International Association of Geomorphologists
Association Internationale de Géomorphologues

IAG/AIG REGIONAL CONFERENCE 2011

GEOMORPHOLOGY FOR HUMAN ADAPTATION TO CHANGING TROPICAL ENVIRONMENTS

GHION HOTEL
ADDIS ABABA, ETHIOPIA

FEBRUARY 18-22, 2011

ABSTRACT VOLUME

Editors:

Asfawossen Asrat, Francesco Dramis, Jan Nyssen, Mohammed Umer

Cover Photo: *Amba Seneyti, Tigray, Northern Ethiopia. Triassic sandstone tor overlying Plaeozoic tillites, which in turn lie over upper Proterozoic metavolcanics-metasediments.*
[Photo © Asfawossen Asrat, 2010]

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CONFERENCE ORGANIZATION

ORGANIZED BY

EAG - ETHIOPIAN ASSOCIATION OF GEOMORPHOLOGISTS

WITH THE SUPPORT OF

Department of Earth Sciences, Addis Ababa University, Ethiopia,
Paleoanthropology & Paleoenvironment Program, Addis Ababa University, Ethiopia
Mekelle University, Ethiopia
Department of Geological Sciences, "Roma Tre" University, Rome, Italy
AIGEO - Italian Association of Physical Geography and Geomorphology, Italy
BAG - Belgian Association of Geomorphologists, Belgium

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Asfawossen Asrat - Department of Earth Sciences, Addis Ababa University, Ethiopia
Mohammed Umer - Department of Earth Sciences, Addis Ababa University, Ethiopia
Francesco Dramis - Department of Geological Sciences, "Roma Tre" University, Rome, Italy
Jan Nyssen - Department of Geography, University of Ghent, Belgium

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Asfawossen Asrat - Department of Earth Sciences, Addis Ababa University, Ethiopia
Mohammed Umer - Department of Earth Sciences, Addis Ababa University, Ethiopia

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Valerio Acocella - Department of Geological Sciences, "Roma Tre" University, Rome, Italy
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Kifle Woldearegay – Department of Applied Geology, Mekelle University, Ethiopia
Gezahegn Yirgu - Department of Earth Sciences, Addis Ababa University, Ethiopia

WE GREATLY APPRECIATE FINANCIAL SUPPORT FROM

IAG (International Association of Geomorphologists)

CONFERENCE PROGRAM

February 18, 2011

14.00 - 17.00	Registration Desk
19.00 -	Welcome Party

February 19, 2011

8.00 - 18.00	Registration
9.00 – 9.50	Opening Ceremony (welcome addresses by IAG, EAG and the Guest of Honour)
9.50 – 10.30	Invited talk by Ilaria Lener from IAG
10.40 – 11.00	Break
11.00 – 13.00	Parallel Sessions ECHI/LDR
13.00 – 14.00	Lunch
14.00 – 16.40	Parallel Sessions ECHI+GGA/LDR
16.40 – 17.00	Break
17.00 – 17.40	Poster Session
17.40 – 18.10	Keynote Lecture by Martin Williams
18.10 - 18.40	Keynote Lecture by Jean Poesen

February 20, 2011

Mid-Conference Excursions

February 21, 2011

8.00 – 10.00	Parallel Sessions LHAZ/MATVG
10.00 – 10.20	Break
10.20 – 12.20	Parallel Sessions LHAZ+GGT/MATVG
12.20 – 13.20	Lunch
13.20 – 15.40	Parallel Sessions FGFH/PG
15.40 – 16.00	Break
16.00 – 16.40	Poster Session
16.40 – 17.10	Keynote Lecture by Olav Slaymaker
17.10 -17.40	Keynote Lecture by Andrew Goudie
17.40 -18.10	Keynote Lecture by Antonio Cendrero

February 22, 2011

8.00 – 10.20	Parallel Sessions QSP/DGD
10.20 – 10.40	Break
10.20 – 12.20	Parallel Sessions GM/GEEG
12.20 – 13.20	Lunch
13.20 – 14.20	Parallel Sessions GM/GEEG
14.20 – 15.20	Poster Session
15.20 – 15.40	Break
15.40 – 16.10	Second invited talk by Ilaria Lener
16.10 – 16.40	Keynote Lecture by Cliff Ollier
16.40 – 17.10	Keynote Lecture by Mike Crozier
17.10 – 17.40	Closing Ceremony
19.00 –	Farewell Banquet

