothesized that geoheritage will be highly impacted by global change in the future. These impacts must be better addressed by geomorphologists. (2) Geotourism: There is currently a lack of research addressing issues such as the needs of the potential public(s) of geotourism, the evaluation of the quality of geotourist products and the assessment of the economic benefits of geotourism for the regional economy in mountain regions. The collaboration with social scientists (economists, sociologists) will help to fulfill this objective. (3) Environmental education: Few studies have addressed the question of using geoheritage to communicate on more general issues like the dynamics and sensitivity of mountain environments or the impacts of climate change on mountain areas. It is, therefore, necessary to develop communication and learning methods – in particular by using new communication technologies – to improve environmental education based on geoheritage site promotion for several kinds of audiences, in particular tourists (to improve their awareness on the sensitivity of mountain environments) and scholars. These three research objectives will be fulfilled by the development of common research, in particular cross-border case studies, and by the elaboration of specific courses for Ph.D. and master students. Collaboration with existing mountain networks (scientific, nature parks, etc.) is expected.

The Sulcis Iglesiente mining compound (Sardegna, Italy) inside the UNESCO World Heritage Tentative List

PANIZZA V.(1), CORATZA P.(2)
(1) University of Sassari , SASSARI, ITALY ; (2) University of Modena, MODENA, ITALY

The Sulcis Iglesiente territory is located in the southwestern part of Sardinia and it is the most important Italian mining compound. This is a very important area from both geological and geomorphological standpoint, due to the complex geodiversity. In terms of geological aspects, other than carboniferous granites and diorites, we can also find metal limestones and dolomites where there are the main lead and zinc veins of the island. From a geomorphological point of view, the relief is predominantly controlled by geological structure and the landforms can be mainly related to different morphogenetic factors and processes: gravity-induced, karstic, coastal. There are evidence of ancient settlement since the prehistory due mainly to seams of lead, silver and zinc in the Iglesiente and to coal in the Sulcis.

Aiming at protecting the rich and unique geological, natural, historical and cultural heritage of this territory, the Italian Minister for the Environment and Land Protection established, in 2001, the geo-mining historical and environmental park of Sardinia, which include other important mining areas of the island. Moreover in 2006 the area have been submitted in the UNESCO World Heritage Tentative List on the basis of the criteria ix and x.

In present work we will highlight the geological and geomorphological values which represent the basis of all the other aspects for which the area has been pointed out and included in several proposal of protection and enhancement.

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Mapping geomorphodiversity. Case study: Bucegi Mountains

COMANESCU L., NEDELEA A., DOBRE R.
University of Bucharest, BUCHAREST, ROMANIA

The present paper aims at developing a new type of map, namely the map of geomorphodiversity of the Bucegi Mts., an area that is representative for the Romanian Carpathians.

The geomorphodiversity map has been done in several stages:

- The first stage investigated the geological conditions of the study area based on specialty literature and on the existing graphic and cartographic sources (geological and geomorphological maps, as well as aerial photographs). In this respect, the geological map has a significant relevance, because structure and petrography generate specific landforms that acquire value thorough the human perception. This so-called geomorphosites lead to high values of geomorphodiversity. In order to correlate them with the geological conditions they were outlined on the geological maps.
- At the base of the geomorphodiversity assessment lies the general geomorphological map, which was developed after several field trips undertaken with the purpose of making measurements and detailed mappings using a Garmin GPS receiver. The general geomorphological map, which was filled with additional data derived from aerial imagery (the flight of 2005), also gave us the possibility to make an inventory of the geomorphosites that can be seen in the study area.
- By making a synthesis of the information collected in the previous stages we were able to compute the geomorphodiversity index based on the formula below:$Gmd = (\sum EgXn + Gm)/S$

where*Gmd* = geomorphodiversity index; *Eg* = the number of landforms; *n* = the number of the genetic types of landforms; *Gm*= the number of geomorphosites; S = area (in sq. km)

Geotopes portal; A methodological approach from the field to the Web

SKENTOS A.(1), MITROU A.(1), PAVLOPOULOS K.(1), ANAGNOSTOPOULOU O.(2)
(1) Harokopio Univeristy, ATHENS, GREECE ; (2) University of Athens, ATHENS, GREECE

The purpose of this paper is to register and promote greek geosites through a web-gis application. The methodology is based on the calibration of a set of criteria for each geosite that covers the topics of geology, ecology, culture, tourism and aesthetics. Further analysis of these data forms a geodatabase. The web application is characterized by a user friendly interface and provides the appropriate tools that allow the user to interact dynamically with the geodatabase. The main features of the application are "map display of the geosite location over base maps", "legend panel" that enables the user to manage the layers of the map, "map interaction tools" such as zoom in, zoom out, pan, full extent, previous view, "information tool" that provides text and photos about the geosite, "search list" by name or location. Also there is a user oriented approach that enables the user to register/ login in order to add new geosites and/or comment about the already existed ones. The web application adopts the latest open source web-gis frameworks like Open Layers, GeoExt and ExtJs api's.

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Typology and repartition of geosites in Danube Gorges (Romania)

IOSIF D.(1), FOUACHE E.(2), GRECU F.(1), GIUSTI C.(2)
(1) University of Bucharest, Faculty of Geography, BUCHAREST, ROMANIA ; (2) University of Paris - Pantheon Sorbonne, PARIS, FRANCE

This study focuses on the main geosites from the Danube gorges in Romania (*Iron Gates*), especially on their typology and repartition. Generally, the Romanian studies on geosites are at beginnings but there are great perspectives. Presenting the geology and the geomorphology of the Iron Gates as geosites is a good opportunity to solve some of the actually questions and, in the same time, to open a perspective for the touristic valorization.

We have identified more than sixty geosites along the Danube but with the aim to make the study more concise we have chosen only forty the most important. Then we have studied every single one with the main intention to establish the typology of those geosites. According to their main geological and geomorphologic characteristics, we have classified those geosites in eight categories. The great number of geosites' categories reflects the geology complexity and especially the geodiversity of the Iron Gates region. We distinguish, among the eight categories of geosites, the petrographical, the geomorphologic and the speleological ones, each with eight elements.

The repartition of those geosites along the Danube reveals many important geological and geomorphological realities. We observed that they are not distributed uniform on our region. We can also separate three zones which are directly related with the dominant geosites. Thus, we distinguish a zone where the petrographical sites are dominant, a zone where the speleological sites are dominant and another one zone where we can find a preponderance of geomorphologic sites. This repartition is not randomly created but it corresponds to the geological and geomorphological features of the most beautiful and the most complex Danube gorges.

Alpine geomorphosites in protected areas and mitigation of natural hazards

KOMAC B., ZORN M., ERHARTIC B., FERK M.
Research Centre of the Slovenian Academy of Sciences and Arts, Anton Melik Geographical Institute, LJUBLJANA, SLOVENIA

Geomorphic processes shape landforms which can be recognized as characteristic or important from specific points of view, such as scientific, ecological, cultural, economic, or aesthetic, and termed geomorphosites.

Landscapes with high number of geomorphosites are often protected but also subject to intensive geomorphic processes. In such areas, management of geomorphosites has to take into consideration both, the value of geomorphosites, and the nature of geomorphic processes that (re)shape (or may even destroy) them. Natural systems can help reduce the impacts of natural hazards. When combined with sustainable management, they represent the most economically effective part of preventive strategies.

In traditional Alpine societies, the management of high-mountain areas was an integrated system, where individuals (mostly farmers), organizations (forest- and hydro-management companies) and states (since 1880 in Slovenia) had each their own important and defined role. The traditional management system was maintained until the economic (tourism, traffic) and political changes in the middle and the end of 20thcentury, respectively. The change of traditional relations was accompanied by raising awareness about the value(s) of the Alpine environment. Some parts of the Slovenian Alps have been protected since 1924. Today, the function of the natural environment as a regulator of natural hazards can easily be maintained in the protected areas.

Some examples of efforts related to management of hydro-geomorphic processes in protected areas in Slovenia, related to geomorphosites and their protection are presented. It is stressed that protected areas can contribute to management of geomorphic processes, and therefore to prevention in the field of natural hazards. By maintaining the sustainable management of high-mountain Alpine areas which are important from the point of view of geomorphosites we also indirectly protect the settlements in valley bottoms.

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Assessment of the geomorphosite on salt from Ocna Sibiului (Transylvanian Basin, Romania)

TOMA B., IRIMUS I.A., PETREA D., ROSIAN G.
Babes-Bolyai University, CLUJ-NAPOCA, ROMANIA

Abstract: The salt ore from Ocna Sibiu is located at the southern end of the anticline Ohaba - Prisaca - Ocna Sibiu, and is one of the oldest exploited salt massif from the Transylvanian Depression. On its surface have been found traces of both Roman and Anteroman explotations. This paper presents a method for assessing the geomorphosite on salt from Ocna Sibiului. In this saliferous area was identified one geomorphosite, Ocna Siubiului Lacustrine Complex. This lacustrine complex is a system geomorphosite with areal extending and with high landscaping and hydrographic relevance. The geomorphosite includes 14 salt water lakes which were formed on the back of the salt massif. Both salt morphology and tectonics and the morphology and dynamics of lacustrine basins provide to this geomorphosite high scientific value. The main characteristic that provides economic value of this geomorphosite is the very small distance, 15 km, from Sibiu airport and highway. The cultural value is given by the presence of Sibiu, which in 2007 was the European Capital of Culture, and the touristic value is given by the climate zone, aerosols and therapeutic effect of the salt water.

Key words: Ocna Sibiului, geomorphosite, salt, assessment, Transylvanian Basin

The Rakov Skocjan Karst Basin: Exceptional natural heritage

FERK M., ERHARTIC B., ZORN M., KOMAC B.
Research Centre of the Slovenian Academy of Sciences and Arts, Anton Melik Geographical Institute, LJUBLJANA, SLOVENIA

The Rakov Skocjan Karst Basin formed in a leveled karst plain in the northern part of the Dinaric Karst. The basin is 3.5 km long and is divided into two parts: (1) the lower Rak Valley, where periodical fluctuations of piesometric level can be observed, and (2) the hydrologically inactive basin of Podbojev Laz. Complex morphological development of the basin with several development stages has been confirmed by previous studies. Changes in local water-flow directions during its genesis resulted in an exceptional variety and quantity of karst phenomena in the small basin.

The amazing scale and astonishing forms of karst features in Rakov Skocjan have attracted people of various professions for centuries. In 1949 it was proclaimed the second protected area in Slovenian territory. Since 2002, the basin has also been included in the Notranjska Regional Park. According to several methodologies for evaluating natural heritage, the Rakov Skocjan Karst Basin may have been interpreted as an exceptional geomorphological phenomenon because of its: (1) exceptional natural beauty and diversity, (2) significant importance for scientific research, (3) important ongoing geomorphological processes, and (4) specific natural habitat for indigenous flora and fauna. Therefore, Rakov Skocjan fits a wide range of UNESCO criteria for determining Natural World Heritage. However, despite its dual protection, the park's management is poorly organized and policies for its long-term preservation remain uncertain. To ensure proper protection and sustainable management of Rakov Skocjan, the Anton Melik Geographical Institute of the Scientific Research Centre of the Slovenian Academy of Sciences and Arts is starting the process for registering it in the UNESCO World Heritage List.

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3D exploration of the San Lucano Valley: virtual geo-routes for everyone who want to understand the Dolomites landscape

TESTA B.(1), ALDIGHIERI B.(2), DI BONA A.(3)
(1) National Council of Research- Institute for Dynamics of Environmental Processes , MILANO, ITALY ; (2) National Council of Research- Institute for Dynamics of Environmental Processes, MILANO, ITALY ; (3) Pangea S.r.l., BOLOGNA, ITALY

In June 2009, San Lucano Valley (Belluno, Italy) was included in the "World Heritage" UNESCO System n.3: Pale of San Martino - San Lucano-Belluno Dolomites.

The Valley is already well known for their naturalistic attractions by hikers and tourists, but the combination between its geological, geomorphological, structural and stratigraphic features with its naturalistic values, make this site a "natural book" of global significance: because of its geomorphodiversity and of its environmental context, this Valley was selected for a broader project of scientific dissemination concerning the Belluno Dolomites.

Our work is to translate the amount of geomorphologic and geological singularities of the Valley into attractive details, useful to underline this unique area as a real key to understand the geological history of Dolomites from Triassic to present.

The purpose is to disseminate geo-scientific knowledge and reaching the most different kind of users (primary and high schools students, sightseers, amateurs, "mystical paths" pilgrims, etc.) by several facilities (GIS, WebGIS, Apps for mobile devices) used together: with a simple click you must be able to prepare for your hikes, knowing in advance the territory, bike riding first at home virtually in 3D, discover the hidden corners of the Valley and then get excited, step after step through the paths prepared for you! Each route must be accompanied by a technical card with altitude, photos, descriptions, PDF maps and .gpx files that can be downloaded. For whom wishing, just moving the mouse searching the most exciting mountain landscape, it become possible to explore by yourself. These utilities could be a starting point to stimulate and develop a sustainable geo-tourism in upland, often depopulated because of lack of expectations.

Following the tracks of Charlemagne in the Cottian Alps. The cultural and geological heritage of the Franks trail (Susa Valley, Piemonte, NW Italy)

GIORDANO E.(1), GIARDINO M.(1), BARAL G.(2), GHIRALDI L.(3)
(1) University of Turin, TURINO, ITALY ; (2) Comunità Montana Pinerolese, PINEROLO, ITALY ; (3) Natural Sciences Museum, TURIN, ITALY

The Susa Valley is one of the Alpine valleys included in the territory of the “Alpi Cozie Geopark” (Interreg Alcotra 2007-2013), whose application to the European Geoparks Network is in progress. The Alpi Cozie Geopark also includes selected areas of the Pellice, Chisone and Sangone valleys (Italy) and of the Briançonnais and Maurienne communities of communes (France). It represents a unique and great geological section that shows all the structures and rocks involved by the Alpine orogenetic events.

Humans have populated the Alps for fifteen thousands of years; during this time, quarries have been opened and mines excavated, villages have been built as well infrastructures. We changed the natural landscapes, but we also felt climatic changes, avalanches and floods, landslides and earthquakes. The union between human actions and components of the physical environment shaped cultural landscapes. We should consider these landscapes as a heritage to be known by people and to be valorised by geotourism.

The Franks trail is a route crossing for 60 km the geopark territory. It probably follows the Charlemagne path on 773 aD planned to avoid the Langobards encamped in the valley bottom. During the centuries the trail has been used by pilgrims on their route towards Rome. The trail goes from Oulx to Saint Michael's Abbey and it runs into many sites that tell about geological, environmental and cultural heritage. It takes about three or four days to hike over the entire trail, during which tourists will visit abbeys, moraines, quarries, mines, ecomuseums and protected areas.

The Franks trail is easily connected with the *Via GeoAlpina*, an international project that aims to show the wonders of alpine geology and geomorphology. On the bottom side an itinerary crosses all the Rivoli-Avigliana morainic amphitheatre, while on the top the “Colletto Verde international geological trail” leads the hiker to the ocean floor showing some pillows lava.

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Geodiversity map of Valderejo Natural Park (Northern Spain)

PELLITERO R.(1), GONZÁLEZ-AMUCHASTEGUI M.J.(2), SERRANO E.(1), MANOSSO F.(3)
(1) Universidad de Valladolid, VALLADOLID, SPAIN ; (2) Universidad del País Vasco, VITORIA, SPAIN ; (3) Universidade Tecnológica Federal do Paraná, FRANCISCO BELTRÃO, BRAZIL

A 1:25.000 geodiversity map of Valderejo Natural Park is presented. Valderejo is situated in the Basque Country, N of Spain. It is only 3500 hectares extent. It is a mid-mountain environment whose peaks rise to 1241 m.a.s.l. whereas valley bottom is at 613 m.s.n.m. Lithology and morphostructures are quite simple at Valderejo. The entire park is situated within an anticline where limestones are situated at the flanks and marls in the centre. The anticline has been eroded at its centre by Purón river, an Ebro tributary. Such erosion opened a *cluse* at the southern flank of the anticline. Here tuffa terraces have developed.

Map was created following Pellitero et al. (2011) methodology but on a raster scheme. Geomorphological, geological and hydrological data coming from relevant 1:25.000 maps has been used to get the 32 geological and geomorphological classes on which geodiversity calculation is based. For geodiversity calculation we have chosen a typical diversity index, the Richness Index, which computes how many different classes exist per each 1 ha. pixel. In order to succeed calculating geodiversity it must be implemented a geoprocess which turns all features into polygons, transforms polygons into raster features, gives different values to each different element and calculates value variety.

Results show that there are two geodiversity hotspots. Cliffs are usually high geodiversity areas; here there are karstic landforms at the top and gravitational landforms and processes at the cliff itself. River margins are also high geodiversity areas where erosion and sedimentation processes, as well as sedimentary landforms as fluvial and tuffa terraces, exist. On the other hand slopes modeled on marls at the centre of the anticline are the lowest geodiversity areas.

Geomorphological protection measures should be focused at high geodiversity areas, where, besides more landforms variety, we can find active processes which are creating future geomorphology.

Setting out the boundaries of geomorphosites on the region of the Chichón volcano in Chiapas, Mexico

HERNÁNDEZ MORENO M.G.
Posgrado, UNAM, DISTRITO FEDERAL, MEXICO

In Mexico, the concept of geomorphosites it's fairly new, therefore up to this moment there is not a zone in the Nacional territory that counts with these. So that, at the current job it's proposed to set out the boundaries of geomorphosites in the region of Chichon volcano. This is located to the North of Chiapas State, in the Southeast of Mexico; at 60 kilometers to the Southeast of Villahermosa, State of Tabasco and 70 km to the Northeast of Tuxtla Gutierrez, State of Chiapas. The area is located in the boundaries of eight municipalities in Chiapas which are inhabited by Zoque indigenous population mainly.

Methodology: For the development for this job, the methodology to develop consist in the elaboration of a multi hazard map, in which will consist the elaboration of a susceptibility map of landslide, susceptibility flood map, and a volcanic hazard map. On the other hand, a map of vulnerability will be elaborated according to the social-economic characteristics of the population of the surrounding entities. Afterwards, a map of risks will be created in which the physic and social topics will be included in the area of study.

To determine the geomorphosites in the area of the Chichon volcano, first and most the interpretation of the geomorphologic map and field work will be realized. This will allow the reconnaissance of the area in study, to then determine and evaluate the geomorphosites. At last a map will be generated of the mentioned sites in relation with the map of risks previously generated. To finally, generated general guidelines which tackle the risk management of disasters in each one.

Preliminary results: So far, the study area has already contemplated geomorphosites, which will be evaluated with additional scientific values. This will be the volcano crater, which presents evidence of two periods of volcanic eruptions, as well as an important part of the Zoque area inhabitants worldview.

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A large fluvial geomorphosite: the Seine River downstream Mantes-la-Jolie (France)

GIUSTI C.(1), PEULVAST J.P.(2), BETARD F.(3)
(1) UMR 8185 ENeC Espaces, Nature et Culture, PARIS, FRANCE ; (2) UFR Géographie-Aménagement Université Paris-Sorbonne, PARIS, FRANCE ; (3) UMR 8586 PRODIG, UFR GHSS Paris-Diderot, PARIS, FRANCE

Rich in historical and cultural heritages, the stretch of the Seine valley that links Île-de-France to Normandy, between Mantes-la-Jolie and the Eure and Andelle confluence zone, belongs to one of the major sets of entrenched meanders known in the world. The valley presents steep hillsides punctuated by white chalk pinnacles alternating with deep funnels, contributing to the picturesque landscape of the valley segment.

The geomorphic history of the Seine valley is inseparable of the Quaternary bioclimatic history, with its alternating glacial-interglacial and stadial-interstadial periods. All along the Pleistocene, periglacial processes interacted with fluvial erosion, leading to the formation, deepening, exaggeration and migration of the large meanders. The resulting, present-day geomorphological landscapes are enriched by many historical landmarks.