PROGRAM LAYOUT

Date: February 18, 2011 Venue: Saba Hall	
Time	**Activity**
14.00 – 17.00	Registration at the Ghion Hotel
19.00 -	Welcome (Ice Breaker) Party at the Lucy Restaurant
Date: February 19, 2011 Venue: Saba Hall	
8.00 - 18.00	Registration
9.00 – 9.50	Opening Ceremony (welcome addresses by IAG, EAG and the Guest of Honour)
9.50 – 10.30	Invited talk by Ilaria Lener: International Cooperation and African countries: enhancing scientific excellence through mobility and training
10.30 – 11.00	***Coffee/tea Break***
Session 1: ENVIRONMENTAL CHANGE AND HUMAN IMPACT (ECHI) Conveners/Chairs: A. Pérez Gonzales, A. Goudie Venue: Saba Hall	
11.00 – 11.20	Viel V., Le Gouée P. & Delahaye D. - *Impacts of climate change on the sensitivity of agricultural land to erosion hazard*
11.20 – 11.40	Nyssen J., Frankl A., Mitiku Haile, Hurni H., Descheemaeker K., Ritler A., Crummey D., Nievergelt B., Moeyersons J., Munro R.N., Portner B., Deckers J., Billi P. & Poesen J. - *Are changes in north Ethiopian mountain landscapes over the last 140 years caused by changing climate, or by human-induced degradation and rehabilitation?*
11.40 – 12.00	Moeyersons J., Vandecasteele I. & Trefois P. - *Applications of the topographic thresholds slope and runon area in the study of hillslope incisions along the Albertine Rift in Kivu (DR of the Congo), Rwanda and Burundi*
12.00 – 12.20	Getachew Eshetu - *An upland farming system under transformation: Proximate causes of land use change in Bela-Welleh catchment (Wag, Northern Ethiopian Highlands)*
12.20 – 12.40	Yu Ge, Shen Huadong & Ke Xiankun - *Geomorphologic system changes in river-lake of Yangtze River and the lacustrine sediments and pollen disposition responses*
12.40 – 13.00	Prokop P. & Bhattacharyya A. - *Environmental response to human impact on the Meghalaya Plateau (NE India) during the last 2500 yrs BP*
Session 2: LAND DEGRADATION AND RESILIENCE (LDR) Conveners/Chairs: Mitiku Haile, J. Nyssen, O. Slaymaker Venue: Hall 1	
11.00 – 11.20	Rosell S. - *Soil productivity and food security in the central highlands of Ethiopia*
11.20 – 11.40	Frankl A., Poesen J., de Dapper M., Deckers J., Mitiku Haile & Nyssen J. - *Assessing gully headcut retreat rates in the semi-arid highlands of North Ethiopia*
11.40 – 12.00	Claessens L., Schoorl J.M., Verburg P.H., Geraedts L. & Veldkamp A. - *Modelling interactions and feedback mechanisms between land use change and landscape processes*
12.00 – 12.20	Afana A., Solé-Benet A. & Pérez J.L. - *Determination of soil erosion using laser scanners*
12.20 – 12.40	Tesfay Araya, Cornelis W.M., Nyssen J., Govaerts B, Fekadu Getnet, Bauer H., Raes D., Kindeya Gebrehiwot, Teklit Yohannes & Deckers J. - *Effects of resource-conserving tillage in the Ethiopian highlands, a sustainable option for soil and water management and crop productivity. A case study from Dogua Tembien*

12.40 – 13.00	Ciampalini R., Billi P., Follain S., Le Bissonnais Y., Ferrari G. & Borselli L. - *Long-term soil erosion analysis on the terrace systems of the archaeological area of Aksum (Ethiopia)*
13.00 – 14.00	***Lunch Break***
Session 1: ENVIRONMENTAL CHANGE AND HUMAN IMPACT (ECHI) Conveners/Chairs: A. Pérez Gonzales, A. Goudie Venue: Saba Hall	
14.00 – 14.20	Embleton-Hamann C. - *The importance of landuse and landcover changes in the Austrian Alps*
14.20 – 14.40	Lajczak A. - *Geomorphological development of post-peat areas in the Polish Carpathian Mts. over the last ca. 200 years*
14.40 – 15.00	Móga J., Szabó M., Borsodi A.K., Kiss K., Kéri A., Darabos G., Mari L. & Knáb M. - *Investigations of the changes (degradation) of karst landscapes and epikarst due to human impact in two Hungarian karst areas*
15.00 – 15.20	Rączkowska Z. - *Recent transformation of alpine debris slopes in the Tatra mts. (Poland)*
Session 1: GEOHERITAGES AND GEOARCHAEOLOGY (GGA) Conveners/Chairs: Asfawossen Asrat, Z. Zwolinski Venue: Saba Hall	
15.20 – 15.40	Fouache E., Cosandey C., Chahryar Adle & Coussot C. - *The fault of Bam (South Eastern Iran), regional water resources and human settlements from the Chalcolithic period to present times*
15.40 – 16.00	Chabrol A., Fouache E., Lecoeur C., Apostolopoulos G. & Pavlopoulos K. - *Reconstructing the early/mid Holocene landscape evolution of the Thyamis delta (Greece): implications for human populations*
16.00 – 16.20	Ackermann O. - *Reading the field: geoarchaeological codes in the Israeli landscape*
16.20 – 16.40	Ecochard E., Fouache E., Kuzucuoğlu C., Carcaud N., Ekmekçi M., Ulusoy I., Çiner A., Cavalier L. & des Courtils J. - *Promoting the geomorphological heritage of the plain of Xanthos and Letoon (Turkey): Issues, practices and problems*
Session 2: LAND DEGRADATION AND RESILIENCE (LDR) Conveners/Chairs: Mitiku Haile, J. Nyssen, O. Slaymaker Venue: Hall 1	
14.00 – 14.20	Teka D., van Wesemael B., Poesen J., Hallet V., Vanacker V., Deckers S., Taye G. & Haregeweyn N. - *A trade-off between fighting land degradation and water harvesting in northern Ethiopia*
14.20 – 14.40	Amanuel Zenebe, Atkilt Girma, Vanmaercke M., Nyssen J., Verstraeten G., Mitiku Haile, Kassa Amare, Deckers J. & Poesen J. - *Intra-seasonal sediment yield variability in response to catchment greenness as detected by hyper-temporal SPOT NDVI image analysis in Geba catchment, Northern Ethiopia*
14.40 – 15.00	Thomaz E.L. - *Microcatchment hydrological response and sediment transport under simulated rainfall, Guarapuava – Brazil*
15.00 – 15.20	
15.20 – 15.40	
15.40 – 16.00	
16.00 – 16.20	
16.20 – 16.40	
16.40 – 17.00	***Coffee/tea Break***
17.00 – 17.40	*Poster Sessions (see separate list for posters)*