The most emblematic sites are the medieval castles of La Roche Guyon and Les Andelys (Château-Gaillard) which were built on rocky promontories on the concave sides of two large meanders. The mid-Seine valley is also known as a high place of the impressionism, the founder and master of which, Claude Monet, settled here for the second half of his life and created the wonderful gardens of Giverny on the lower Epte river. He and many other impressionist and post-impressionist painters, sensitive to a certain harmony of the local landforms, represented and immortalized the surrounding landscapes.

Therefore, we propose to consider this relatively long valley segment as a “disconnected geomorphosite” (Reynard, 2009) at the geosystem scale owing to the unique combination of cultural and scientific values offered by its individual geotopes at the geofacies scale.

Assessing worth in geomorphology: Earth Sciences Comparitive Matrix (ESCoM) a comparative tool for nominations to the Australian National Heritage List

WHITE S.(1), WAKELIN-KING G.(2)
(1) La Trobe University, PARKVILLE, VICTORIA, AUSTRALIA ; (2) Wakelin Associates, CLIFTON HILL, AUSTRALIA

The lack of a suitable robust and repeatable geological/geomorphological methodology for Australian conditions has been a serious constraint on assessing geomorphological sites suitable for the National Heritage List (NHL). In 2011 the Earth Science Comparative Matrix (ESCoM) was developed for a desktop heritage assessment of Australian arid zone geomorphology. This related sites' intrinsic natural values to NHL criteria, and allowed comparison of a diverse group of sites spread over a vast area.

In the ESCoM matrix, sites are grouped in process themes. Each is assessed against NHL criteria (outstanding events and processes, rarity, potential for research, characteristics of a class, aesthetics, technical/creative achievements, social values and a site's association with significant people), which are then compared with other similar places. A site scoring well across multiple themes has increased heritage significance. The overall values of a site are quantified, indicating whether it achieves the threshold of outstanding heritage value. This methodology can be used with available published and unpublished information rather than requiring fieldwork. Significance is determined based on rigorous comparisons of specific values. It is qualitative rather than quantitative, but repeatable and robust.

The commissioned study assessed the potential National Heritage values of Australian desert landforms within a defined study area. Sites were spread cross 9 geomorphic themes (astroblemes, sand deserts, vertisols, karst, arid coasts, tectonic landforms, uplands, regolith, hydrology) and 29 sites were identified with high potential to pass heritage criteria demonstrating the history and development of Australia's characteristic desert landscapes.

While the study for which ESCoM was developed was focussed on arid zone landforms, it could be used for other areas of earth science values (e.g. tectonic or palaeontological heritage), with modification of matrix theme headings.

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Proposals for the valorisation of alpine geoheritage and mountain cultural landscapes: the Valli di Lanzo's Geosites and the Val Grande's Geotouristical Trail

GIARDINO M.(1), BRANDOLINI P.(2), RE FIORENTIN G.(3), PEROTTI L.(1), TORRENO F.(2)
(1) University of Turin, TURIN, ITALY ; (2) Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, GENOVA, ITALY ; (3) Arpa Piemonte, TORINO, ITALY

Within a master thesis committee on Environmental – Geographical Sciences and G.I.S. for sustainable development, a cooperative project have been set up for the analysis of geological – geomorphological assets and of characteristic elements of the Valli di Lanzo's cultural landscape. These valleys are located in the Torino province (NW-Italy) along the Via Alpina's Blue Trail, an important way for the international touring in the Alps.

The studied elements talk about the geomorphological history of the area; these landforms with the cultural elements create a peculiar alpine landscape, which belongs to our heritage and need to be preserved for next generations. A concrete proposal is here presented including geoconservation concepts and geotouristic approaches or a sustainable development of the mountain territory.

As a results of geological and geomorphological studies 17 geosites have been identified in the Valli di Lanzo, then evaluated for being part of a geotouristical trail through the Val Grande's Sentiero Balcone, a trail intersecting the Via Alpina's one. The Sentiero Balcone is a hillside trail within the Chialamberto and Groscavallo's municipal territory, where 22 geotouristic element of interest have been identified: 20 geological, cultural and geopanoramic points and 2 complex geosites. Trail and elements have been represented on a dedicated geotouristic map.

A GPS-integrated palmtop equipped with ArcPad G.I.S. software allowed direct field data collection in a digital format. Dedicated forms for the geosites' inventory created by the Earth Science Department of the University of Turin allowed elaboration of information for the selection of best path and points of interest of the Sentiero Balcone geoturistic trail.

Results contributed to the popularization and valorisation of the Alpine landscape and geoheritage: they are addressed to create an added value to the Valli di Lanzo territory and to its social – economical and touristic contexts.

Quaternary glacial geomorphosites from the Redes Natural Reservation and Picos de Europa Regional Park (Cantabrian Mountains, Iberian Peninsula)

RODRIGUEZ RODRIGUEZ L., JIMÉNEZ-SÁNCHEZ M., DOMÍNGUEZ-CUESTA M.J.
Departamento de Geologia, Universidad de Oviedo, OVIEDO, SPAIN

The Cantabrian Mountains is a mountain range 480 km-long with a max altitude of 2648 m (Torre Cerredo Peak) which is disposed parallel to the Cantabrian Coastline from Pyrenees to northwest Iberian Peninsula (~43^{o}N 5^{o}W). It is an interesting region to research the climatic patterns across South Europe during the Quaternary glaciations due to i) the presence of glacial features that evidence the occurrence of former mountain glaciations and ii) the climate transition from maritime to Mediterranean type across the mountain. The available studies in the Cantabrian Mountains stand that the recorded regional glacial maximum here is prior to ca 38 cal ka BP, and that glaciers were in some locations remarkably retreated by the time of the global Last Glacial Maximum (Jiménez-Sánchez et al., in press).

This study is focused on an area about 220 km^2 partially covering the Redes Natural Reservation and Picos de Europa Regional Park. A geomorphologic database in ArcGIS was produced for this area to reconstruct in detail the extent, flow pattern and chronology of the former glaciers (PhD under progress). Here we present a selection of 11 geomorphosites as examples of well-preserved glacial landforms and deposits that prove the occurrence of glacial and paraglacial processes in this region during the Quaternary glaciations.

Jiménez-Sánchez, M., Rodríguez-Rodríguez, L., García-Ruiz, J.M., Domínguez-Cuesta, M.J., Farias, P., Valero-Garcés, B., Moreno, A., Rico, M., Valcárcel, M., in press. A review of glacial geomorphology and chronology in northern Spain: timing and regional variability during the last glacial cycle. Geomorphology, doi: 10.1016/j.geomorph.2012.06.009.

Research funded by the project CANDELA (CGL2012-31938) of the Spanish national research program in Earth Sciences and Hydric Resources (MINECO). L. Rodríguez-Rodríguez has developed her research under a grant of the Severo Ochoa Programme (FICYT- Asturias).

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Geomorphosites within the inventory of geosites with national and international relevance in Portugal

PEREIRA P.(1), PEREIRA D.(1), CRISPIM J.(2), NUNES J.C.(3), BRUM DA SILVEIRA A.(2)
(1) Geology Centre of University of Porto / University of Minho, BRAGA, PORTUGAL ; (2) Geology Department of University of Lisbon, LISBON, PORTUGAL ; (3) Geosciences Department of the University of Azores, PONTA DELGADA, PORTUGAL

146 geomorphosites with international or national relevance have been inventoried under the scope of the scientific research project “Identification, characterisation and conservation of geological heritage: a geoconservation strategy for Portugal”, financed by the Portuguese Foundation for Science and Technology (PTDC/CTE-GEX/64966/2006). The inventory procedures were based on the ProGEO guidelines with definition of geological frameworks followed by the identification of representative geosites with national and international relevance for each framework. Overall, 322 geosites were selected exclusively based on their scientific value with about seventy geoscientists supporting geosites selection in 27 frameworks. The 146 geomorphosites were inventoried in the frameworks “Landforms and river network of the Portuguese Iberian Massif”(39), “Karst systems”(38), “Active and fossil coastal cliffs”(6), “Low coasts”(6), “Vestiges of Pleistocene glaciations”(16), “Volcanism of the Azores Archipelago”(29), and “Volcanism of the Madeira Archipelago”(10). That selection was based on the criteria representativeness, rareness, diversity, integrity, and scientific knowledge. Their protection and adequate management is essential because of specificities like large size, aesthetics and dynamics, and due to their high geotourism potential. In that scope a quantitative assessment of their scientific value and vulnerability was performed. This constitutes the first systematic inventory of geosites at national level and is now important raw data to support nature conservation initiatives. The inventory is being integrated in the natural heritage database (SIPNAT) under the responsibility of the Institute of Nature Conservation and Forestry (ICNF) as expected in the Portuguese legislation for nature conservation (DL 142/2008).

Geomorphosites as a tool for understanding the geological history: a proposal of geo-itineraries for the National Park of Abruzzo, Lazio and Molise and Matese areas (Molise region, Italy)

ROSSKOPF C.(1), FILOCAMO F.(1), AUCELLI P.(2), DI PAOLA G.(1), CESARANO M.(1)
(1) Department of Biosciences and Territory, University of Molise, PESCHE, ITALY; (2) Department of Environmental Sciences, University of Naples Parthenope, NAPLES, ITALY

Due to its geological-structural, orographic and climatic features, the Molise region is characterized by a high geo-diversity. Several protected areas are present which cover about 34% of the regional territory. Our contribution deals with the presentation of some geo-itineraries that embrace several of the geomorphosites which have been assessed during the recent geosite census in the Molise region aimed at contributing to the preservation and valorisation of the regional geological heritage. The selected geomorphosites are located in two areas of great naturalistic value, the National Park of Abruzzo, Lazio and Molise and the SIC (Site of Community Importance) area of Matese Mountains, respectively. These geomorphosites, which are characterized by a high scientific and didactic value, allow to appreciate the variety of environments and landscape features that characterize these mountain areas and are important for understanding several steps of their geological history and related landscape evolution during Quaternary times. They are represented mainly by glacial landforms (the glacial cirques of Mt. Miletto and Mt. Mare and related moraine deposits), exokarst and endokarst landforms (i.e. the Campo Puzzo and Le Forme polja and the Pozzo della Neve and Cul di Bove caves), periglacial/slope landforms (i.e. the talus slope of Mt. Gallinola), and fluvial landforms (i.e. the Quirino gorge). In order to enhance and promote this rich geomorphological heritage and to contribute to the development of sustainable tourism within these areas of high natural value, we have developed some geo-touristic itineraries which can be easily enjoyed also by a non-scientific audience. To improve their promotion, specific cards are prepared, enriched with photos, geomorphological sketch maps, 3D scenes, DEMs etc., to be distributed by tourist operators and other associations and institutions interested in tourist promotion and educational activities.

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The remains of mining and metallurgy industry as examples of geomorphosites in the Tatra Mts. Assessment, their role in education and geotourism

BIALY S.
Pedagogical Uniwersity of Cracow, KRAKOW, POLAND

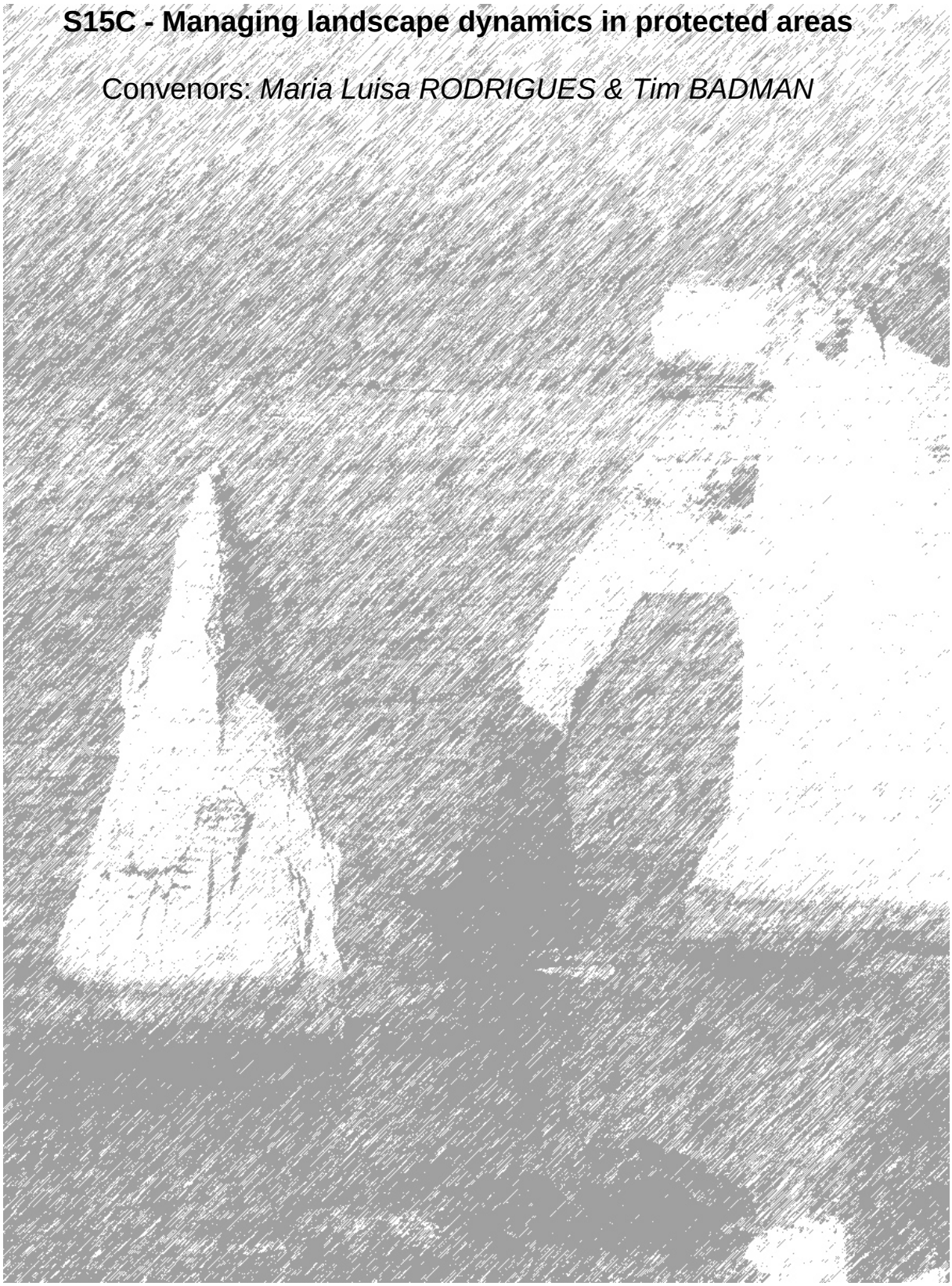
The aim of the paper is to present the remains of the 19th century mining and metallurgy industry in context of their attractiveness for geotourism. Historical, cultural, scientific and socio-economic values of the sites has been taken into consideration. Presented sites are located within Polish Tatra National Park (TPN) which is thought to be the most attractive mountain national park for tourists in Poland.

The mining company consisted of mine fields in Dolina Jaworzynki and in Kopa Magury Mt, where mine tunnels were dug. Iron ores as the concentration of hematite in shales and sandstones of upper Triassic of Fatricum were mined. The remains are still present in the field. In Kuźnice millrace, blast furnace, smithies, rolling mill and foundry was situated. Next to them workers' and officers' houses, administration building and owner palace with park have been build. Old quarry of Eocene numulitic limestone, used as flux in iron furnaces, is situated in northern part of the enterprise. The consequence of timber harvesting for charcoal productionis deforestation of the valley. In 1954 TPN was established. Protection and geomorphological process acting since then on mentioned sites caused their renaturalisation. Many tourist trails in TPN are led on the old mine roads.

The Tatra Mts. are not only natural landscape as the tourists may have mistaken beliefs. In the landscape we may see many evidences of human impact, which are easily visible. Their origins, geological and geomorphological processes acting on them for over 130 years need to be explained to the tourists, which is important in educational and geotourist aspects. Without the act of cognition of their origins, tourism would have only esthetic value. However restriction makes impossible visiting all the interesting sites, the remains of mining and metallurgy activity are important elements of the cultural landscape represent industrial geological and geomorphological heritage of the region.

S15C - Managing landscape dynamics in protected areas

Convenors: *Maria Luisa RODRIGUES & Tim BADMAN*



Oral presentations:

The landscape of man-made terraced slopes in Cinque Terre (Liguria, Italy): a world heritage site at geomorphological risk

BRANDOLINI P., CEVASCO A., FIRPO M.
Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, Università degli Studi di Genova, GENOVA, ITALY

Since about 1100 A.D. most of slopes of Liguria have been terraced for agricultural purposes through reworking of millions cubic meters of debris and the construction of thousands kilometers of dry-stone retaining walls. In particular the man-made terraces at Cinque Terre (eastern Liguria), due to their great extent, peculiar construction characteristics, high historical and cultural value, are one of the most famous and emblematic examples of landscape evolution in the Mediterranean area. Therefore the Cinque Terre were included in the "Cinque Terre National Park" and recognized as a world heritage by UNESCO since 1997.On an area of ca. 20 km^2 a total lenght of nearly 6000 km of terraces, which were cultivated for vineyards and olive groves, can be estimated.

Man-made terraces have represented over the centuries a basic factor for erosion control and landslides prevention at Cinque Terre, where geological and geomorphologic complex settings favor slope instabilities. Instability phenomena are increasing during the last decades consequently to the progressive abandonment and degradation of cultivated terraces, which played an important role on water control over the past centuries. Currently, entire sectors of terraced slopes - up to several hectares - have been lost.

In this framework, also taking in account the climate change, detailed studies of the relationships between geological-geomorphological conditions and the state of conservation of the terraces are fundamental both for the evaluation of slopes stability and risk scenarios.

Currently, a scenario of high geomorphological risk is rising at Cinque Terre. That can also be seen at regional, national and Mediterranean scale in other abandoned terraced areas, which primarily require conservation strategies for preserving the memory of the rural culture and its interrelations with geo-hydrological and landscape dynamics, and for promoting sustainable development of agriculture and tourism.

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Environmental fragility in the southwest amazon associated with its occupation modes the surrounding Jamari National Forest Case

BASTOS A.(1), MANIESI V.(2), GOMES F.(1)
(1) Centro de Estudos RIOTERRA, PORTO VELHO, BRAZIL ; (2) Universidade Federal de Rondônia - UNIR, PORTO VELHO, BRAZIL

This research had as objective comprehend the dynamics and consequences of natural and induced erosion process and its associations with the land occupation in the Jamari National Forest and its surrounding, area used as a study case. Geoprocess works, thematic maps compilation, numerical terrains models and a data base were used in the research. Lately, field activities took place to verify the natural erosion vulnerability map generated, to interpret the induced erosion dynamic process facing the actual land occupations modes, to collect and analyze soil and sediments. There are soils rich in sand fraction grains and quartz mineralogy, which varies of 76 to 93% in the west, where are the biggest anthrop interference of the area. The forest installation shows that the geomorphological balance between vegetation, soil and dissected relief is fragile. Thus, the breaking of this balance by altering any of these elements can accelerate erosion processes and nutrient loss in depth to the water table. The structural and mineralogical characteristics of the soils show marked limitations for agricultural use due the reduced volume of weathered material available to physically support the cultivars. Although erosion induced process were not registered in advanced stages. There are signs of degradation, not just the soil, but in the whole area due cattle, the only economic activity observed in the region. It has been found aspects that favor the class change indices related to natural erosion vulnerability measured, making them more vulnerable, related to the occupation mode around the Jamari National Forest as deforestation activities on the tops of hills, forest and riparian areas close to sub basins water dividers.

In situ biophysical data analysis establishing the draining process of Central African lakes whose origins are hypothetical: complementarities with an original small scale satellite based study

NAVARO B., LEROUGE G., NETTER C., ROUSSELIN T.
Geo212, PARIS, FRANCE

In the Sangha National Park tropical rainforest (Central African Republic), in situ sensors allowed us to study over 15 month (December 2010-February 2012) the functioning of a lake area whose origin is supposed to be karstic. Pressures and temperatures at the bottom of the lakes and in the canopy allow to estimate sub metric variations in water elevation and isolate rainy events. These measures are related to a geomorphological analysis of the watersheds. The lakes set out a synchronous and instantaneous response to the rainy events all year long. During the swelling or drop in level, this simultaneity lies with the saturation of a sandy subsoil located under the vegetable litter. The groundwater overload (rain contribution) is immediately transferred to the lakes by gravity. The lakes are drained by underground flow so the lake surface can be assimilated to a free piezometrical surface. No streaming has been observed above the ground. Therefore from one lake to another the floods move back or forward. This cannot be explained by the hydromorphic soils, but demonstrates an aquifer loading time different from one watershed to the other. The identification of those, under the canopy, needed a change of scale made possible thanks to a geomorphological analysis of GDEM ASTER V2. Dissymmetric and eroded anticline lines and faults intersecting them have been highlighted. They create morphological projections which isolate some lakes, explaining the difference between rising water levels at the beginning of the flood. The combination of in situ measures interpretation and geomorphological analysis explains the draining process of the lakes, which appears to be led by the evolution of independent aquifers. Even if this study stops short of confirming the link between lakes and a deep karst, it highlights the complementarities between two differently scaled methods.

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The hazard, the geomorphologist and the lawmaker - Geomorphological dynamics as a perspective for a resilience legislations in the domain of natural hazards

RAPISARDI E.(1), GIARDINO M.(1), CRISCI A.(2), MASCAGNI S.(3)
(1) UNITO - Earth Sciences Department, TORINO, ITALY ; (2) CNR-IBIMET, FLORENCE, ITALY ; (3) LIPU - Riserva Santa Luce, SANTA LUCE, ITALY

The degree of vulnerability to disaster in a given area is the result of multiple factors related to the human system and to its coping capacity. Analysis and monitoring, information to the public and planning, rescue and restoration: all these issues call for actions defined by the law. We are facing environmental changes, some experiences highlight a lack of alignment between the dynamics of the environmental change and the rigidity of the regulations, impacting also on risk communications.

The case study proposes a new reading of the drying up of a small artificial lake in S. Luce - (Tuscany), wildlife reserve and SCI - Habitats 92/43/EEC - occurred in 08/2012. The case analysis will illustrate the geomorphological context, including the vulnerability [Aysan 1993], and the coping capacity (resilience) [Wisner] of the human system of the area [Alcàntara-Ayala] and will illustrate the complex mutual relationships and dynamics between geomorphological, political, socio-economic, and law dimensions in the response capacity to a creeping phenomenon such as drought.

The aim is to highlight how geomorphology, as one of the building block for situational awareness, could represent the connective tissue to foster disaster risk reduction policies and actions based on interdisciplinary, open data and collaboration. In this perspective, geomorphological dynamics should be transferred to the lawmaker and to the institutions, not only in terms of accurate and analytical knowledge, but as an approach to an environmental sense-making, based on adaptation to environmental dynamics particularly influenced by climate change and soil use. In the same perspective, an open and shared geomorphological approach could represent the driving factor to switch towards the concept of adaptation in complex systems, including their inherent uncertainty [Snowden; Ciborra] so to build a more resilient and cross-discipline approach to risk analysis, communications and environmental regulations.

Planning of the recreational trails in protected areas: application of the regression tree analysis and GIS

TOMCZYK A.(1), EWERTOWSKI M.(2)
(1) Faculty of Geographical and Geological Sciences, Adam Mickiewicz University, POZNAN, POLAND ; (2) Department of Geography, Durham University, DURHAM, UNITED KINGDOM

One of the most important tasks for managers of natural protected areas is achieving a balance between conservation of nature and recreational opportunity. This paper presents a framework based on geographic information system (GIS) and regression tree analysis of optimised recreational trail location for flexible, user-defined input parameters. The method utilizes: (1) the GIS to create a database containing field data and existing GIS/cartographic materials; (2) regression tree analysis to establish the relationships between indicators of degradation and environmental, use-related and managerial factors for existing trails, as well as to predict trail degradation for potential new trials; (3) least-cost path algorithm within a GIS framework to optimize trail route.

The framework was applied to the Gorce National Park in the south of Poland. A large sample (> 4500) of the field collected data about degradation of the existing trail network was linked with data about soil, geology, geomorphology and relief, and with information about the type and amount of recreational use. Based on the existing relationship, predicted trail degradation was calculated and routes for two examples of trails (hiking and motorized) were designated. The proposed methodology is objective and quantitative, and can also include knowledge of local stakeholders. The framework has the potential to design new trails (or to re-route old ones), characterized by the best possible solution for recreational and conservation functions to coexist, by routing visitors through trails with the lowest possible impact.

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Poster presentations:

Trail impact assessment - Cairuçu Protection Area case study, Paraty Municipality - Rio de Janeiro State ' Brazil

RANGEL L., GUERRA A.
Federal University of Rio de Janeiro, RIO DE JANEIRO, BRAZIL

Regarding the protection and rehabilitation of forest fragments, Environmental Protection Areas (EPA) have been created in Brazil. These EPAs are large areas with different kinds of human settlement, in order to protect biological diversity, to regulate the settlement and to ensure the natural resources sustainability.

In some cases, the EPA is impacted by tourism, due to its natural attraction. Therefore, this research aims to assess the impact on the trails in the southern part of Cairuçu EPA.

For this, we have made a land use and cover map, using RapidEye satellite images, for 2011. The image classification has been made in Spring Software version 5.2, and post-classification and georreferencing has been carried out in ArcGIS 9.3. Soil samples have been collected to determine aggregate stability at six sites of *Laranjeiras-Sono* trail; three on the trail and three on the forest, at two depths (0-10cm and 10-20cm).

Soil aggregation has been determined by the mean weight diameter (MWD), the geometric mean diameter (GMD) and the aggregate stability index (AS%), which were obtained by breaking the soil into aggregate classes by the wet sieving method (Yoder, 1936).

The results have been compared and they indicate that, despite the area has a high percentage of forest coverage (91.2%), the trails are affecting the fragments, as it is possible to observe rill initiation and slope degradation along the trail. Furthermore, it was found that, at some sites on the trail, the MWD was less than 1.8 mm (Site 1 - trail depth 0-10 cm: MWD = 1.78 mm), indicating the presence of micro aggregates and therefore, soil degradation.

As expected, the sampling sites in the forest at 10-20 cm deep, aggregates showed a lower value of MWD (Site 2 - Forest: MWD = 1.96) than at depths of 0-10cm (Site 2 - Forest: MWD = 2.60) where there is a higher concentration of organic matter and therefore, larger aggregates.

Multiannual Variability of Novosibirsk Reservoir's Morphometry

KHABIDOV A., FEDOROVA E., MARUSIN K., KHOMCHANOVSKII A.
Institute for Water and Environmental Problems of SB of RAS, BARNAUL, RUSSIAN FEDERATION

The environment of relief formation and sedimentation is not uniform. It includes fluvial-dominated, wave-dominated and transitional environments. When describing the environments most attention was concentrated on wave-dominated environments distinguished by the largest water area, shoreline perimeter and the extent of coastal erosion. Less emphasis was placed on the fluvial-dominated areas; so far it is the least described environment of relief formation and sedimentation in man-made lakes. Therefore, the paper considers the fluvial-dominated environment by the example of Novosibirsk reservoir that is one of the most widespread valley man-made lakes in lowlands and low plateaus with seasonal flow regulation.

Erosion and abrasion play the main role in the relief formation and sedimentation in the basin of Novosibirsk Reservoir. These processes caused important changes of morphometric characteristics of the basin. For instance, the average thickness of accreted sediments has reached 0.94 m, the reservoir total capacity has reduced by 1.02 км^3, its average and maximum depth and water area have diminished notably, but average and maximum width have increased. The shoreline length, the number and area of islands have changed too. The characters of these changes in similar to changes in other reservoirs of this type.

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Historical channel change and sediment dynamics in a heavily managed and protected small catchment: the Afon Dysynni, North Wales

GRIFFITHS H.(1), YORKE L.(2), GRIFFITHS S.(1)
(1) Aberystwyth University, ABERYSTWYTH, UNITED KINGDOM ; (2) School of Environment, Natural Resources and Geography, Bangor University, BANGOR, UNITED KINGDOM

European rivers have, in general, incised and narrowed over the twentieth century as a result of a wide range of climatic and anthropogenic factors (flood frequency and magnitude changes, regulation, gravel extraction, land use change, historical metal mining). In Welsh rivers these factors have led to decreases in exposed riverine sediment (ERS) area during that time. Such morphological changes and sediment dynamics can significantly affect flood risk through changing channel capacity. The Afon Dysynni catchment (131 km^2), North Wales, is particularly prone to both fluvial and coastal flooding. During the 18th and 19th centuries, the river was heavily managed through extensive flood embankments and land drainage works, but is currently protected through National Park, Landscape of Historic Interest, UNESCO Dyfi Biosphere and Sites of Special Scientific Interest designations. Geomorphological mapping, air photo interpretation and historical and contemporary OS map analysis (1888, 1891, 1901, 1964, 1974, 1981 and 2012) was undertaken in order to assess lateral channel migration rates, ERS changes, sinuosity, channel width and sediment dynamics. Anthropogenic activities during the last 300 years have resulted in the progressive confinement of the river along a significant proportion of its length, and have limited the floodplain width, across which the river is able to freely meander, to ~ 70 m. In its middle, unconfined reach (~ 2 km in length), the river has been laterally active, displaying rates of bank erosion of > 3 m yr^{-1}(1964-1974). Between 1888 and 2012 ERS area decreased from 43,506 m^2 to 8425 m^2. Palaeochannels, located outside the flood embankments, indicate the river was highly laterally active prior to confinement. This study demonstrates that the response of the Afon Dysynni is typical of other Welsh rivers in protected areas, where the legacy of historical anthropogenic activity continues to exert its influence on the rate of natural process change.

Impacts of Mountain Bike activity in Atlantic Forest, Rio de Janeiro

CHIROL a.(1), OLIVEIRA R.R.(2), CATALÃO C.G.(2), ERTHAL L.(2)
(1) UERJ - State University of Rio de Janeiro, RIO DE JANEIRO, BRAZIL ; (2) PUC-Rio, RIO DE JANEIRO, BRAZIL

Mountain biking is an increasingly recreational outdoor activity in Rio de Janeiro, and the reasons are related both to the geomorphological characteristics of the city (two main mountainous physiographic units: the Tijuca Massif and the Pedra Branca Massif) and the city vocation for outdoor sports. The expansion of mountain biking has increased the concern about its environmental impacts, which remain poorly understood, since most of the trails are situated in the two biggest conservational units in the city: the Tijuca Forest National Park and the Pedra Branca State Park. So this research look for a better understanding of the ecological and hydrological effects of mountain biking.

The study area is situated in the Tijuca massif in the city of Rio de Janeiro, covering a total area of 118.7Km^2 (11.870 ha). The slopes of this massif are revegetated by late secondary vegetation. The area is inserted in the Rio de Janeiro metropolis and therefore undergoes direct interference of pressures and vectors that change the city. The chosen trail is located in a steep area (25^o or higher) and surrounded by well-preserved forest.

Three main procedures have been made: soil penetrability essays and vegetation structure (diameter at breast height and height) analysis at the trail, the trail edges and a well-preserved area, and transversal trail profiles through the trail, to observe the presence of any erosive features like rills. The vegetation data showed what might be signs of some edge effects at the trail, as there are higher density of low DBH trees and dead trees, especially at the lower parts of the trail. The trail profiles showed that rill erosion is significantly more intense at the lower parts of the trail, what is a direct effect of the higher soil compactation and water velocity through the trail. So the mountain biking might be a vector of degradation and there is a need to constant monitoring in areas with high precipitation as the city of the Rio de Janeiro.

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Trail morphodynamics in the Stolowe Mountains National Park (SW Poland) - how nature helps managing erosion

LATOCHA A., PARZÓCH K.
UNIVERSITY OF WROCLAW, INSTITUTE OF GEOGRAPHY AND REGIONAL DEVELOPMENT, GEOMORPHOLOGICAL UNIT, WROCLAW, POLAND

The Stolowe Mountains National Park comprises steep slopes of sandstone escarpments and level intervening terrain. Recent detailed geomorphic mapping revealed that morphodynamics of the area is rather low, except for human-disturbed surfaces of unpaved roads and paths. Tourist trails are especially prone to erosion. Four morphodynamic categories of tourist trails were distinguished, basing on the microrelief of their surface and vegetation cover: stabilization, low degradation, moderate degradation and strong degradation. The first two categories prevail, accounting for 92% of total trail length. The morphodynamic state of a trail section depends mainly on slope angle, intensity of tourism and type of road surface. In order to reduce erosion along the most degraded sections of the trails anti-erosion constructions have been installed such as debris traps.

The actions undertaken by the Park's authorities in order to reduce erosion are additionally enhanced by the natural processes. The area used to be densely populated. It had been also under agricultural land use, which was entirely withdrawn from the area in the 1950-60'. The road network was reduced by 10-50%. The abandoned field access roads, often transformed into road gullies, have been overgrown and evidence of present erosion can be hardly detected within them. The morphodynamics of the region has been substantially reduced, which is best evidenced by inactive road gullies, now partly filled with organic and mineral material.

The example of Stołowe Mountains shows that the most effective strategy to counter erosion would consist of closure of gullied trails, at least temporarily. However, this is an option difficult to follow on societal grounds since the area belongs to the most popular tourist destinations in south-west Poland and declaring further parts of the Park off-limits would negatively impact on the image of the Park and nature conservation.

Geomorphological restriction in urban landscape management. Case study: Piatra-Neamt - Romania

ROSU C., IRIMUS I.A., ILIES M., TOGANEL C.
Babes-Bolyay University, Faculty of Geography, CLUJ-NAPOCA, ROMANIA

The paper approaches the issue of restriction induced by the geomorphological processes in urban landscape management from Piatra-Neamt city, Neamt district, Romania.From the entire surface of the city, 45,5% belongs to the forests, these providing protection, recreation, preservation and surrounding the studied area. As a number of four, these areas have legal status as: forest reservation- Cernegura Hill, flowers reservation: Vulpea Hill, and paleontological reservations: Cernegura Hill, Cozla Hill and Pietricica Hill.

The restriction evinced in these protected areas is provided by the slopes geomorphological processes such as: crumbling, land fallings and land slides which affects quite large surfaces on the west side of Cozla Hill, Cernegura Hill and on the east side of Pietricica Hill.

These phenomena are produced because of the clay bedrock, precipitation`s water infiltration and human intervention: sky run (Cozla Hill). Another geomorphological process inducing restricted areas is soil erosion which forms gullies and rills spread especially in Cozla Hill and in Cernegura Hill because of the high declivity and Miocene and Quaternary bedrock.The processes presented has induced restrictions in urban-development projects (issues specified in General Urban Plan of the city) and they also induce the need of preservation and enhancing measures.

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Stream recovery in protected areas: planning with a geomorphological approach

TESTA B., ALDIGHIERI B., CAIELLI G., DEFRANCO R.
CNR-IDPA, MILANO, ITALY

San Lucano Valley (Belluno, Italy) is included in the UNESCO System n.3: award of “World Heritage” area. The land use in the valley is not intensive and there has not been interference to the riparian zone, since the flood of 1966, during which the majority of the existing trees (conifer) were uprooted. After 1966, an exceptional riparian forests of *Alnus incana* and *Fraxinus excelsior* with some Mountain Maple and Spruce, took over. These forests are of high natural interest for the E. C.: (site BL28 from Natura 2000 network), and constantly under observation and carefully preserved. For these reasons, the lower Tegnas River has become an open-laboratory to study the stream and how it adjusts from past periods to recent morphodynamic events, and to verify the applicability of the methodology referred as Watershed Assessment of River Stability and Sediment Supply (Rosgen, 2006) in the morphological context of the Alps and in their hydroclimatic environment. The stream geomorphology shows the evidence of channel changes during over 50 years. Quaternary fluvial deposits, postglacial landslides and debris flows are filling the valley bottom with a 200m thick covering. The gravel of this flat area must be periodically quarried to ensure the hydraulic protection of the sideway road, but the newly rebuilt banks are quickly eroded due to the floods and the streambed becomes impracticable and unsuitable for spontaneous fish habitats and for forest growth. The monitoring of streams over time, modeling their geomorphologic trends, gives some contribution to understand the erosion-transport-deposition process in order to reset a more stable, long-lived, riverbed with natural solutions. This may be a useful approach in restoration plans, in order to make the riverbed renaturalization more stable and improving the accessibility to the riparian zone, without disregarding the preservation of the natural environment quality.

Sediment movement and storage in small headwater catchments in an eroding peatland, Peak District National Park, UK

SHUTTLEWORTH E.(1), EVANS M.(1), ROTHWELL J.(1), HUTCHINSON S.(2)
(1) University of Manchester, MANCHESTER, UNITED KINGDOM ; (2) University of Salford, MANCHESTER, UNITED KINGDOM

Upland blanket bogs in the UK have suffered severe erosion over the last millennium but there is evidence to show that this has increased in intensity in the last 250 years, coinciding with increased pressures on the land during the British Industrial Revolution. Peatlands represent major carbon stores and those in close proximity to urban and industrial areas can be contaminated with - and act as sinks for - high concentrations of atmospherically deposited lead. Erosion of these peats has the potential to release lead into the fluvial system and impact carbon storage through the physical export of particulate organic carbon (POC). Detailed quantification of sediment movements across the surface of actively eroding peatlands is important in order to understand carbon and lead storage and release in such environments.

This project aims to increase understanding of the small-scale process of sediment transport and deposition active during peat erosion. Peat erosion is widespread in the Peak District National Park, UK, and the Bleaklow Plateau has been a focus of restoration over the past decade. Ahandheld *Niton XL3t 900*XRF analyser was used to acquire detailed *in situ* measurements of Pb concentrations across a series of small parallel gullies at a severely degraded site on Bleaklow. A considerable proportion of sediment is not directly transferred to the fluvial system after it has been removed from its surface source, but there is significant storage of Pb contaminated sediments on gully walls and floors.

The potential for enhanced peatland erosion resulting from climatic and land use changes in peatland areas requires a fuller understanding of geomorphological controls on carbon and contaminant losses. Such knowledge can aid the construction of accurate sediment and pollutant budgets, and direct restoration strategies which require a clear understanding of sediment dynamics.