	-ENVIRONMENTAL CHANGE AND HUMAN IMPACT (ECHI) -LAND DEGRADATION AND RESILIENCE (LDR) -GEOHERITAGES AND GEOARCHAEOLOGY (GGA) -LANDSLIDE HAZARD ASSESSMENT AND ZONING (LHAZ) -GEODIVERSITY AND GEOTOURISM (GGT)
Keynote Lectures; Venue: Saba Hall	
17.40 – 18.10	Martin Williams - Geomorphic evolution of the Ethiopian tributaries of the Nile: volcanism, tectonism, climatic change, and human impact
18.10 – 18.40	Jean Poesen - Research challenges for soil erosion, soil and water conservation in tropical environments
Date: February 20, 2011 Mid-Conference excursions	
Date: February 21, 2011	
Session 1: LANDSLIDE HAZARD ASSESSMENT AND ZONING (LHAZ) Conveners/Chairs: Bekele Abebe, J. Moeyersons Venue: Saba Hall	
8.00 – 8.20	Williamson S.J. & Dias A. - *Geomorphological mapping for natural terrain hazard assessment, Hong Kong*
8.20 – 8.40	Solomon Hishe, Adalberto A. & Alfred T. - *Landslide susceptibility assessment in Kilte_Awulaelo Woreda, Tigray Region, Ethiopia*
8.40 – 9.00	Kifle Woldearegay, Schubert W., Klima K. & Aberra Mogessie - *Application of analytical hierarchy process (AHP) for GIS-based landslide susceptibility mapping; the case of northern highlands of Ethiopia*
9.00 – 9.20	Kalita K. - *Landslide hazards of Gangtok, Sikkim (India)*
9.20 – 9.40	Soldati M., Bruschi V.M., Devoto S., González Díez A., Mantovani M., Pasuto A. & Piacentini D. - *A multi-technical integrated approach to investigate lateral spreading phenomena in the north-west coast of Malta*
9.40 – 10.00	Migoń P. & Kasprzak M. - *Using LiDAR to detect landslide remnants under forest. A study from SW Poland*
Session 2: MORPHOTECTONICS, ACTIVE TECTONICS & VOLCANIC GEOMORPHOLOGY (MATVG) Conveners/Chairs: M. Coltorti, Gezahegn Yirgu, C.D. Ollier Venue: Hall 1	
8.00 – 8.20	Vandenberghe J. - *Differential tectonic Impact on fluvial evolution (Huang Shui, China)*
8.20 – 8.40	Coltorti M., Pizzi A., Bekele Abebe, Disperati L., Firuzabadì D., Pomposo G., Sacchi G. & Salvini R. - *Geomorphology of the southern border of Afar in the Dire Dawa district (Ethiopia)*
8.40 – 9.00	Ufimtsev G. & Shchetnikov A. - *Morpotectonics and lakes of the inner and eastern Asia Rift systems*
9.00 – 9.20	Papanastassiou D., Gaki-Papanastassiou K. & Karymbalis E. - *Geomorphological observations in the Mani Peninsula, (South Peloponnesus, Greece) and their seismotectonic implications*
9.20 – 9.40	Molin P., Sperini S., Nocentini M., Fubelli G., Scotti V.N., Dramis F. & Grecu F. - *The interplay of mantle dynamics, tectonics, and surface processes: the Romanian Carpathians topography*
9.40 – 10.00	Scotti V., Molin P. & Dramis F. - *The Influence of surface and tectonic processes in the Late Miocene to Quaternary landscape evolution of Western Alps: a quantitative*

	geomorphological analysis
10.00 – 10.20	***Coffee/tea Break***
Session 1: LANDSLIDE HAZARD ASSESSMENT AND ZONING (LHAZ) Conveners/Chairs: Bekele Abebe, J. Moeyersons Venue: Saba Hall	
10.20 – 10.40	Fubelli G. & Ferrari M. - *Rainstorm-triggered shallow landslides in a urban context: the case of S. Vito Romano (Rome, Italy)*
10.40 – 11.00	Gutiérrez F., Guerrero J, Galve J.P., Lucha P., García-Ruiz J.M., Bonachea J. & Carbonell D. - *Detailed mapping of landslides in the Gállego glacial valley (Spanish Pyrenees) as a basis for hazard analysis and risk mitigation*
Session 1: GEODIVERSITY AND GEOTOURISM (GGT) Conveners/Chairs: Metasebia Demissie, Frances Williams Venue: Saba Hall	
11.00 – 11.20	Thomas M. - *Geodiversity and landscape sensitivity – engaging geomorphology in a new dialogue about geoconservation*
11.20 – 11.40	Asfawossen Asrat, Metasebia Demissie & Aberra Mogessie - *Geo-scenery based on geo-diversity in Ethiopia*
11.40 – 12.00	Williams F. - *Ethiopia: a geotourist's perspective*
12.00 – 12.20	Zbigniew Zwolinski - *Geodiversity of Tatra Mts., Poland*
Session 2: MORPHOTECTONICS, ACTIVE TECTONICS & VOLCANIC GEOMORPHOLOGY (MATVG) Conveners/Chairs: M. Coltorti, Gezahegn Yirgu, C.D. Ollier Venue: Hall 1	
10.20 – 10.40	Stamatopoulos L., Pavlides S. & Kamberis S. - *Evolution of a fault-line scarp after the 8 June, 2008 earthquake, in the western Peloponnese*
10.40 – 11.00	Panin A. & Selezneva E. - *Active tectonic and seismicity in permafrost environment: the Terekhol Basin, Southern Siberia*
11.00 – 11.20	Sheth H.C. - *Volcanic geomorphology of flood basalt provinces: an overview of the Deccan Traps and similarities with the Ethiopian Traps*
11.20 – 11.40	Purcell P., Mege D. & Jourdan F. - *Volcanic geomorphology of Southeast Ethiopia*
11.40 – 12.00	Zangmo Tefogoum G., Kagou Dongmo A., Nkouathio D. G. & Wandji P. - *Hazards zonation and assessment of the associated risks in the Mount Manengouba Caldera (Cameroon volcanic line)*
12.00 – 12.20	Gountié Dedzo M., Nono A., Kamgang P., Njonfang E., Zangmo Tefogoum G. & Nédélec A. - *Evaluation and mapping of the volcanic hazard related to the ignimbritic eruption by AMS in Mount Bambouto, West Cameroon*
12.20 – 13.20	***Lunch Break***
Session 1: FLUVIAL GEOMORPHOLOGY AND FLOODING HAZARD (FGFH) Conveners/Chairs: P. Billi, M.J. Machado Venue: Saba Hall	
13.20 – 13.40	Billi P. & Aklilu Amsalu - *Sediment transport of a flash flood stream in Tigray, Ethiopia*
13.40 – 14.00	Douvinet J., Delahaye D. & Langlois P. - *Linking surface flow concentration and geomorphic forms in dry valleys: what kind of information the CA model RuiCells supports?*
14.00 – 14.20	Oliveira F.A. - *Analysis of suspended sediment variation in a subtropical watershed, Southern Brazil*
14.20 – 14.40	Rowntree K.M. & Van der Waal B.W. - *A geomorphological response model for*