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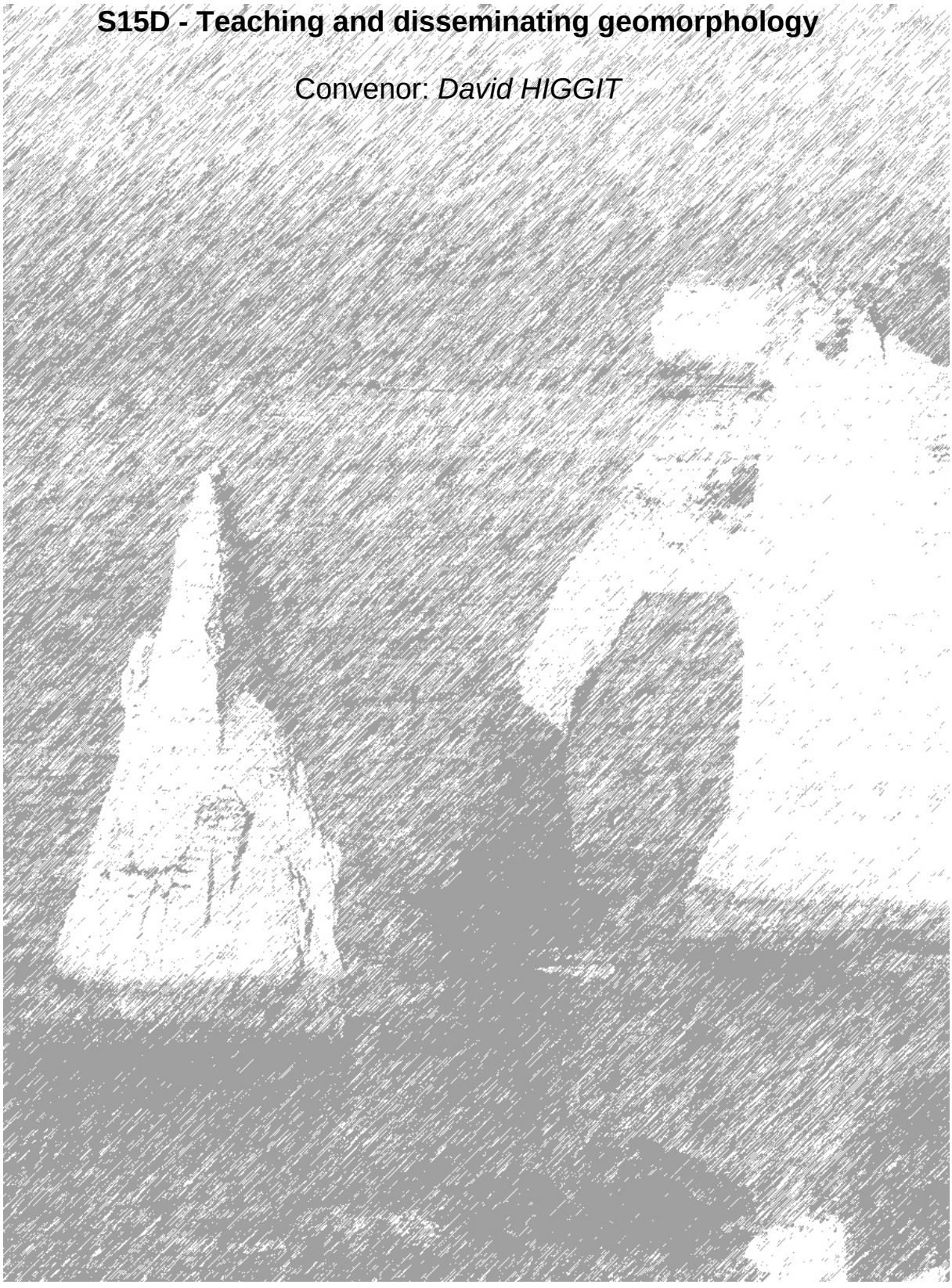
Areas of permanent preservation and their usage planning in the watersheds context: methodology for legal pattern adjustments applied in a pilot area in Northwestern Rio Grande do Sul, Brazil

VERDUM R.(1), GASS S.L.B.(2)
(1) Universidade Federal do Rio Grande do Sul , PORTO ALEGRE, BRAZIL ; (2) Universidade Federal do Rio Grande do Sul, PORTO ALEGRE, BRAZIL

Land usage and settlement process based on deforestation and unsystematic land management bears conflict between environment recovery and farmer's economic reproduction. This dichotomy is displayed in the effective application of the Forest Law (Federal Law 4.771/65) that deals with permanent preservation areas (APPs) in the marginal strips along water courses. We aim to present a methodology to define the waterside permanent preservation areas using elements of fluvial geomorphology and vegetal cover as an alternative to current legal patterns. We present an historical refurbishment of Northwestern Rio Grande do Sul settlement (Brazil), a theoretical interpretation of nature's conservation and discuss the permanent preservation areas in two analysis levels: the current juridical structure and the area usage in Northwestern Rio Grande do Sul. The discussion of the farm's social function is fundamental because farmers are responsables for preservation. We try to understand the public policies in the official agencies (Ibama, Fepam and Ministério Público Estadual) and how this agencies act. We chose three sectors of the Santo Cristo river to apply the methodology. In each sector, we assigned the floodplain levels and the levees by the cartographic analysis and evaluated the regional structures. As a result, we detected that the river influence areas varies from 20 up to 380 meters and concluded that permanent preservation areas can be 330 meters larger than the legal parameter. This shows the inefficiency of the metric definitions currently used. The main conclusion of the study is the need to take into account other ecological and geomorphological parameters for the definition of permanent preservation areas. We can say that conservation practices made by rural producers should be seen as positive impacts for rural property, as well as for the enrichment of biodiversity in small, medium and large properties.

S15D - Teaching and disseminating geomorphology

Convenor: *David HIGGIT*



Oral presentations:

Geomorphological Virtual Tours: multimedia e-books for undegraduate education

PARON P.(1), GOUDIE A.(2), SMITH M.J.(3)
(1) UNESCO-IHE, DELFT, NETHERLANDS ; (2) St Cross College, University of Oxford,, OXFORD, UNITED KINGDOM ; (3) Kingston University, School of Geography, Geology and Environment, KINGSTON-UPON-THAMES, UNITED KINGDOM

Sauer (1956) in his opening address at the Annual Conference of the AAG said that 'the principal training of the geographer should come, wherever possible by doing fieldwork'. Almost 60 years have passed and several pathways of geographical studies have developed since. Still the first approach for identifying, and being fascinated by, geographical forms, processes and their spatial interactions is primarily observational. Since 1956 the development of satellite technologies has added significantly to our ability to quantitatively observe the landscape and at scales that enable holistic understanding geomorphological processes and forms. Over the last decade a number of websites have championed aerial views of our planet, whilst the interactive exploitation of imagery demonstrated by Google Earth literally revolutionised the use of remote sensing and broadened its user base and application. Examples, using case studies, are primarily drawn from North America, Europe or Australia such as Brock (http://tinyurl.com/9ajxduk) or Arrowsmith (http://tinyurl.com/8blokyg).

We identified a gap in educational resources built around Google Earth: existing case studies are either *placemarks* or *animations* without any sort of annotation. None of the available free examples couple a Google Earth annotated animation with scientific text and a more general introduction to the environment. We present here a new and freely available resource for geomorphological education targeted at undergraduate students, where annotated video animations from Google Earth are integrated in an e-book with explanation of each virtual landscape visited. The e-book develops through 10 different morpho-climatic environments and landforms: arid, coastal, fluvial, glacial, periglacial, weathering, biogenic, human, slopes, and tectonic landforms. The examples are global and from locations that are outside the mainstream of geomorphological images used as examples from the most popular textbooks or websites.

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Landscapes, Geology and Sport: the Earth Sciences at the 'Giro d'Italia'

LUGERI F.(1), FARABOLLINI P.(2), GRAZIANO G.V.(3), LUGERI N.(1)
(1) Istituto Superiore Protezione e Ricerca Ambientale, ROMA, ITALY ; (2) Scuola di Scienze Ambientali - Università degli Studi di Camerino, CAMERINO (MC), ITALY ; (3) Consiglio Nazionale dei Geologi, ROMA, ITALY

The “GeoloGiro” is a proposal for the popularization of the scientific knowledge, explaining the geological setting of the landscapes crossed by the cycling race “Giro d’Italia”. The project is now starting, thanks to the synergy established between the Geological Survey of Italy-ISPRA, the National Council of Geologists and the “Gazzetta dello Sport”, the legendary newspaper organizing the race. A better enhancement of the geological heritage of a land can be reached and shared, thanks to a simple scientific analysis of the stages of the Giro d’Italia, according to the "Landscape" methodological approach.

The morphology of the territory becomes a key component in the race context: if explained by the geologist, can offer to the public a new and interesting point of view of the landscapes, linking scientific information to the agonistic valence of the stage. Shape and position of Italy entails a wide variety of landscape types, natural and anthropic, concentrated in a long and narrow area.

The “Giro d’Italia”is one of the most loved sport event, and is here identified tool for the scientific popularization. In the project, the geo-morphologic setting of an area is also related to the local culture and tradition, always deeply linked to geology. In this sense, it can help the touristic promotion of a land: the landscape becomes an anti-crisis resource. The presence of World Heritage Site and/or protected areas, gives a further opportunity to deepen the relationship between the nature of the land and its own developed culture. The Giro d’Italia 2012 has already welcomed the presence of the geologist: the stages in the Dolomites, offered a special chance to observe the spectacular geology of the "pink mountains", UNESCO WHS.

From the Porphyry in the Pusteria Valley to Cortina, the pearl of the Dolomites, in an unforgettable “Dolomites big stage” between geological domains, telling a fascinating geological story.

Batur Caldera Complex, the first land-form volcanic laboratory in Indonesia

PRATOMO I., PERMANADEWI S.
Center for Geological Survey, BANDUNG, INDONESIA

Batur Caldera is a composite volcanic complex situated in Bali Island, Indonesia. This caldera complex with a caldera-lake in the middle of the second caldera, is one of the most beautifull panoramic-view in the world. Batur Caldera has been declared as a member of Global Geopark Network (GGN) by UNESCO, during 11th European Geopark Conference held in Auroca Geopark, Portugal, on 20 September 2012. This caldera complex consist of two caldera formations were dated in 29.300 BP and 20.150 BP, have three active volcanic-cones situated in the center of the second caldera. The recent activity is characterized by the development the volcanic cones, which is dominated by the formations of lava flows and the stombolian-type eruptions. The successions of three actives cones followed of small fissure oriented almost on E-W direction, give a spectaculer sun-rise and sun-set panoramic views. The historic-lavas flows which are flowed-down to the caldera-lake formed the lava channels, kipuca's, tumulies, pillow-lavas, and the lava tubes figured by their beautifull cave-ornaments. Famous Baliness culture with the religious-Pura buildings are presenting the traditional relationship between active-volcano and the peoples, also as excelent natural volcano-laboratory.

Keywords: Batur Caldera, Bali island, lake, active-volcanic cones, lava flows, lava tubes, pillow-lavas

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Sharing the past with students: teaching geography and history through digital palaeogeography

GALANI L., KRITIKOS G., THEODORAKOPOULOU K., SKENTOS A., PAVLOPOULOS K.
Department of Geography, Harokopio University, ATHENS, GREECE

This study reports early results of a research from the department of Geography of the Harokopio University, Athens, Greece. The project focuses on Digital Palaeogeography and specifically the cartographical presentation of cultural succession in Greek Chorochronos" (space and time). The subject of the program is particularly important because it is closely associated with core concepts of geographic and historical education.

The pedagogic value of this project lies in the development of five distinct skills: chronological thought, historical and geographic comprehension, analysis and interpretation of geographic space, ability to perform geo-historical research, and analysis interpretation of geo-historical decision-making.

The data base as a product of the process and as an educational tool, gives the ability to create documents, to organize and present the information, to investigate and analyze quantitative data, to categorize and classify the information, based on specific criteria.

In addition, maps and 3D presentations of the sites derived from this data base have facilitated the study of factors leading to changes evolution over time. As result, the students are able to develop a multidimensional, evidence driven approach, in order to answer questions and to "rebuild" the historical "Chorochronos" through interdisciplinary and methodological pluralism which characterizes the modern geography, suppressing the barriers between the sciences.

Physical Geography Must Reclaim French High-school Geography

ECOCHARD E.
Laboratoire de Géographie Physique Pierre Birot, MEUDON, FRANCE

French high-school geography has lost its legitimacy in teaching physical geography. One of the reasons for it is the insufficient epistemological reflexion in the French academic physical geography. Human geographers dominate the arena of geographical epistemology. And no didactic progress can thrive without epistemological studies.

Nowadays in French secondary education, “sciences of life and earth” almost have a monopoly of teaching geomorphological, climate and biogeographical dynamics. But this perspective is not as well suited to highlight the spatial organization of human societies as the geographic one is. The absence of physical geography in French curriculum is detrimental, especially as sustainable development and environmental changes are central concepts in the new “college” and “lycée” curricula. Physical geography must reclaim French high-school geography through the concept of environment.

One avenue for this is to think about the environment along a different time frame than currently offered. The concept of environment is now taught referring to the present (resources, quality of life, risk) and future (climate change, sharing scarce resources) contexts. It must now incorporate the past, which will allow teaching environmental evolutions with emphasis on human dynamics. This would be an opportunity to highlight the relevance of teaching history and geography together, but also to promote interdisciplinary collaboration with sciences of life and earth as well as with physics and chemistry. A richer concept of the environment would emerge, no longer perceived by students as a subjectified object (to protect), but as an objectified space form, which dynamics must be understood. Additionally, the concept of natural heritage could be developed at the same time. In short, physical geography is at the heart of geographical education issues in the new curriculum: it must take its full place.

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Poster presentations:

Importance of introducing visual aids and 3D models in teaching geomorphology at secondary schools in Sri Lanka

WICKRAMASOORIYA A.
South Eastern University of Sri Lanka, SAMMANTHURAI, SRI LANKA

Geography is one of the main subjects included at the secondary level school curriculum in Sri Lanka. After secondary school level, students enter to universities for continue their higher studies. Therefore, secondary school level can be considered as the most important stage where the basic concepts describe in geomorphology can be introduced to students. Also teachers have the responsibility to teach these concepts using more attractive methods so that students pay more interest to study the subject at university. Geomoprphology is one of the widely applied subjects teaching in Geography. Understanding the surface features, surface processes, natural hazards experience on the surface, depositional environments, etc plays an important role in finding solutions for many environmental and socioeconomic problems. Thus, producing geographers with sound applied geomorphology knowledge will be an essential step that should be completed for the betterment of the country. According to the survey carried out in different parts of the country including rural and urbanized areas, it was found that teachers follow very old traditional methods in their teaching. Nearly ninety percent of teachers use only the compulsory text book as the teaching guide. This is mainly due to lack of facilities at schools, do not have access to internet, do not aware about new teaching aids, shortage of teacher training related to new teaching techniques. After analyzing the questionnaire survey results ii was clearly identified that nearly sixty to seventy percent of students imagine the concepts and processes teaching under geomorphology rather than understand them properly. This can be a main barrier to produce applied geomorphologists. By implementing new teaching approaches like introduce low cost teaching aids such as 3D surface models, visual aids like animations, video films related to geomorphology, etc this situation can be overcome in future.

Significance of selected teaching strategies and bilingual education in the teaching and popularisation of geomorphology

PIOTROWSKA I.
Faculty of Geographical and Geological Sciences, Adam Mickiewicz University, POZNA?, POLAND

The action of external relief-forming factors (running water, groundwater and sea water, wind, glaciers), visible in each climatic zone on Earth, determines the development of a specific type of relief. At the same time relief determines the operation and effects of external processes which mould the Earth's surface. Their widespread and permanent nature can be an excellent basis for the formation of geomorphological perception, thinking, and explanation of the causes and patterns of those processes, which belongs to the tasks of geomorphology as a science. It is also important to teach geomorphology at a variety of educational levels. In order to shape geomorphological knowledge in a proper way, much attention should be paid to the selection of suitable teaching strategies. Examples include anticipatory learning and Learning by Teaching (LdL). The process of education and popularisation of geomorphology can be enriched with bilingual teaching, which is a bridge between the preparation for learning and understanding the processes occurring in the geographical environment and the ability to explain and describe them in various linguistic codes, irrespective of the scale of spatial differences. The specificity of bilingual teaching requires an integrating approach embracing substantive and linguistic aspects as well as the learning skills that pupils possess. During this process a special task is the acquisition of a basic geomorphological vocabulary in the foreign language. One can then observe in pupils a transition from the BICS level (Basic Interpersonal Communication Skills) to that of CALP (Cognitive/ Academic Language Proficiency). This mode of education can produce young people able in the future to anticipate not only the consequences of the action of relief-forming factors for the natural environment, but also their effects on the operation of the socio-economic system, and ready to act in accordance with the idea of sustainable development.

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Participatory GIS to investigate urban river habitat quality in Singapore

HIGGITT D.
National University of Singapore, SINGAPORE, SINGAPORE

One of the challenges confronting the geomorphology educator is how to enthuse students about landscape processes in an increasingly urbanized environment. Singapore provides an extreme example where rapid urbanization from the 1960s onwards produced a landscape which is heavily modified by structural engineering. However, recent interest in improving the aesthetic and ecological conditions of riparian environments has opened opportunities to engage students in fieldwork activities and debate about river management. As part of a Ministry of Education project to enhance geospatial literacy, a participatory GIS approach has been adopted to engage students in data collection and analysis of information about river habitat quality in urban environments. Some of the challenges and benefits of using this approach for large introductory classes are discussed. Participatory GIS has the potential to open up new 'learning spaces' in situations where the logistics of organizing fieldwork activities would have been very difficult.

Difficulties encountered by professionals in training regarding geomorphology contents: a brazilian university case study

SOUZA C.J.O.(1), VALADÃO R.C.(2)
(1) Department of Geosciences - Universidade Federal de São João Del-Rei - UFSJ, SÃO JOÂO DEL-REI, BRAZIL ; (2) Institute of Geosciences - IGC - Universidade Federal de Minas Gerais, BELO HORIZONTE, BRAZIL

In Brazil, until the late 1990s, undergraduate geomorphology courses followed the historical approach which gives emphasis to the macroforms and geological and morphoclimatic processes that favor relief description on global and regional scales. This relief approach, based on an evolutionary concept, contributed to foment problems among professionals in training regarding the interpretation of processes and forms on the scale of lived space. These difficulties were observed in field activities and reports carried out by 27 geography students, organized into 11 groups. Of this total, 18.2% confused conditions and processes; conditions and agent; agent and process.No relationship was drawn between processes and forms, nor did they know how to explain many of the processes involved in the genesis and evolution of a gully. Despite demonstrating knowledge of the processes responsible for the formation of a gully, the majority (54.5%) applied the idea of cause and effect, as in the morphogenesis concept.Only 27.3% used systemic reasoning for the processes.Environmental geomorphological studies demand that the professional in training be able to: a) identify evidence of agents, processes and conditions; b) associate form, processes and conditions; c) recognize forms resulting from specific processes; d) devise processes that act simultaneously, are integrated, and show different rhythms and velocities according to local conditions; and, e) use visible elements (deposits, erosive scarring, sediment characteristics, spatial organization of the observed elements) as references for developing hypotheses and arguments that help to explain the geomorphological processes responsible for the erosive scarring and features of the local relief. These skills must be worked on during training for the professionals to understand the functionality and rhythms of processes and the dynamics of forms.

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Recognition and development of fundamental skills and competencies for the construction of geomorphological knowledge in higher education in Brazil

SOUZA C.J.O.(1), VALADÃO R.C.(2)
(1) Department of Geosciences - DEGEO - Universidade Federal de São João Del-Rei (UFSJ), SÃO JOÃO DEL-REI, BRAZIL ; (2) Institute of Geosciences - IGC - Universidade Federal de Minas Gerais (UFMG), BELO HORIZONTE, BRAZIL

In Brazil, geomorphology is commonly taught in higher education by instructors of Geography undergraduate courses also offering subjects of geomorphology to other professionals in training, such as geologists, environmental engineers, and urban planners. The process of constructing geomorphological knowledge demands the development of specific skills and competencies whoserecognition is not always clear to instructors, nor to professionals in training. The specialized literature rarely reflects on the inherent skills to think and do geomorphology. Such is the context of the present study which, while addressing the notion of competence and resuming the path of constructing geomorphology, proposes structural concepts from this field of knowledge. The authors have developed a reference guide for evaluating the performance of professionals during their preparation, which includes fundamental skills for learning geomorphology. These skills have been organized along three axes: i) conceptual understanding and geomorphological reasoning; ii) geomorphological representation – imagetic language; and iii) language. Activities applied to a group of professionals in training have confirmed that mastering this set of skills leads to autonomy in solving situations and problems where the geomorphological dimension is present.However, this mastering can only be exercised by professionals capable of: i) broadening linear reasoning to the systemic; ii) improving or developing the perception and spatial visualization of relief landforms; iii) breaking away from preconceived thinking structures regarding concepts of erosion, relief, and spacial and temporal scales; iv) knowing the meaning of topographic map representations; and, v) understanding that Geomorphology contents, as approached in academia and literature, enable geomorphological reflection but do not constitute geomorphology *per se*.

Geomorphology teaching for environmental engineering from the fieldwork - theory and practice

ALMEIDA E.(1), PENIDO F.(2)
(1) Universidade FUMEC, BELO HORIZONTE, BRAZIL ; (2) ICF International, RIO DE JANEIRO, BRAZIL

The Geomorphology has been a science increasingly exploited by the various knowledge areas. Learn to interpret the space, has become point of interest for environmental engineering since the future professionals will act in environmental studies those have as part of their scope the physical environment and within this, the geomorphology. The paper presents the results from an analysis carried out in the second half of 2012 from the geomorphology discipline taught to students of environmental engineering. The goal was to show the importance of teaching geomorphology from fieldwork. The Iron Quadrangle region was chosen because its importance and the numerous interventions that has suffered. Were covered 5 counties: Belo Horizonte, Nova Lima, Itabirito, Cachoeira do Campo and Catas Altas. Were defined 12 stop points for analysis and description of the geology, geomorphology, pedology and land use, based on maps and visual analysis. At those stop points were analyzed the environmental problems encountered and existing solutions. The basic idea was the observation of the landscape after understanding the substrate. Several issues were raised from the new look over the space. The reasoning about the viewed problems, now grounded on prior knowledge from the classroom, directed new proposals showing the non insertion of geomorphological knowledge in existing interventions. The students were able to understand the importance of geomorphology in the modification of the landscape and its future role as professional.

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Geology and Wine: Landscapes in a bottle (remembering Lucilia Gregori)

LUGERI F.(1), ALDIGHIERI B.(2), FARABOLLINI P.(3), GIANNELLA G.(4)
(1) Istituto Superiore Protezione e Ricerca Ambientale, ROMA, ITALY ; (2) Istituto per la Dinamica dei Processi Ambientali, CNR, MILANO, ITALY ; (3) Scuola di Scienze Ambientali - Università degli Studi di Camerino, CAMERINO (MC), ITALY ; (4) Libero professionista, ROMA, ITALY

The socio-economic scenario of a region is closely linked to the geomorphologic arrangement of the land. By integrating geology and land use, it is possible to study the relationship between landscape and wine areas. The production of wine is one of the most important component in the Italian culture as well as in the economy. At the same time, it is an expression of the territory: in this way it becomes a "medium" to communicate the landscape and to promote the sustainable development. In this context, the conferences on "Landscapes of Wine"created and organized by Lucilia Gregori, Professor of Geomorphology at the University of Perugia, dead in January 2012, have been for many years an opportunity for a significant and permanent dialogue between the experts (academics, producers, consumers) offering proposals for knowledge and qualified enjoyment of the best iIalian wines.

One of the most important Lucilia's projects was the realization of "geological labels" on the wine bottle, describing the landscape of the production area by a geo-morphologic point of view. We are trying to continue these projects, following an integrated methodological approach, GIS based.

The Geographical Information Systems represent new tools and new ways of dialogue, aimed at an easier access to the information in a scientific and cultural way, using simple communication codes.

GIS technologies can synthesize, manage and represent large amounts of data, giving the researchers as well as the public, a complete information about wine, landscapes and territory. A further and interesting opportunity is the identification of those wine-producing areas characterized by environmental and cultural value such special to be considered as geosites.

A multidisciplinary methodology allows a complete knowledge of territory, useful in territorial planning policies oriented to a sustainable development, and contributes significantly to a better understanding of the culture of Italian wines.

Geodiversity of the Colorado River Delta, Baja California, México

TELLEZ M.(1), SPELTZ R.(1), FLESSA K.(2), ARANDA F.(1)
(1) Universidad Autonoma de Baja California, Facultad de Ciencias Marinas, ENSENADA, BAJA CALIFORNIA, MEXICO ; (2) University of Arizona, TUCSON, UNITED STATES

Although the Colorado River delta is best known for its diversity of birds, for its endangered porpoise and its fisheries, the delta's rich cultural and geological diversity is not well-recognized – despite its designation as the Biosphere Reserve "Alto Golfo de California y Delta del Río Colorado". The delta´s landscape is dominated by extensive tidal flats and floodplains with impressive shell beaches, coastal lagoons, abundant sedimentary and biogenic structures, dunes, cliffs and marine terraces These features document the diversity and heterogeneity of geomorphological processes and their links with biodiversity. Nowadays they are often disturbed by human-caused stresses such as the lack of river flow and coastal erosion by the removal of dune vegetation. The surrounding area also includes intrusive and extrusive rocks, Paleozoic fossiliferous metasediments, proto-gulf bathyal diatomites and Pleistocene fossiliferous sandstones. The cultural heritage in the coastal zone is dominated by numerous prehistoric shell Indian middens with abundant stone tools and scattered ceramic sherds. Prehistoric rock paintings and petroglyphs are common in the foothills of the nearby mountains. Managing the diverse and valuable natural and cultural resources of the Colorado delta is a major challenge because of potential conflicts over water, agriculture, fisheries and tourism. The Geodiversity concept can be used in education and regional tourism to emphasize the functional integrity of the landscape, ecosystems and the maintenance of natural processes. This is a scientifically-based approach to the sustainable development of the region.

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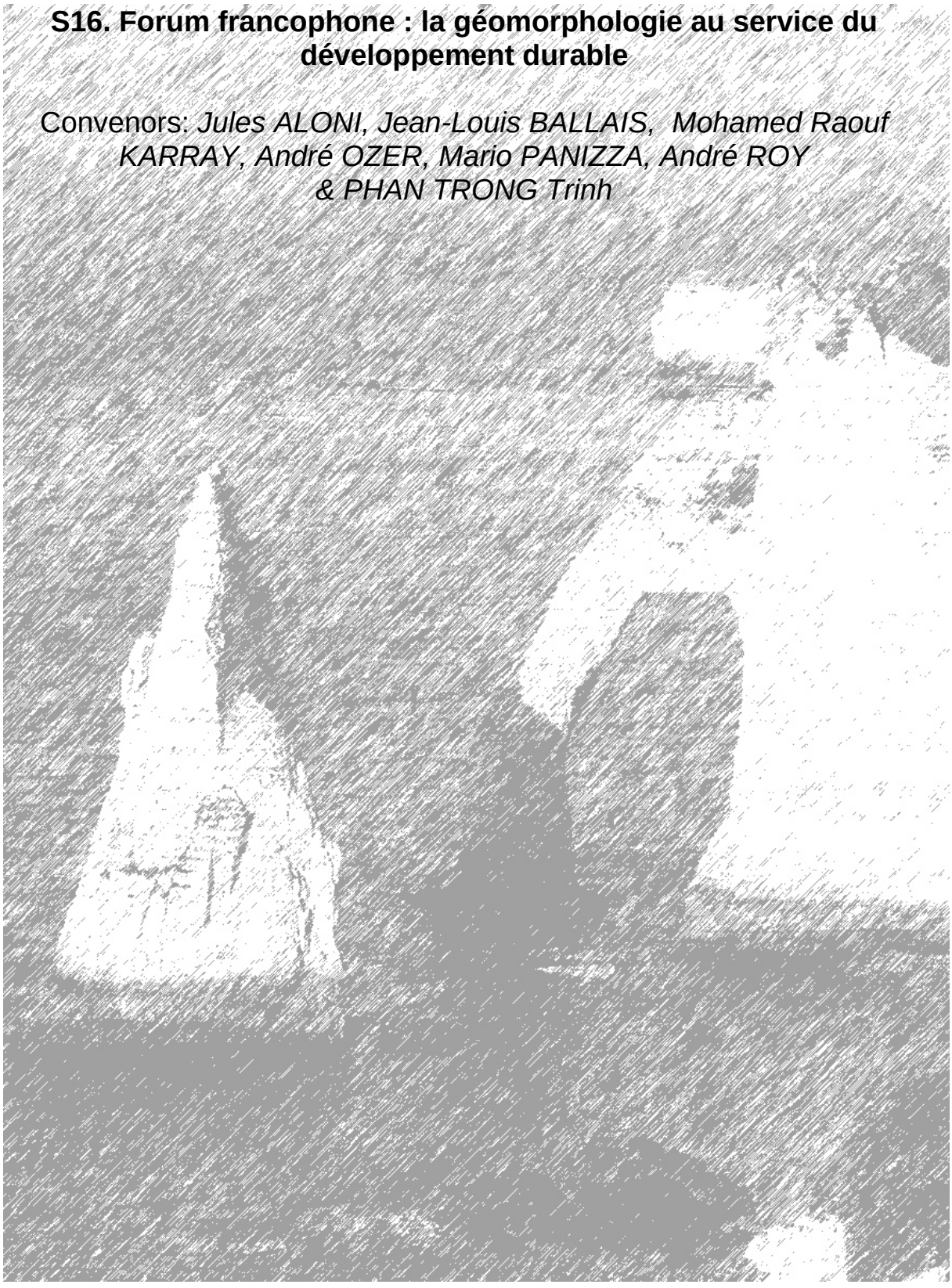
S16. Forum francophone : la géomorphologie au service du développement durable

Convenors: *Jules ALONI, Jean-Louis BALLAIS, Mohamed Raouf KARRAY, André OZER, Mario PANIZZA, André ROY & PHAN TRONG Trinh*



Oral presentations:

Géodiversité et Géomorphodiversité: exemples en Italie

PANIZZA M.
Dipartimento di Scienze Chimiche e Geologiche - Universite di Modena e Reggio Emilia, MODENA, ITALY

Dans le but d'étudier, d' interpréter et de mettre en valeur le patrimoine géomorphologique (et géologique) selon un code de déchiffrage original, on a introduit le concept de 'géomorphodiversité' (et redéfini celui de 'géodiversité'): évaluation critique des caractéristiques géomorphologiques (et géologiques) d'un territoire, en les considérant tant au niveau 'extrinsèque' (par rapport à d'autres territoires), qu' 'intrinsèque' (dans le périmètre du territoire considéré), en prenant en compte leur qualité scientifique, l'échelle et le but de la recherche'.

Trois exemples en Italie sont pris en considération: les Dolomites, qui ont été insérées au sein du Patrimoine Mondial de l'UNESCO; les Apennins émiliens, qui sont candidats à l'inscription dans la liste des Géoparcs Européens; le Vésuve, qui fait partie du réseau des Parcs Nationaux Italiens.

En général on a exécuté une évaluation critique et spécifique des caractéristiques géomorphologiques (et géologiques) de ces montagnes, en faisant la comparaison soit entre d'autres montagnes (niveau extrinsèque), soit entre les particularités plus ou moins significatives des trois régions montueuses considérées (niveau intrinsèque).

Pour exemple les caractères d'excellence stratigraphique dans l'espace et dans le temps (Dolomites), la complexité tectonique et sédimentologique (Apennins), la typologie des éruptions entrée dans la nomenclature volcanique internationale (Vésuve): géodiversité extrinsèque à niveau global. On peut citer le large spectre de formes du relief plurigénétiques (Dolomites), l'exemplarité de la morphologie épigée et hypogée du Karst en lithotypes gypseux (Apennins), l'emblématicité didactique des formes du relief volcanique en rapport avec la pétrographie et les mécanismes d'éruption (Vésuve): géomorphodiversité intrinsèque en prenant en compte leur qualité scientifique.

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Modélisation et géomorphologie dynamique dans le nord de l'Algérie

DAOUDI M.
King Abdulaziz University, JEDDAH, SAUDI ARABIA

Le processus du ravinement est le moteur de la géomorphologie dynamique. Très fréquent en Afrique, il touche particulièrement le nord de l'Algérie ce qui engendre l'envasement des barrages et diminue les potentialités des sols. Le bassin versant de l'oued Isser, d'une superficie de 4165 km², constitue une zone d'étude d'intérêt particulier en raison des caractéristiques physico-climatiques représentatives de la zone tellienne méditerranéenne. Le présent travail propose une méthode univariée-multivariée, basée sur des données multisources, afin de déterminer les variables indépendantessignificatives qui favorisent l'existence de l'érosion ravinante et calculerla probabilitédes zones de susceptibilité au processus de ravinement. Pour déceler l'influence d'une variable sur le processus et comparer leur distribution, une analyse statistique et spatiale des différentes variables a été appliquée. Le test de Student et le test de Kolmogorov-Smirnov ont été appliqués aux variables quantitatives et le test de Chi carré a été appliqué aux variables qualitatives. Des variables explicatives sont retenues pour le modèle de régression logistique : il s'agit de la lithologie, la pente, l'orientation des versants, l'altitude, la morphopédologie, la couverture du sol et l'agressivité des précipitations. Elles permettent de généraliser le modèle prédictif pour des régions semblables du nord de l'Algérie ou du Maghreb.

Mots clefs **:** Géomorphologie dynamique, érosion ravinante, données multisources, analyse spatiale et statistique, régression logistique.

Erosion et impact des vagues exceptionnelles sur le littoral ivoirien à l'est d'Abidjan

KONAN E.(1), AKA K.(2), ABE J.(3), NEUMEIER U.(4), NYSSEN J.(5), OZER A.(6)
(1) Centre de Recherches Océanologiques, ABIDJAN, COTE D'IVOIRE ; (2) Université de Cocody, ABIDJAN, COTE D'IVOIRE ; (3) PNUD, ACCRA, GHANA ; (4) Institut des sciences de la mer, Université de Québec, RIMOUSKI, QUEBEC, CANADA ; (5) Université de Gand, GAND, BELGIUM ; (6) Université de Liège, LIEGE, BELGIUM

Cette étude estime les impacts des vagues exceptionnelles enregistrées le 14 août 2007 sur le cordon littoral ivoirien à l'est d'Abidjan (Abidjan Grand-Bassam et Assinie-Aforenou). La méthode d'appréciation est basée sur une analyse diachronique de photographies aériennes (1979-1989) et sur un important travail de terrain appuyé sur une série de profils topographiques du Centre de Recherches Océanologiques d'Abidjan (ex-ORSTOM). A partir de la superposition des courbes enveloppes obtenues, une approche quantitative des dépôts de sédiments est utilisée pour mesurer l'ampleur du recul du trait de côte. L'application de ces méthodes montre que la vitesse d'érosion de la baie de Port-Bouet et des plages d'Assinie, n'excède généralement pas 1,5 m/an, est exacerbée sur des courtes durées par des houles violentes qui naissent dans l'Océan Atlantique sud. Certaines seraient d'origine sismique comme celles qui ont submergé puis érodé une partie de la côte ivoirienne dans la nuit du 13 au 14 août 2007. La côte a reculé de 2,3 à 18 m en un cycle de marée faisant d'importants dégâts dans la baie d'Abidjan (Port-Bouet). Cette étude met en exergue que le cordon littoral étudié, qui subit de façon générale une érosion, présente une sensibilité élevée aux vagues anormales.
Mots-clés: érosion côtière, engraissement, courbe enveloppe, séisme, vagues exceptionnelles.

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Etude de la morphodynamique et de la dynamique sédimentaire de la côte atlantique de Tanger (Maroc) par l'imagerie aérospatiale

EL ABDELLAOUI J.E.
Université Abdelmalek Essaadi, TANGER, MOROCCO

Des images satellites et des photographies aériennes, à haute et très haute résolution, ont été étudiées afin de caractériser la dynamique morpho-sédimentaire de la côte atlantique de Tanger.

Les résultats montrent que la morphodynamique présente un état modal intermédiaire avec un système à barres multiples dont le nombre, la position et la configuration sont variables en fonction des conditions d'ondes, des vents et de la géomorphologie antécédente. Les barres subtidales présentent une configuration linéaire légèrement ondulée avec des chenaux de retour. La zone intertidale présente une géomorphologie variable avec de larges terrasses et des chenaux de retour réduits, mais une morphologie prononcée avec une configuration à barres et chenaux de retour relativement développés, est souvent rencontrée.

L'évolution rapide du système à barre et l'irrégularité de sa topographie constituent un risque pour la navigation côtière et favorisent l'ensablement des ports de taille moyenne. Elle mettent en danger la vie des baigneurs à cause des forts courants de retours qu'elles engendrent.

La cartographie de la matière en suspension dans des conditions hydrosédimentaires variables a été réalisée. Elle a permise l'appréciation de la direction des courants et de leurs interactions avec les ouvrages portuaires, la morphologie sous-marine et la configuration de la côte.

La dynamique de la matière en suspension montre qu'au large de la plate forme continentale, le courant est de direction N-E pendant le flot. En s'approchant du rivage, la direction du courant change vers le N-NE. Ce changement forcé par la configuration de la ligne de côte conduit à une forte concentration de la matière en suspension au niveau de la frange côtière. Au cours du jusant la matière en suspension longe la côte au nord avec une direction S-SW parallèle à la ligne de rivage et s'étale ensuite au large de la plate forme continentale avec une direction S-W.

Apports et résultats de l'imagerie radar SAR et l'interférométrie InSAR/DinSAR dans les études géomorphologiques dans la région subcarpatique de Buzău (Roumanie)

HACHEMI K.(1), OZER A.(2)
(1) CNRS LGP, MEUDON (PARIS), FRANCE ; (2) Université de Liège, LIÈGE, BELGIUM

La région de Buzau, située sur la région subcarpatique en Roumanie est le siège de deux grands types d'aléas naturels; géologiques-géomorphologiques (glissements, séismes, …) et climatiques/hydrologiques (phénomènes d'inondation accentuant souvent l'érosion des sols). On peut alors s'interroger sur le moyen le plus adapté pour établir un suivi permanent de ces risques, en établir une cartographie aussi fidèle que possible et estimer, éventuellement, les dégâts et les modifications du paysage qui en résultent. L'un des avantages d'imagerie radar (amplitude/phase) est la possibilité d'enregistrement par tout temps indépendamment des conditions météorologiques (jour, nuit, nuages). Cet outil nous a permis d'obtenir plusieurs résultats géomorphologiques dans la région : 1) l'analyse diachronique a permis de mettre en évidence les variations de surface, notamment au niveau des lacs et de la plaine; 2) la réalisation d'un MNA de Buzău (100x100km^2) avec une résolution de 20 m et précision verticale globale inférieure à 17m; 3) l'association des images diachroniques avec le MNA réalisé a donné des images en 3D (différentes dates) ; 4) l'exploitation des images de cohérence des différents intervalles (1995/2005), nous a permis de distinguer plusieurs constructions qui se sont multipliées au périphérique et à l'extérieur de la ville de Focşani. Par contre, le centre de la ville avait subi des rénovations se traduisant par des espaces verts ; 5) la comparaison entre le MNAréalisé et le DEM-SRTM a donné une différence de morphologie au niveau du glissement du Shela ; 6)le volcan de boue nord (Paclele Mici) est plus actif que le volcan sud (Mari) dans cette période (octobre 2004/avril 2005); 7) la détection des déformations près de la ville de Saranga (déplacements d'environ 24,08cm/70j et 11,70cm/105j) ;8) les trois lacs de Buzau apparaissent nettement dans l'image de cohérence. Les deux lacs au nord et sud diminuent et le lac du milieu s'agrandi durant cette période (1963/1995).

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Tourisme, privatisation des littoraux et érosion des côtes: cas de Phan Thiet, Vietnam

OZER P.
Département des Sciences et Gestion de l'Environnement, Université de Liège, ARLON, BELGIUM

Avec ses plus de 3200 km de côtes, le Vietnam fait partie des pays les plus exposés aux effets du réchauffement climatique : élévation du niveau des mers, augmentation de la fréquence des typhons et des inondations.

Début 2009, 27 maisons situées dans le village de pêcheurs de Phan Thiet se sont effondrées. Selon les médias internationaux et les autorités locales, une forte marée de tempête –conséquence du réchauffement climatique– était la cause de cette rapide érosion littorale.

Cet article montre comment, en utilisant la fonction multi dates Google Earth, il est possible de nier cette argumentation et de mettre en évidence les vraies causes de ce rapide et inéluctable retrait des côtes au niveau de ce village de pêcheurs, à savoir la construction anarchique de la station balnéaire de Mui Ne, quelques kilomètres à l'est.