	predicting habitat change in non-perennial river systems: lessons from the Mokolo River, Limpopo Province, South Africa
14.40 – 15.00	Lajczak A. - *Deltas development in dam-retained lakes in the Carpathian part of the Vistula River drainage basin, Southern Poland*
15.00 – 15.20	Pandey P.K. & Das S.S. – *A new hypothesis in stream ordering methodology*
15.20 – 15.40	Mazurek M., Dobrowolski R., Osadowski Z. - *Role of geological and hydrological factors in the development of spring mires in the Parsęta River catchment (Northern Poland)*
Session 2: PLANETARY GEOMORPHOLOGY (PG) Conveners/Chairs: R.M.C. Lopes, J. Radebaugh Venue: Hall 1	
13.20 – 13.40	McEwen A.S. & the HiRISE Team - *Meter-scale geomorphology of Mars*
13.40 – 14.00	Mège D., Le Deit L., Lucas A. & Bourgeois O. – *Gravitational spreading of high wallslopes on Mars: evidence of past tropical glaciations on Mars*
14.00 – 14.20	Radebaugh J., Barth B, Schleiffarth K., Lopes R.M.C. & Christiansen E.H. - *Global volcanism and tectonism on Jupiter's moon Io as manifested in surface features*
14.20 – 14.40	Lorenz R. - *Titan's lakes, dunes and wadis: an arid landscape shaped by methane weather*
14.40 – 15.00	Pappalardo R.T. - *Ridge and trough terrains on outer planet satellites*
15.00 – 15.20	Lopes R.M.C., Peckyno R., Stofan E.R., Radebaugh J. & the Cassini RADAR Team - *Geomorphological mapping of Saturn's moon Titan*
15.20 – 15.40	Diniega S., Bridges N.T., Byrne S., Dundas C.M., Hansen C.J. & McEwen A.S. - *Seasonal activity within Martian dune gullies*
15.40 – 16.00	***Coffee/tea Break***
16.00 – 16.40	*Poster Sessions (see separate list for posters)* -MORPHOTECTONICS, ACTIVE TECTONICS & VOLCANIC GEOMORPHOLOGY (MATVG) -FLUVIAL GEOMORPHOLOGY AND FLOODING HAZARD – FGFH -DRYLANDS GEOMORPHOLOGY AND DESERTIFICATION (DGD) -QUATERNARY STRATIGRAPHY AND PALAEOCLIMATES (QSP)
Keynote Lectures; Venue: Saba Hall	
16.40 – 17.10	Slaymaker O. - Drivers of landscape change during the present century
17.10 – 17.40	Goudie A. - Environmental changes in Africa – Past, present and future
17.40 – 18.10	Cendrero A. - Evidences of major changes in Earth's surface processes. Should the Anthropocene be considered as a new period in geologic history?
Date: February 22, 2011	
Session 1: QUATERNARY STRATIGRAPHY AND PALAEOCLIMATE (QSP) Conveners/Chairs: Mohammed Umer, M. Williams Venue: Saba Hall	
8.00 – 8.20	Mohammed Umer - *Glaciation, deglaciation and postglacial history of the Ethiopian mountains*
8.20 – 8.40	Pietsch D. & Kühn P. - *Palaeosols as proxies for Holocene climate change along the ITCZ (Yemen, Ethiopia)*
8.40 – 9.00	Accioly Teixeira de Oliveira M., Porsani J.L., Leite de Lima G., Jeske-Pieruschka V. & Behling H. - *Highland peatland evolution in Southern Brazil, since the Late Pleistocene, as depicted by radar stratigraphy, sedimentology and palynology*
9.00 – 9.20	Machado M.J. & Pérez-González A. - *Land cover resilience and environmental changes during the last 3000 yrs in Northern Ethiopia: phytolithic and palaeosols evidences*

9.20 – 9.40	Chunchang Huang, Xiaochun Zha & Yali Zhou - *Extraordinary floods recorded by slackwater deposit during the 4200 a BP climatic event in the middle reaches of the Yellow River, China*
9.40 – 10.00	Karasiewicz M.T. & Hulisz P. - *Reconstruction of the environmental changes during the Late Vistulian and Holocene (north-central Poland) using kettle-hole sediment analysis*
10.00 -10.20	Dramis F., Fubelli G. & Mazzini I. - *Aggradation/erosion of tufa and paleoclimatic implications: the Nera River dam at Triponzo (Central Italy)*
Session 2: DRYLANDS GEOMORPHOLOGY AND DESERTIFICATION (DGD) Conveners/Chairs: J. Poesen, M. Thomas Venue: Hall 1	
8.00 – 8.20	Smolska E., Dłużewski M. & Biejat K. - *Present-day development of gullies in semi-dry areas: examples from the Gabes region (N Tunisia)*
8.20 – 8.40	Penven M.J., Bouhahad Smail & Cotonnec A. - *Control of geomorphic patterns on the development of aeolian processes during the last dry period in a Sahelian region (1970-1999)*
8.40 – 9.00	Dunkerley D.L. - *Hillslope and river responses to climate change – analyses from inland Australia*
9.00 – 9.20	Xinbao Zhang - *Mechanisms for the formation of dry planation surfaces*
9.20 – 9.40	Abd Elbasit M.A.M., Yasuda H., Kimura R. & Fan J. – *Spatiotemporal variability of rainfall erosivity in Loess Plateau, China*
9.40 – 10.00	Cantón Y., Chamizo S., Rodriguez-Caballero E., Miralles-Mellado I., Lázaro R., Domingo F., Calvo-Cases A. & Sole-Benet A. - *Key variables of soil crusting involved in their hydrological and erosive response*
10.00 – 10.20	
10.20 – 10.40	***Coffee/tea Break***
Session 1: GEOMORPHOLOGICAL MAPPING (GM) Conveners/Chairs: F. Dramis, P. Paron Venue: Saba Hall	
10.40 – 11.00	Coltrinari L. & Reis J.P.P. - *Geomorphologic Information Systems, why not?*
11.00 – 11.20	Junqueira Villela F.N. & Sanches Ross J.L. - *Rock-soil-relief relationships in the transition of the Atlantic Plateau to the Peripheral Depression of Sao Paulo*
11.20 – 11.40	Coltorti M., Firuzabadì D. & Pieruccini P. - *The 1:200,000 scale geomorphological map of the Siena Province (Southern Tuscany, Italy)*
11.40 – 12.00	Mulas M., Fubelli G., Sandric I., Balteanu D., Micu M. & Ignat P. - *Morphodynamic mapping of landslide affected slopes: the case of the Groapa Vantului (Romania)*
12.00 – 12.20	Szefler K., Tęgowski J. & Nowak J. - *Mapping of Southern Baltic submarine landscapes and habitats*
Session 2: GEOMORPHOLOGICAL ENVIRONMENTS AND ENVIRONMENTAL GEOMORPHOLOGY (GEEG) Conveners/Chairs: A. Mottana, H. Regnauld Venue: Hall 1	
10.40 – 11.00	Asfawossen Asrat, Baker A., Agazi Negash - *Geomorphology of limestone terrain of Tigray, Northern Ethiopia: implication for cave formation and speleothem growth*
11.00 – 11.20	Regnauld H., Pian S., Musereau J., Haya M. & Menier D. - *Present forcings on coastal evolution: the coastlines of western France*
11.20 – 11.40	Haubold F. & Faust D. - *The bolsa phenomenon: a conceptual model of its origin*
11.40 – 12.00	Joubert R. & Ellery W.N. - *Controls on wetland formation and geomorphic dynamics:*