La création de ce désormais haut lieu touristique est extrêmement récente, le premier établissement étant sorti de terre en 1994. Vu le succès croissant des plages de sable blanc, la côte a depuis été lotie sur près de 5 km. Mui Ne a modifié son espace pour accueillir les touristes occidentaux : les cocoteraies ont été abattues, les liserons des sables ont été arrachés, le sable a été égalisé et les infrastructures hôtelières ont recouvert les dunes pour être en contact direct avec la plage.

Ainsi, le fragile équilibre littoral a été rompu et le bilan sédimentaire est devenu négatif. Entre 2006 et 2009, la plage de 30 m a totalement disparu. Or, la plage étant vitale pour ce lieu, les promoteurs ont eu recours à la construction d'épis qui interrompent le transit sédimentaire pour recréer les plages. La dérive littorale est ainsi stoppée ce qui engendre la disparition des plages suivantes et l'effondrement des maisons de pêcheurs.

Cette analyse montre la rapide modification géomorphologique qui résulte d'une conversion économique locale non encadrée répondant aux processus de mondialisation sans tenir compte des externalités négatives.

Une cartographie du risque "instabilités de terrain" au service du développement durable : l'exemple du complexe portuaire "Tanger Med" et de son arrière-pays (Rif septentrional, Maroc)

PATEAU M.(1), FORT M.(1), BEN MOUSSA A.(2)
(1) Université Paris Diderot, Sorbonne Paris Cité, PRODIG UMR 8586, 75013 PARIS, FRANCE ; (2) Université Abdelmalek Essaâdi, Faculté des Sciences, Département de Géologie, BP 2121 93000 TETOUAN, MOROCCO

Le nord du Maroc, longtemps marginalisé (Protectorat espagnol de 1912 à 1956, isolement suite aux révoltes du Rif à la fin des années 1950), connaît un développement sans précédent porté par de grands projets tels que le complexe portuaire « Tanger Med ». Ses aménagements imposants (trois ports, zones franches et logistiques, réseaux autoroutier et ferroviaire) ont profondément bouleversé à la fois les dynamiques de versants de l'arrière-pays et la vie des populations locales. En se basant sur une étude de terrain approfondie et une cartographie de l'occupation du sol, notre travail propose un inventaire et une description précise des secteurs et infrastructures fortement exposés aux instabilités de terrain (prédominance de terrains flyscheux).

Deux études de cas seront présentées. La première expose le problème du stockage des déblais sur des versants naturellement sujets aux instabilités de terrain. Ces dépôts massifs sont situés en bordure des principaux oueds et entraînent, en cas de fort épisode pluvieux, une charge sédimentaire grossière vers l'aval, aggravant ainsi la vulnérabilité des exutoires anthropisés. Le second cas traite du relogement des populations expropriées par l'aménagement du complexe. Certaines se sont vues proposer une habitation neuve construite sur un secteur géologiquement sensible à l'érosion (solifluxion dans un flysch argilo-calcaire détritique). Ces constructions (majoritairement des villas et une imposante mosquée) ont bloqué les écoulements naturels de l'eau (imperméabilisation des sols) et amené une concentration du ruissellement, engendrant des phénomènes de ravinement intense et une déstabilisation de certains bâtiments.

La cartographie de synthèse ainsi produite pourra servir, à l'avenir, de document de référence pour les futurs aménagements, afin de ne pas réitérer les erreurs déjà commises et ainsi assurer une gestion durable de cette zone aux potentialités économiques et touristiques croissantes.

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Seuils topographiques des ravins dans la haute ville de Kinshasa (RD. Congo)

MAKANZU IMWANGANA F.(1), MOEYERSONS J.(2), NTOMBI M.(3)
(1) Laboratoire de Géomorphologie et Télédétection, Centre de Recherches Géologiques et Minières (LAGEOT/CRGM), KINSHASA, CONGO (THE DEMOCRATIC REPUBLIC OF THE) ; (2) Division of Geomorphology and Remote Sensing, Royal Museum of Central Africa, TERVUREN, BELGIUM ; (3) Département des Sciences de la Terre (Géographie-Géologie), Faculté des Sciences, Université de Kinshasa, KINSHASA, CONGO (THE DEMOCRATIC REPUBLIC OF THE)

Le ravinement constitue un processus important de l'érosion des sols en Afrique centrale. Ce sont surtout les villes qui en sont victimes. Le ruissellement incise les sols à partir d'un point où une combinaison critique de la pente (S) et de la surface drainée (A) est dépassée. L'objectif de ce travail est de connaître ces combinaisons critiques, de façon de les utiliser dans la prévention de l'érosion en ravine dans une zone urbanisée. La haute ville de Kinshasa avec ses 240 km2, en est la zone d'étude.

Des mesures de S et de A ont été faites pour 308 ravins de >5 m de large inventoriés sur une image SPOT 2007. Selon leur genèse, une typologie des ravins a été faite. Les ravins dits axiaux se produisent par érosion régressive des structures urbaines. Les ravins de débordement sont provoqués par une érosion progressive aux abords de ces structures. La relation statistique de S et A de ces ravins a été vérifiée sur un graphique à double échelle logarithmique. Pour ces ravins, l'équation de l'enveloppe est Scr=0,0001A-1,329 avec Scr en m/m et A en ha. L'enveloppe qui décrit la relation entre S et la longueur des routes L montre une relation semblable. Cette équation représente le seuil topographique de l'apparition de l'érosion en ravine dans cette région. En comparaison avec les seuils trouvés dans d'autres régions en Afrique et ailleurs, le sol sableux de Kinshasa apparait comme l'un de plus vulnérables du monde face au ruissellement. Dans certains cas, la configuration des routes fait aussi accroître la surface de drainage et les routes mêmes sont des grands producteurs de ruissellement. Une pluie même de faible intensité occasionne du ruissellement.

La relation qui existe entre la pente critique et la surface de drainage est un outil qui pourrait contribuer dans la gestion de l'eau, la conservation des sols et dans la lutte anti-érosive dans les milieux urbains à l'instar de la haute ville de Kinshasa.

Mots clés : Seuil topographique, surface drainée, ruissellement, ravin, Kinshasa

Quatre lits pour un cours d'eau. Conséquences pour le risque d'inondation et l'aménagement

BALLAIS J.L.(1), CHAVE S.(2), DELORME V.(3), ESPOSITO C.(4)
(1) Université d'Aix-Marseille, AIX-EN-PROVENCE, FRANCE ; (2) Prédict-Services, MONTPELLIER, FRANCE ; (3) Fluvialis, BRIENNE-LE-CHÂTEAU, FRANCE ; (4) Centre d'Etudes Techniques de l'Equipement, AIX-EN-PROVENCE, FRANCE

La tradition initiée par les chercheurs étatsuniens du milieu du XX^{ème} siècle a permis de distinguer d'une part le *channel* et, d'autre part, la *floodplain.* Cette distinction a suscité un très grand nombre de travaux, surtout parmi les anglo-saxons, et a montré son efficacité pour l'étude des processus hydrogéomorphologiques.

L'irruption de la problématique des risques d'inondation en France et sa concrétisation en termes d'aléa a conduit à s'intéresser à nouveau aux formes, longtemps négligées au profit des processus. C'est ainsi que plusieurs centaines de kilomètres de plaine alluviale fonctionnelle ont été cartographiés en France, en Tunisie et en Chine. S'il est certain que, sous climat tempéré océanique et semi-continental, le lit mineur (*channel*, ou mieux *low water bed*) et le lit majeur (*floodplain*, ou mieux *high water bed)* constituent bien, généralement, les deux seuls lits d'un cours d'eau, il n'en est pas de même sous d'autres climats. C'est ainsi que nous avons été conduits à définir un lit moyen (*mean water bed*), généralement placé entre le lit mineur et le lit majeur, et un lit majeur exceptionnel (*exceptional high water bed*), en position distale, pour traduire la complexité de situations observées en domaine méditerranéen (France, Tunisie, Roumanie), tempéré continental (Xinjiang) ou tropical sec à cyclones (Australie du Nord-Ouest).

Ainsi, la réduction du nombre des formes de lit à seulement deux, nécessaire pour l'application de la modélisation hydraulique il y a 50 ans, se révèle être un des derniers avatars de la conception davisienne de l'érosion normale, c'est-à-dire tempérée. De plus, la possibilité de l'existence de jusqu'à quatre lits impose de ne pas considérer les limites externes du lit majeur ordinaire comme limites de la zone inondable, au risque de négliger des surfaces unondables très recherchées par les aménageurs.

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Vulnérabilité de la plaine d'inondation du fleuve Hathanh (Centre Viêt-Nam) face aux changements environnementaux

GRIVEL S.(1), NGO A.T.(1), ZANINETTI J.M.(1), LUONG T.V.(2)
(1) Université d'Orléans, ORLÉANS, FRANCE ; (2) University of Quynhon, QUYNHON, VIET NAM

Le fleuve Hathanh, dans la province de Binh Dinh (Centre du Viêt-Nam), est un hydrosystème fluvial peu étudié : un court linéaire (58 km), entre les hauts bassins et le delta; une plaine deltaïque alimentant la lagune de Thinai; un contexte hydroclimatique de type tropical de mousson avec une saison des pluies centrée sur juillet et une période cyclonique en octobre-novembre. Depuis la libéralisation économique du pays, de la fin des années 1980, la croissance urbaine de Quynhon est soutenue. Les projets d'aménagements de cette ville se réalisent dans le delta du fleuve Hathanh. Or, la plaine d'inondation constitue un écosystème et un agrosystème très fragiles et sensibles aux perturbations. Elle est directement affectée par les changements environnementaux comme les modifications hydroclimatiques et la montée du niveau de la mer. Selon le rapport du Ministère des Ressources Naturelles et de l'Environnement du Viêt-Nam (2009), le centre du Viêt-Nam pourrait connaître, en 2100, une élévation moyenne du niveau de la mer d'un mètre et une augmentation des températures de près de 3°C (augmentation générale du nombre de jours > 35°C; augmentation de la fréquence et de l'intensité des précipitations; augmentation de la saison sèche). La faible distance entre les hauts bassins et son delta engendre des écoulements très rapides et contribue à aggraver les conséquences des inondations dans la plaine deltaïque, comme en novembre 2009 après le passage de la tempête tropicale Mirinae. Cette communication présentera l'évaluation environnementale de la vulnérabilité physique de la plaine d'inondation à travers des méthodes hydrogéomatiques et géomorphologiques (SIG, télédétection, modélisation). La crue de novembre 2009 servira également d'évènement hydrologique de référence pour appuyer l'analyse de la vulnérabilité. Cette évaluation permettra de mieux anticiper les changements environnementaux (naturels et anthropiques) à venir.

Hydrogéomorphologie et risque d'inondation dans la vallée de la Karakash Darya (Xinjiang, Chine)

WULAMU M.(1), BALLAIS J.L.(2), DELORME V.(3)
(1) Université Normale du Xinjiang, URUMQI, CHINA ; (2) Université d'Aix-Marseille, AIX-EN-PROVENCE, FRANCE ; (3) Fluvialis, BRIENNE-LE-CHÂTEAU, FRANCE

Le bassin versant de la Karakash Darya est situé dans la partie méridionale du Xinjiang, sur le piedmont septentrional du Karakorum et des Kunlun, au sud du désert du Takla Makan. Dans ce bassin versant, les crues se produisent en été et détruisent les cultures irriguées qui sont la principale ressource des populations. L'applicabilité de la méthode hydrogéomorphologique de détermination des zones inondables, mise au point en France méditerranéenne, a été prouvée pour le bassin versant de la Karakash Darya. La cartographie hydrogéomorphologique fournit des informations qui peuvent permettre un aménagement spatial pour prévenir et réduire les risques d'inondation. De plus, cette cartographie montre que la plaine alluviale fonctionnelle de la rivière est en cours d'ajustement aux débits maximaux en diminution depuis la construction du barrage d'Ulugata. En conséquence, le risque d'inondation diminue sur le lit majeur de la rivière.

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Etude des processus morphodynamiques et leur impact sur le modelé dunaire dans le sud-ouest de la Mauritanie par imagerie satellitale optique et radar

NIANG A.J.(1), OZER A.(2)
(1) Université Nouakchott, NOUAKCHOTT, MAURITANIA ; (2) ULG, LIEGE, BELGIUM

Les processus morphodynamiques consécutifs ou inhérents à la désertification représentent un sérieux défi qui aggrave l'état de dégradation environnementale dans les zones arides et semi-arides. Dans le sud-ouest mauritanien, l'érosion éolienne est devenue, depuis les années 70 et 80, un élément essentiel de la dynamique morphogénétique des formations dunaires.

Plusieurs traitements ont été appliqués aux images satellitales pour la mise en évidence des changements environnementaux qui ont affecté le secteur étudié et les caractéristiques morphologiques et morphodynamiques des systèmes dunaires.

L'utilisation de l'imagerie satellitale radar a été également très efficiente pour l'identification et la localisation des sables en mouvement.

Les traitements appliqués aux images satellitales optiques montrent une dégradation généralisée des ensembles dunaires et une exacerbation de l'activité morphogénétique impliquant des remaniements successifs des dunes ogoliennes.

L'application de certains filtres nous a permis de discriminer les crêtes vives qui se forment sur les sommets des cordons dunaires, comme des sifs orientés N-S (obliques par rapport aux dunes ogoliennes) et sur certaines parties des interdunes. La réactivation des anciennes dunes s'exprime par la multiplication et la migration des crêtes vives dont l'agencement transforme les cordons dunaires en dunes longitudinales complexes.

Par ailleurs, l'évolution temporelle de la cohérence des images Radar sur ds longues périodes indique que la majeure partie de la zone d'étude est composée de sables vifs qui participent à l'édification des nouvelles formes dunaires et qui sont en général situés à proximité des installations humaines. Des auréoles de dénudation apparaissent quasi-systématiquement autour des villages, les zones qui sont restées les plus stables sont celles qui ne sont pas directement dans le voisinage des installations humaines.

Le contexte urbain et climatique des risques hydrologiques de la ville de Butembo (Nord Kivu/ RDC)

SAHANI M.(1), OZER P.(2), MOEYERSONS J.(3)
(1) Faculté des Sciences Agronomiques, Université Catholique du Graben, BUTEMBO, CONGO (THE DEMOCRATIC REPUBLIC OF THE) ; (2) Département des Sciences et Gestion de l'Environnement, Université de Liège, ARLON, BELGIUM ; (3) Unité de Géomorphologie et Télédétection, Musée Royal de l'Afrique Centrale, TERVUREN, BELGIUM

Butembo constitue un cas typique de zone urbaine en région tropicale humide rencontrant une explosion démographique exceptionnelle. La concentration spontanée des populations, due à l'exode incontrôlé sur un territoire assez restreint, a conduit à une urbanisation sans cesse croissante. L'imperméabilisation des vastes étendues de terres consécutive à une expansion spatiale rapide de la ville a généré des problèmes environnementaux qui affectent la structure urbaine. La ville est actuellement confrontée à des risques hydrologiques diversifiés : ravinements progressif et régressif, inondations, et remobilisation d'anciens glissements de terrain.

Après avoir réalisé la carte de la ville de Butembo, ce travail aboutit notamment à la production d'une carte des risques hydrologiques sur base d'approches combinant la télédétection et travaux de terrain.

Les résultats révèlent une expansion urbaine exceptionnelle. L'emprise urbaine de la ville de Butembo est passée de 2,39 km² en 1957 à 85,83 km² en 2008. Son accroissement est consécutif à l'augmentation de la population qui est passée de 9 653 à 581 449 habitants entre 1957 et2008. Cette urbanisation a abouti à une nouvelle affectation du sol avec des conséquences sur le paysage urbain. Depuis 1957,le ravinement de fond de vallée ainsi que celui sur les versants sont toujours restés confinés à l'intérieur des extensions urbaines respectives. L'urbanisation précède le développement des ravins et ceux-ci sont confinés dans les zones où le coefficient d'écoulement est accentué par elle. Les inondations pourraient s'étendre sur tous les fonds plats de valléesen cas d'inaction. Quant aux16 glissements de terrain actifs, ilsse trouvent dans la phase de creep et 11 sont partiellement co-engendrés par lasismicité. La pluie n'est pas à la base de l'accentuation des problèmes environnementaux qui perturbent la structure urbaine de Butembo. C'est bien l'urbanisation qui en est la principale cause.

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Poster presentations:

Le « Voyage en Italie » de J.W.Goethe et le paysage de la géologie

PANIZZA M., CORATZA P.
Dipartimento di Scienze Chimiche e Geologiche - Universite di Modena e Reggio Emilia, MODENA, ITALY

Le voyage que Goethe effectua en Italie il y a 225 ans est de nouveau parcouru en établissant une comparaison entre ses observations géographiques et surtout celles géologiques avec les résultats les plus modernes et les théories les plus avancées de la Science de la Terre.

De nombreux chercheurs adhérents à différents Instituts de recherches géologiques, reproposent l'itinéraire des Alpes à la Sicile que le fameux écrivain allemand fit en fiacre, à pieds, ou en bateau.

La recherche est composée d'une série de fiches standard. Celles-ci contiennent des informations préliminaires de caractère strictement géographique, cartographique et iconographique (photos, dessins etc...); elles indiquent aussi le thème géologique affronté, en spécifiant l'importance scientifique. Le paragraphe original de Goethe est confronté avec la description géologique moderne en l'encadrant dans le contexte originale et en mettant en relief les caractéristiques scientifiques (théories, découvertes, roches, formes du relief, fossiles etc...). Ensuite les informations de type logistique, bibliographique et d'intérêt culturel (archéologique, historique, architecturales, artistiques etc...) y sont citées.

De cette façon il en résulte une description fascinante et savante: celle des paragraphes de Goethe et celle moderne. La description est faite de façon rigoureuse du point de vue scientifique, mais aussi, accessible à ceux qui ne sont pas experts en matière géologique. Le tout accompagné d'une riche iconographie tirée des dessins originaux du poète et d'autres artistes, mais aussi de sources modernes.

Taferdoust: la merveille du méandre et du douar perché sur le "Calcaire-corniche" (Moyen Atlas plissé, Maroc)

ALDIGHIERI B.(1), DI GREGORIO F.(2), CHARRIÈRE A.(3), OUARHACHE D.(4), EL HAMZAOUI O.(4), HESSANE M.A.(4)

(1) IDPA - CNR, MILAN, ITALY ; (2) Università di Cagliari, Dipartimento Scienze Chimiche e Geologiche, CAGLIARI, ITALY ; (3) Université Toulouse III, TOULOUSE, FRANCE ; (4) Université Sidi Mohamed Ben Abdellah, FSDM, FÈS, MOROCCO

Le géosite de Taferdoust est situé dans la région de Fès-Boulemane-Skoura, dans la profonde et sinueuse vallée de l'Oued Guigou, loin des principales voies de communication.

L'emplacement de la petite forteresse de Taferdoust dans la partie axiale du synclinal de Skoura, ses singulières caractéristiques géomorphologiques, confèrent au lieu un intérêt scientifique doublé d'une valeur esthétique supplémentaire.

Dans le synclinal de Skoura se retrouvent les différentes formations du Dogger du Moyen Atlas central, qui constituent le comblement du sillon moyen-atlasique. Le douar est bâti sur la partie supérieure du "Calcaire corniche", dépôt de calcaires de plate-forme épi-récifale (F. de Recifa). Au-dessus, se développent des dépôts marno-calcaires et marneux correspondant aux fluctuations d'environnement marin de plate-forme (F. Bou Akrabène-Ich Timellaline).

Le douar est placé sur un éperon rocheux constituantle lobed'un méandrede l'Oued Guigou, accessible uniquement par un sentier étroit. Pour les constructions on a utilisé les matériaux disponibles sur le site même : les pierres, les poutres en bois de cèdre, l'eau, la terre, la paille.

La vue au NE de Taferdoust donne une première approche en contre-plongée de ce douar pittoresque, entouré de falaises abruptes dues à l'érosion fluviale du "Calcaire corniche".En contrebas apparait un pont étroit et en rive droite grimpe le seul chemin d'accès à ce site naturellement fortifié. Un second point de vue, au SW du douar, permet une vue plongeante sur le douar et le méandre encaissé qui l'entoure dans son contexte géologique.

Le géosite de Taferdoust ne représente pas un cas isolé. Plusieurs sites forts intéressants sont échelonnés dans la vallée reliant les villes de Skoura et de Boulemane, présentant ainsi un grand potentiel qui pourra être exploité avec des projets visant à un «géo-écotourisme scientifique» associé à un développement durable de cette région hors des circuits touristiques traditionnels.

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Paysages, géosites et patrimoine géologique dans le Massif Central du Maroc comme nouvelles ressources pour le géotourisme

ALDIGHIERI B.(1), DI GREGORIO F.(2), EL WARTITI M.(3), ZAHRAOUI M.(3), FADLI D.(3)

(1) IDPA - CNR, MILAN, ITALY ; (2) Università di Cagliari, Dipartimento Scienze Chimiche e Geologiche, CAGLIARI, ITALY ; (3) Université Mohammed V-Agdal, Laboratoire de géologie appliquée, RABAT, MOROCCO

La présente étude propose l'inventaire des sites naturels géologiques et géomorphologiques dans le paysage extrêmement diversifié du Massif Central du Maroc. La région est caractérisée par des morphologies contrastées, en relation à la grande diversité lithologique des terrains paléozoïques (schistes-grés, quartzites, calcaires, granites, vulcanites, etc.), et liées aux longs et complexes processus géomorphologiques qui les ont édifiées au cours du temps. Ces terrains ont été déformés, métamorphosés et intrudés par des granites pendant l'orogenèse hercynienne et, par la suite, ont été sujets à pénéplanation à partir du Permo-Trias jusqu'au Plio-Quaternaire.

En plein massif central il y a le batholite granitique hercynien de Ment (279Ma), intrus dans des terrains ordoviciens et viséens. A côté il y a le paysage de la région d'Oulmès, constitué de grès, de pélites et de schistes d'âge cambro-ordovicien, déformés pendant l'orogenèse hercynienne engendrant des structures synschisteuses plurikilométriques déversées vers le SE, également intrudés par une masse granitique hercynien allongée selon la direction NNE, qui a développé une large auréole de métamorphisme.

Ce paysage géologique est caractérisé d'une large surface d'aplanissement d'où émergent des culminations modestes de piles de blocs des formes rudérales (tors) ou des rochers de grande intérêt scénographique dans le domaine granitique, et aussi nombreux appareils volcaniques (Plio-Quaternaire) en forme de cônes de scories rouges ou grises essentiellement, des coulées de laves, aussi avec typique fissuration prismatique, qui se sont épanchées directement sur les incisions latérales du socle.

Le travail vise à promouvoir des initiatives de développement durable dans une région à prédominance économique agro-pastorale.

Télédétection géomorphologique au nord-est de Jeddah (Arabie Saoudite)

DAOUDI M.
King Abdulaziz University, JEDDAH, SAUDI ARABIA

La télédétection optique constitue un outil précieux et fondamental pour les études géomorphologiques des zones désertiques où l'accès sur le terrain est difficile. Le présent travail s'intéresse au traitement numérique des données satellitaires TM et ETM+ de Landsat qui couvrent une zone de Harrat, au nord-est de Jeddah, complété par d'autres documents cartographiques et appuyé par les observations de terrain. Par les différents traitements : composition colorée, classifications combinées utilisant la texture des images, divers indices, etc., et grâce à la vue synoptique que permet la télédétection, une carte morphologique a pu être dressée à partir de l'interprétation visuelle des images satellitaires. Afin de mettre en évidence les linéaments, la méthode des filtres directionnels a été appliquée.
Mots clefs : Télédétection, zones désertiques, géomorphologie, Harrat,linéaments.

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Le risque d'effondrement de carrières souterraines dans la région parisienne : quelle gestion pour demain ?

ZITOUNI S., FORT M.
Université Paris-Diderot, Sorbonne et UMR 8586 PRODIG CNRS, PARIS, FRANCE

En région parisienne, plus de 3000 hectares de terrains sont affectés par le risque d'effondrement d'anciennes carrières souterraines. Ces carrières, de calcaire, craie, gypse, argile ou sable, ont été intensément exploitées à Paris et ses alentours pour répondre à des besoins industriels, économiques et architecturaux. La création de l'Inspection Générale des Carrières (IGC) dès 1777 a permis le recensement, la cartographie, la surveillance et la consolidation des cavités sous le domaine public.

Nous avons étudié la perception du risque lié à l'effondrement potentiel de ces carrières dans vingt communes du département des Hauts de Seine (ouest de Paris). Dans la majorité des cas, nous avons constaté que la connaissance par les responsables de l'emplacement et des caractéristiques des cavités était très lacunaire, données pourtant servant de base à toute politique efficace de prévention (information préventive, zonage réglementaire, gestion de crise). De plus, les disparités économiques entre communes ne facilitent pas la mise en œuvre de mesures de traitement de ces cavités, et ce au détriment des mairies pauvres, sauf pour des projets rentables.

Seule une implication réelle dans l'élaboration du dispositif de prévention de tous les acteurs, privilégiant échanges de compétences techniques et administratives, mettant de côté toute instrumentalisation politique ou tout conflit d'intérêt, peut permettre une évaluation fiable de ce risque. La consolidation des carrières souterraines n'est sans doute pas politiquement rentable sur le court terme, mais devient une nécessité pour un développement « durable » des zones urbanisées de Paris et de sa périphérie.

Cartographie, pétrographie, géochimie et dynamisme de mise en place des coulées basaltiques cénozoïques: cas de la ville de Bukavu et ses environs. (Sud-kivu,RDCongo)

BIRHENJIRA M.
Université Officielle, BUKAVU, CONGO (THE DEMOCRATIC REPUBLIC OF THE)

Situé dans le système du Rift Est Africain (EARST), la ville de Bukavu et ses environs présentent des affleurements des formations volcaniques d'age miocène à actuel (Kampunzu et Al. 1986).

L'étude cartographique montre bien que les affleurements basaltiques ne sont pas plus distribués dans notre région et que la grande partie de ses formations présente un important recouvrement conduisant ainsi à une altération avancée.

Les affleurements sont soit massif soit en orgues.

Plusieurs phase des coulées on été remarquée : coulée supérieure plus saine reposant sur un paléosol d'environ 3 m d'épaisseur et la coulée inférieur étant la plus altérée expliquant ainsi l'activité volcanique non continue.

Les basaltes présentent des phénocristaux relevant d'un caractère basique (Olivine + Pyroxène (clino pyroxène) + Plagioclase) et un mesostase faite des Oxydes opaques. La majorité des nos échantillons montre que lors de la différentiation magmatique le processus s'est arrêtée au pole basique (teneur en SiO2 comprise entre 45 et 54 %).

Les analyses géochimiques ont conduit a classer la grande partie des nos basaltes dans la série tholeitique et certaines dans la série calco-alcaline.

Le caractère serial permet aussi de confirmer que nous sommes dans la série transitionnelle située dans la zone d'extension caractérisée par le magmatisme anorogénique.

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Erosion littorale et migrations forcées de réfugiés environnementaux. L'exemple de Cotonou, Bénin

OZER P.(1), HOUNTONDJI Y.C.(2), DE LONGUEVILLE F.(3)
(1) Département des Sciences et Gestion de l'Environnement, Université de Liège, ARLON, BELGIUM ; (2) Département Aménagement et Gestion des Ressources Naturelles, Université de Parakou, PARAKOU, BENIN ; (3) Département de Géographie, Université de Namur, NAMUR, BELGIUM

Situé dans le Golfe de Guinée, le littoral béninois est soumis –sur certains tronçons– à une érosion assez rapide ces dernières décennies. Cette érosion côtière est principalement due actuellement aux activités humaines parmi lesquelles les perturbations sédimentaires occasionnées par la construction de divers barrages dont celui de Nangbéto sur le fleuve Mono ; le blocage du transit littoral par les ouvrages portuaires de Cotonou ; les carrières de sable exploitées à même la plage ; et la diminution d'apports sédimentaires provenant de l'ouest suite à divers travaux de protection des côtes.

En utilisant la fonction multi dates disponible dans Google Earth, cet article estime la superficie érodée à Cotonou entre 2002 et 2011 à l'est de l'exutoire du Lac Nokoué. En outre, il évalue le nombre de maisons détruites ainsi que le nombre de personnes contraintes à une migration forcée. Les figures sont importantes puisque de l'ordre de cent mètres de zone côtière ont totalement disparu au cours des dix dernières années sur un tronçon de près de six kilomètres de long en pleine ville ou en proche périphérie.

Cette analyse montre qu'actuellement les dommageables modifications géomorphologiques résultent essentiellement de l'addition non envisagée d'activités humaines couplée à l'absence de gouvernance. Par ailleurs, nous sommes en droit de nous interroger sur les risques d'érosion côtière dans les décennies à venir avec l'amplification annoncée de l'augmentation du niveau des océans due au réchauffement climatique.

Evaluation des processus géomorphologiques en région montagneuse: utilisation des ondelettes pour la modélisation du terrain à de multiples échelles

NAPARUS M.(1), GOLAY F.(1), PATRU-STUPARIU I.(2)
(1) EPFL-ENAC-LASIG, LAUSANNE, SWITZERLAND ; (2) University of Bucharest, Faculty of Geography, Transdisciplinary Research Center Landscape - Territory - Information Systems, BUCHAREST, ROMANIA

La précision des modèles numériques de terrain (MNT) a beaucoup augmenté ces dernières années.Dans le domaine de la géomorphologie, ces modèles permettent ainsi de mieux prédire les risques et les dangers naturels, ainsi que la vulnérabilité du paysage. Cette augmentation de la précision a permis de réduirel'incertitude sur les terrains complexes. Les modèles numériques de terrain (MNT) à haute résolution (1m) nous donnent l'accès aux structures géomorphologiques les plus détaillées. Ces petites structures constituent la base des grandes structures géomorphologiques et sont souvent leur moteur au niveau des phénomènes multi-échelle.

Cette étude s'inscrit dans un projet de collaboration entre la Suisse et la Roumanie. Elle s'appuie sur l'analyse à plusieurs échelles d'unMNT obtenu par un levé LiDAR dans une zone cible, dans les basses Carpates, dans le sud-ouest de Roumanie. La complexité du terrain requiert l'emploi de techniques adaptées pour la filtration des données et pour l'analyse des processus géomorphologiques.

On a choisi de représenter le terrain avec la technique des ondelettes, qui provient de l'analyse d'images. L'utilisation des ondelettes en géomorphologie aide à comprendre les phénomènes particuliers qui apparaissent dans les sous-espaces spécifiques du continuum d'échelles. D'une part, nous utilisons la procédure de filtrage progressif descoefficients d'ondelettes pour représenter la hiérarchie complexe d'éléments topographiques caractéristiques des processus géomorphologiques considérés. On obtient un modèle détaillé caractérisant la vulnérabilité du paysage avec le MNT à plusieurs échelles. Le modèle contient des propriétés réunies de la zone d'étude (analyse de surface topographique, contraintes, limites et facteurs d'agression du paysage) et a pour ambition de servir de base méthodologique pour une future évaluation du potentiel écologique du paysage et de la vulnérabilité de la région entière des Carpates roumaines.

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Contexte d'évolution des terrasses limoneuses quaternaires du bassin inférieur de l'oued Moulouya comparés aux étagements quaternaires aperçus sur ses affluents (Maroc oriental)

BOUMEAZA T.
Universit_ Hassan II mohammedia -Casablanca, MOHAMMEDIA, MOROCCO

Dans son bassin inférieur, l'oued Moulouya est drainé par des affluents issus des montagnes proches. Ces affluents, encaissés dans des substrats géologiques, sont restés perchés, avec des niveaux étagés traduisant les étapes quaternaires bien préservés qu'on trouve spécialement à l'amont sur la rive gauche descendant des Kebdana, et sur la rive droite, sur l'oued Cherrâa. Leur évolution est liée à une tectonique locale comparée à l'oued Moulouya qui a subit une influence importante pour la mise en place des terrasses limoneuses qui sont en liaison directe avec les fluctuations du niveau de la mer depuis la dernière période glaciaire il y a 18 000 ans. Au cours de la dernière glaciation, quand le niveau marin était beaucoup plus bas qu'aujourd'hui le lit de la Moulouya était à -57 m, 3.5 km en amont de son embouchure actuelle. La remontée du niveau de la mer, qui a atteint son niveau actuel vers 7 ka cal BP, a fait apparaître une ria de 19 km de longueur qui a ensuite été colmatée par les sédiments fluviatiles, déterminant la formation d'une épaisse terrasse limoneuse. La surface de cette dernière, que l'on suit sur plus de 45 km, surmonte de 22 m le lit actuel de la rivière à 20 km de l'embouchure. Cette terrasse de remblaiement est constituée de limons en couches horizontales bien stratifiées. Des terrasses d'érosion y ont été dégagées lors de l'encaissement de la Moulouya depuis 2000 ans. La datation ^{14}C des limons permet de comprendre comment cette terrasse s'est déposée. Après la remontée du niveau de la mer, le comblement de la ria et l'avancée concomitante de l'embouchure ont accumulé progressivement les limons. L'arrivée d'une charge limoneuse importante autour de 7 ka cal BP est probablement d'origine climatique. Après 3.5 ka cal BP, l'intense érosion des sols déclenchée par la déforestation. Depuis 1.9 ka cal BP, l'encaissement final de la Moulouya dans la terrasse résulte probablement d'une diminution des apports limoneux.

Approche méthodologique de cartographie des zones à risque potentiel d'érosion des sols du bassin versant du Srou (Moyen Atlas, Maroc)

EL BOUQDAOUI K.(1), EZZINE H.(2), ZAHRAOUI M.(3), LOUKILI M.(4), OZER A.(5)

(1) Hassan II Agronomic and Veterinary Medicine Institute, RABAT, MOROCCO ; (2) Royal Centre for Remote Sensing (CRTS), RABAT, MOROCCO ; (3) University Mohammed V, Faculty of Science, RABAT, MOROCCO ; (4) National School of Agriculture, MEKNES, MOROCCO ; (5) University of Liège, Faculty of Science, LIEGE, BELGIUM

La modélisation de l'érosion appuyée par l'analyse et l'observation sur le terrain s'avère nécessaire pour l'évaluation rapide et générale de l'érosion et la délimitation des zones sensibles à l'érosion des sols dans une région.

La première partie de la présente étude se base sur le modèle « Land Erodibility Assessment Methodology, (LEAM) » développé par Manrique (1988). Le modèle intègre l'érodibilité des sols, l'inclinaison des versants et l'érosivité climatique pour l'évaluation des zones à risque potentiel d'érosion. Le modèle ne tient pas compte du couvert végétal. Ce dernier joue cependant un rôle considérable dans l'évaluation du risque d'érosion, afin d'inclure ce facteur, une carte d'occupation des sols élaborée de l'imagerie satellitaire, a été utilisée pour améliorer le processus de la méthodologie.

La deuxième partie, se base sur l'étude d'un sous-bassin versant du Srou, celui du Chbouka, qui a été choisi comme secteur représentatif de l'ensemble du bassin du Srou. Il s'agit d'une approche méthodologique basée essentiellement sur le modelé du relief qui constitue le principal facteur de la structuration du paysage et des types de sols correspondants, ce qui a permis de dégager les grandes unités morpho-pédologiques du bassin du Chbouka et leur caractérisation, qui ont servi de base pour l'élaboration de la carte de susceptibilité à l'érosion des sols du bassin du Chbouka, mettant en évidence les zones instables, nécessitant une intervention prioritaire.

La confrontation de cette carte avec celle obtenue par le modèle LEAM confirme les résultats du modèle et appuie son efficacité.

Le système d'information géographique (SIG) a servi pour l'analyse, la combinaison, la modélisation et la cartographie des différentes couches d'informations.

Mots clés : Bassin versant, Srou, Chbouka, cartographie, érosion, SIG.

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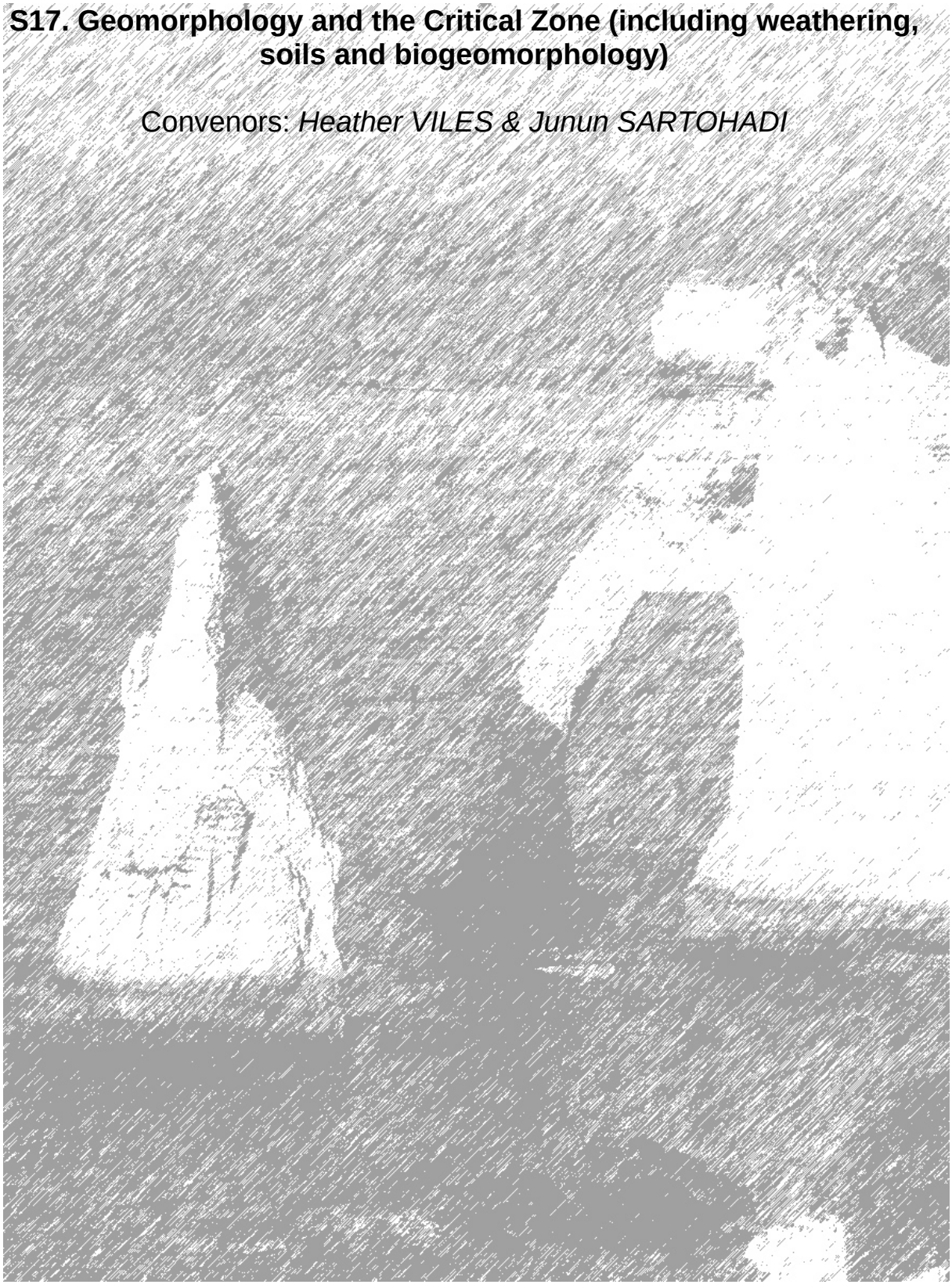
S17. Geomorphology and the Critical Zone (including weathering, soils and biogeomorphology)

Convenors: *Heather VILES & Junun SARTOHADI*



Oral presentations:

Landscape evolution models and the critical zone

KIRKBY M.
University of Leeds, LEEDS, UNITED KINGDOM

Geomorphological models for landscape evolution generally subsume the influences of weather and climate within general expressions of response to topographic drivers, ignoring both our detailed process knowledge for particular environments and the need to acknowledge the frequency distribution of event sizes. Although it is still at a broad brush level, it is now possible to incorporate processes more directly, so that rates and styles of sediment transport respond directly to average climate and may be integrated explicitly over the underlying event distributions.

One of the key processes that should be made explicit in models is weathering, which is also linked to climatic drivers and acts, through the critical zone, to modify landscape and regolith evolution. Chemical and physical evolution of the critical zone affect, inter alia, soil hydrology and grain sizes, and so interact dynamically with hillslope sediment transport, modifying landscape form. Under past and prospective climate change, these interactive relationships themselves evolve, creating landscapes that are, in many cases, far from even a quasi-equilibrium with current conditions. Aspects of these inter-relationships are explored through numerical models.

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Altitudinal variations in the size and flux of eroded sediment revealed by cosmogenic nuclides and detrital thermochronometry

LUKENS C.(1), RIEBE C.(1), SKLAR L.(2), SHUSTER D.(3)
(1) University of Wyoming, LARAMIE, UNITED STATES ; (2) San Francisco State University, SAN FRANCISCO, UNITED STATES ; (3) University of California, BERKELEY, UNITED STATES

Quantifying the size and flux of sediment in landscapes is central to understanding the interplay of climate and tectonics in erosion and weathering. Although sediment flux is widely quantified using cosmogenic nuclides, there is no complementary method for measuring how the size of eroded sediment varies across landscapes. Here we present a new technique that couples cosmogenic nuclides and apatite (U-Th)/He (AHe) dating in stream sediment to simultaneously solve for how the size and flux of sediment vary with altitude. As a proof of concept we present data from Inyo Creek, which drains the steep eastern range front of the Sierra Nevada, California, USA. AHe ages from detrital apatite are markedly higher, on average, in gravel than in sand. This shows that gravel originates from higher elevations than sand, and thus that particle sizes in eroded sediment increase with altitude in the catchment. We find that ^{10}Be concentrations in gravel are roughly half those measured in sand, despite higher ^{10}Be production rates implied by the higher gravel source elevations. This suggests that erosion is faster at higher elevations. Together, our ^{10}Be and AHe data are consistent with an exponential increase in erosion rates with hillslope gradients, which increase with elevation in the catchment. Hence erosion at Inyo Creek is broadly consistent with threshold slope behavior. In addition, our analysis calls for caution in interpreting spatially averaged erosion rates from cosmogenic nuclides measured from a single grain size; in Inyo Creek, the ^{10}Be concentration in sand alone under-predicts the catchment-averaged erosion rate that we infer from the full suite of data by nearly a factor of four. Our results show that measuring ^{10}Be and AHe ages in multiple sizes of stream sediment can resolve altitudinal variations in both the size and flux of sediment eroded from slopes and thus may permit considerable advances in understanding of geomorphic processes and landscape evolution.

Impact of biological soil crusts on the infiltration / runoff balance along a rainfall gradient in south-eastern Tunisia

GUIDEZ S.
Université Paris 7 (LGP de Meudon) / Université de Bologne (IGRG de Ravenne), MONTPELLIER, FRANCE

Mediterranean Africa is increasingly vulnerable to climate change. We focuses on the desertification risk in an rural arid environment due to a decline of traditional agriculture. In the mountains, this translates into a lack of maintenance in some structures and lands, it results in increased water erosion.In the plain, intensive irrigation and overgrazing caused some soildegradation and sand encroachments reflecting a more intense wind erosion. We set out to determine the hydrological impact of the presence of Biological Soil Crusts (BSC). They have an important role by the existence of control strategies against land erosion and of compensatory logics against climatic aridity.

The BSC play a major ecological role on the hydrology because they have a great ability to take advantage of small rainfall events.They change the infiltration of water into the soil and influence the production of surface runoff, therefore the amount of water erosion.

We studied the topography, hydrography and geology but also of the structural and dynamical geomorphology and pedology of this region. Then, we carried out measurements of surface infiltration/runoff, analyzed humidity contents in soil and studied the BSC rates and properties.

We notices that there was less runoff for the bare soil plots than for the BSC. The hydrological balance may not be accounted for by the rates, the roughness and thickness of BSC but by their typology. The high rates were correlated with mixed crusts (cyanobacteria-lichens-bryophytes), the average rates with biological crusts dominated by bryophytes or by lichens and the low rates with the crusts dominated by cyanobacteria. The evolution infiltration may also be accounted by BSC : the high and constant infiltration is represented by cyanobacteria-BSC, the bryophytes-BSC have linear and slow infiltrations, the lichen-BSC know infiltrations which decrease by stages, the mixed-BSC correspond to the infiltration decreasing immediately and sharply.

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Non-lateritic red soils of the Brazilian drylands: pedogenic processes and landscape evolution

BETARD F.(1), PEULVAST J.P.(2)
(1) Univ Paris-Diderot, PARIS, FRANCE ; (2) Univ Paris-Sorbonne, PARIS, FRANCE

Non-lateritic red soils cover vast areas of the semiarid region of Northeast Brazil, or “sertão”, whereas laterites remain currently scarce in the landscape and are confined to ancient summit surfaces and/or to more humid areas along the coast. The land cover of the Brazilian drylands is dominated by dry deciduous woodland, or “caatinga”, in areas with mean annual rainfall and temperatures of 400-800 mm/y and 24-26 °C, respectively. According to morphological descriptions and analytical data, the red soils of semiarid Brazil mainly classify as Luvisols (chromic) in the WRB soil correlation system, and Alfisols in the USDA Soil Taxonomy. In all cases, their formation is strongly controlled by clay illuviation, allowing the diagnosis of a Bt (argic) horizon. Contrary to lateritic soils extending over large tracts of tropical South America, the red soils of NE Brazil are high-activity-clay soils with high cation exchange capacity and moderate to high base saturation ratios. The pedogenic interpretation for their development is that of a fersiallitic pedogenesis, which involves high contents of free iron and the prevalence of 2:1 clays in the soil mineral assemblage. In the regional setting, the red fersiallitic soils typically formed above shallow, grus-type weathering mantles developed from crystalline parent rocks, under pedoclimatic conditions of low, but irregular, deep drainage. In many ways, they are very similar to the red, decalcified fersiallitic soils formed on the crystalline shield of dryland peninsular India, but are very different from tropical ferruginous soils of semiarid West Africa developed from lateritic paleoweathering mantles. As in the Indian setting, persistent epirogenic uplift of the Brazilian margin during the Neogene steered the landscape towards the stripping of most of the paleoweathering mantle, favoring the development of a primary fersiallitic pedogenesis under the newly established semi-arid conditions.

Sandization in Southern Brazil Campos (Ibicui Basin, Rio Grande do Sul State)

VERDUM R.(1), CORBONNOIS J.(2), MESSNER F.(2), LAURENT F.(2), SOARES V.G.(1)
(1) Universidade Federal do Rio Grande do Sul, PORTO ALEGRE, BRAZIL ; (2) Université du Maine, LE MANS, FRANCE

In Southern Brazil, erosion is now damaging large pieces of land on sandy soils that are overexploited by agricultural activities. These erosion processes are called “sandization” and have been studied by Brazilian researchers for 15 years. In the Ibicuí watershed, sandization takes place on mountain sides and in small valleys dug in sandstone, on the top of which lays loose sand, because of herbaceous vegetation. This process is worsened with agricultural intensification. Eventually, it can lead to a landscapes shift, all the more as the remedy usually used on the eroded lands is eucalyptus plantations. The analysis of erosion characteristics, based on Brazilian research results, is lead with satellites images and on the field. It allows to identify and to locate the different forms of sandization and to explain their formation, especially in the recent years. The research will also focus on the way the local populations take into account the erosion process, in an economic change context, related to a new organization of farming activities.

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Cenozoic evolution of the critical zone on Kangaroo Island, South Australia: a framework of landscape geochemical and biogeochemical evolution and the effect of contemporary anthropogenic landscape change

STOATE K.(1), HILL S.M.(2), BAROVICH K.(2)
(1) The University of Adelaide , ADELAIDE, SOUTH AUSTRALIA , AUSTRALIA ; (2) The University of Adelaide, ADELAIDE, SOUTH AUSTRALIA, AUSTRALIA

The study considers the critical zone within the context of landscape geochemistry and biogeochemistry. Kangaroo Island is a 4400 km^2 area off the south coast of Australia, where chemical surveys of bedrock, ferruginous regolith, and vegetation (*Eucalyptus* and *Xanthorrhoea* grasstrees) have been conducted. Results from these surveys show the interaction hosted within the critical zone between bedrock, weathered substrate and plants. Of particular interest are the strong expressions of gold and base metal mineralisation associated with the major shear zone which extends across the central part of the island. This has major implications for utilising critical zone processes for mineral exploration within highly weathered landscapes, in particular the chemical expression of buried bedrock lithologies in ferruginous regolith geochemistry and plant biogeochemistry.

The ferruginous regolith has been evolving in the area since the Permian, and remnants of these materials are mostly expressed within a ‘lateritic plateau’ across most of the island. Since the onset of the Neogene ferruginisation has continued but depositional and weathering processes on the island have been dominated by carbonates (i.e. limestones and calcretes). European settlement only occurred in the late 19^{th}century, but large-scale vegetation clearance has only been significant since the late 1940’s. This has had a major impact on hydrological processes within the critical zone and a major shift in the landscape geochemical processes has occurred. This includes increased catchment salinities and associated trace element mobility, mostly triggered by the absence of deep-rooted vegetation and erosional incision into saprolitic weathering profiles underling the ferruginous regolith.

The discrete nature of systems on Kangaroo Island provides an ideal area for a case study into the landscape geochemical and biogeochemical evolution of the critical zone and how this is influenced by anthropogenic activity.

Analysis of Relief-Rock-Soil Relationship in the Contact Atlantic Plateau - Peripheral Depression of Sao Paulo

NADAL JUNQUEIRA VILLELA F.(1), ROSS J.(2), MANFREDINI S.(2)
(1) Universidade Federal de Sao Carlos, SAO PAULO, BRAZIL ; (2) University of Sao Paulo, SAO PAULO, BRAZIL

This work aims to establish the integrated approach to landscape factors according to the landforms, bedrock and soils. A geomorphopedological compartmenting is made in a detailed scale of an area between two major geomorphologic units in southeastern Brazil, one being the Atlantic Plateau, crystalline shield of rough landforms, and the other the Peripheral Depression of Sao Paulo, a transition unit from Plateau to the Sedimentary Basin of Parana, whose smooth landforms are generally sculpted over sedimentary terrains. The transitions of these two macro-compartment domains create contrasts of relief forms according to the basement structure and soils originating from weathering and erosion. Smooth landforms supported by sedimentary lithotypes alternate with small hills of more dissected slopes sustained by igneous or metamorphic rocks, and Red Oxisols located in areas of flat summits change to Inceptisols in areas of smooth hills. This is a common situation at the research area, a small hydrographic basin and its rural surroundings in Sorocaba, a county undergoing remarkable urban expansion. To reach an understanding of the above mentioned factors relationship, aiming at a diagnosis of the physical environment under research, it was necessary to carry out geological, geomorphological and pedological surveys in order to search for the relief-rock-soil relationship to the area considered. The work resulted in geomorphological and geomorphopedological compartments and the better understanding of some functional characteristics of the physical environment, such as the control of landforms and drainage system by lithostructure, the combination of exogenous processes, slope morphology and lithologic variations in forming soils and the possibility of relief being degraded by geochemical erosion.

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Relation of soil depth and slope degree in Loano District, Central Java Province, Indonesia

PULUNGAN N.(1), SARTOHADI J.(2), STOETTER H.(1)
(1) Innsbruck University, INNSBRUCK, AUSTRIA ; (2) Gadjah Mada University, YOGYAKARTA, INDONESIA

Loano District is an area in Central Java Province having hilly up to mountainous topographic. Generally, this area has steep slopes up to very steep slopes which are 20^{o} - 40^{o}. Topographic condition becomes the controlling factor in this area. Loano District is characterized by structural and denudation processes. As the result, mass movement events dominate this area. Material resulted by mass movement occurrences produces colluviums material to the lower part. The colluviums become parent materials for further soil development in this area. Therefore, this process mostly leads to the residual soil to be buried by recent materials.

Method used in this research is field survey. The sampling method applied is stratified random sampling. Slope classes are used as strata for defining sampling area. The areas which have different slope classes are sampled. Deep of soil in each different slope class is measured. The numbers of samples in each slope class are depended on relief variation and width area.

The result of this research is about a relation of slope degree and soil depth in Loano District. This research indicates that there is no correlation between slope classes and soil depth in the research area. Theoretically, the steeper slope is the thinner depth of soil as well the more flat slope is the thicker depth of soil. In fact, this theory did not work for Loano District. Colluviums material due to denudated processes has a crucial role to develop soil in this area. Combination materials in colluviums cause various development of soil. They determine the speed of soil development. As a result, in a buried soil area, the depth of soil does not be depended on the degree of slope.

Key words: soil development, soil depth, slope degree, buried soil.

The layered Critical Zone (CZ)' established geomorphic concepts but a novelty for Critical Zone Observatory (CZO) Science?

VOELKEL J.
Technische Univeritaet Muenchen, MUENCHEN, GERMANY

By literature and common definitions the Critical Zone (CZ) is described as monolayered. At best a line is given on so-called moved regolith. In fact the CZ is often characterized by stratified and multilayered slope deposits with thicknesses exceeding 1 m. These stratified slope sediments play a significant role in the nature of the physical and chemical properties as well as on soil forming processes in the CZ. Examples are given for CZ sediment sourced chemical elements and common clay minerals, and the significance of slope sediments as both barriers and pathways for interflow that moves through the stratified sediments. Examples are also taken from latitudinally different geographic areas, as well as from varying altitudes. The stratified CZ is often datable by numeric age techniques showing up how sediment features contradict weathering effects and meaning e.g. for soil genesis. In the mid latitudes, geomorphic and sedimentologic evidence supports a periglacial origin, involving solifluction, for the origin of these CZ slope deposits.

Literature: Völkel, J., Huber, J. & Leopold, M. (2011): Significance of slope sediments layering on physical characteristics and interflow within the Critical Zone… - Applied Geochemistry 26: 143-145.

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δ18O isotopic signature of glacier meltwaters in the tree rings: basis for long-term high-resolution hydrological reconstructions in glacial environments

LEONELLI G., PELFINI M.
Università di Milano, MILANO, ITALY

Glacial environments on the Alps are experiencing a generalized shrinkage phase mainly driven by the thermal perturbation related to global warming. As a result, after a higher runoff from snow and ice melting in a first phase, a large runoff reduction is expected in the mid to long term. Changes in glaciological features and in meteorological conditions influence the hydrological regimes of the glacial environments (and in particular of the glacier forefields), inducing also alterations in the water stable isotopes distribution in the soil. Glacier streams and hydrological conditions at the glacier terminus are characterized by a great variability concerning melt water runoff and the directions taken by the glacier streams along the glacier forefields.

The $^{18}O/^{16}O$ ratio in the tree rings is mainly driven by the source water isotopic signature and isotope fractionation processes at the leaf level related to stomatal conductance and the amount of depleted soil water replenishing the transpired water. The analysis of $\delta^{18}O$ and $\delta^{13}C$ in the tree rings from glacial environments from the Miage Glacier and the Forni Glacier forefields has demonstrated the potential of using tree rings for the high-resolution reconstruction of hydrological changes occurred over long time periods. In fact trees growing in proglacial areas (mainly fed by glacier melt waters that flow down valley from the glacier) resulted more depleted in $\delta^{18}O$, whereas trees growing on the slopes or on the moraines were more enriched, thus allowing long tree-ring chronologies to be potentially used as a proxy of past and ongoing climatically-driven hydrological changes in glacial environments. The opportunity of reconstructing past long-term changes in $\delta^{18}O$ signature in glacier melt waters occurred over time in the Alpine glacial environment is a critical issue both for understanding glacier responses to climate warming and for assessing water availability in the Alpine environment.

Effects of bedrock nutrient density on life and topography in granitic landscapes

HAHM W., RIEBE C., ARAKI S.
Dept. Geology and Geophysics, University of Wyoming, LARAMIE, UNITED STATES

In hilly landscapes, the competition between soil erosion and bedrock weathering determines whether rock retains a mantle of soil or is stripped bare. When rock is bare, it tends to break down more slowly, retarding nutrient supply to overlying ecosystems and impeding pedogenesis. Hence, the presence/absence of soil may often be central to the interplay of erosion, weathering and vegetation in Earth surface dynamics and biogeochemical cycling. Yet the factors that regulate whether soil is present are poorly understood, especially in granitoids, which are often dichotomous in their soil cover. Here we present evidence of a feedback in which the presence of soil is regulated by bedrock nutrient concentrations through their influence on vegetation. Across our field area, in unglaciated portions of the Sierra Nevada, California, the concentrations of essential plant nutrients such as phosphorus (P) vary markedly in bedrock, often changing abruptly at pluton contacts that coincide with ecotones between forest and bare rock. Moreover, we find that vegetative cover is strongly correlated with bedrock [P] across climatically and topographically diverse sites within the batholith. The proposed biologically-mediated coupling between lithology and soil cover may have key implications for landscape evolution; our measurements of cosmogenic nuclides reveal that erosion is slower when soil is absent, implying that areas with low nutrient concentrations should tend to rise in relief relative to their more heavily vegetated, soil-mantled counterparts. The paradigm for nutrient evolution in physically stable soils is that bedrock-derived P becomes depleted with time to the point that it is limiting to the overlying ecosystem. Our analysis from the Sierra Nevada presents a counterexample in which ecosystems developed on nutrient-poor granitoids may experience P limitation under conditions of dynamic equilibrium and during incipient stages of weathering and pedogenesis.

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Variability of SOC stabilization with the mineral phase along a slope transect

DOETTERL S.(1), OPFERGELT S.(2), CORNELIS J.T.(2), VAN OOST K.(1), SIX J.(3)
(1) UCL/ ELI-C/TECLIM, LOUVAIN-LA-NEUVE, BELGIUM ; (2) UCL/Eli-E, LOUVAIN-LA-NEUVE, BELGIUM ; (3) UC Davis, Plant Sciences, DAVIS, CA, UNITED STATES

Research in the Belgian Loam Belt has shown that, driven by soil redistribution, the quality and quantity of soil organic carbon (SOC) in sloping cropland differs with topographic position. These differences were most visible in the subsoil, while the size and composition of topsoil SOC pools were similar along the hillslope. Here, we present an analysis that aims to clarify the chemical and mineralogical components involved in stabilizing SOC at various depths and slope positions. For this we analyzed soil samples from different soil depths along a slope transect applying a sequential extraction scheme of the reactive soil phase using pyrophosphate, oxalate and dithionite-citrate-bicarbonate and a semi-quantitative and qualitative analysis of the clay mineralogy.

The results show that pyrophosphate extractable soil compartments, especially Manganese are responsible for stabilizing SOC in the bulk soil and with non-aggregated silt and clay fractions. Pyrophosphate extractable Iron and Aluminum components are largely abundant in water-stable soil aggregates, but show no strong correlation to SOC, indicating importance for aggregate stability but not for SOC retention. Oxalate extractable amorphous and poorly crystalline minerals are a temporally limited but important compartment to stabilize SOC at the depositional site, especially for the more recalcitrant SOC fractions, but are of minor importance for SOC stabilization at other slope positions. Non-expandable clay minerals experience a relative enrichment at the depositional site and expandable clay minerals at the eroding site and these changes in clay mineralogy along the slope are partly responsible for the abundance of silt or clay associated SOC. Current rates of soil erosion and the associated rejuvenation of soils at eroding sites and burial of soil at depositional sites provide a temporally limited local net sink for atmospheric C.