	the case of Wakkerstroom Vlei, Mpumalanga Province, South Africa
12.00 – 12.20	Lebedeva E. - *Planation surfaces of South Africa and topographic levels of the Drakensberg*
12.20 – 13.20	***Lunch Break***
Session 1: GEOMORPHOLOGICAL MAPPING (GM) Conveners/Chairs: F. Dramis, P. Paron Venue: Saba Hall	
13.20 – 13.40	Andrzejewski L. - *Geomorphological map of the forefield of Tungnaárjökull (Iceland)*
13.40 – 14.00	Kit-Ying Ng, Millis S.W. & Wallace M.I. - *Characterising natural terrain landslide distribution at Catchment Scale, West Lantau, Hong Kong*
14.00 – 14.20	Sadiki Ndyanabo, Ine Vandecasteele, Jan Moeyersons, Philippe Trefois, André Ozer, Pierre Ozer, Kalegamire Dunia, Bahati Cishugi - Vulnerability mapping for sustainable hazard mitigation in the city of Bukavu, South Kivu, DRCongo
Session 2: GEOMORPHOLOGICAL ENVIRONMENTS AND ENVIRONMENTAL GEOMORPHOLOGY (GEEG) Conveners/Chairs: A. Mottana, H. Regnauld Venue: Hall 1	
13.20 – 13.40	Goracci G., Bonavia F. & Mottana A. - *The non-diamondiferous rocks occurring in the vicinity of the Mega diatreme (Sidamo, Ethiopia)*
13.40 – 14.00	Bruschi V.M., Otero C., Manchado C., Arias R. & Cendrero A. - *Development and application of a methodological tool for landscape impact assessment in mining areas. Application as a decision-support tool for impact mitigation*
14.00 – 14.20	Bondesan A., Francese R., Coren F. & Fabbrucci L. - *Geomorphological study of the El Alamein battlefield (Egypt): a military geology approach*
14.20 – 15.20	*Poster Sessions (see separate list for posters)* -GEOMORPHOLOGICAL MAPPING (GM) -GEOMORPHOLOGICAL ENVIRONMENTS AND ENVIRONMENTAL GEOMORPHOLOGY (GEEG)
15.20 – 15.40	***Coffee/tea break***
Keynote Lectures; Venue: Saba Hall	
15.40 – 16.10	Illaria Lener – Second talk
16.10 – 16.40	Ollier C.D. - Variety in rift valleys and in passive margins
16.40 – 17.10	Crozier M.J. - Locational controls of landslides: where will the next one occurs?
17.10 – 17.40	Closing Ceremony
19.00 –	Farewell Banquet

SCHEDULE OF POSTER PRESENTATION

February 19/2011
Venue: Hall 1; Time: 17.00 – 17.40

ENVIRONMENTAL CHANGE AND HUMAN IMPACT (ECHI)

1. Florek W., Kaczmarzyk J. & Majewski M. - Evolution of a South Baltic Sea cliff near Ustka (Poland):natural and human impact
2. Paron P. & Munro R.N. - Analysis of environmental change in Somalia using historical aerial photography archives
3. Zaporozhchenko E.V. - The influence of the changing climate on conditions of initiation, movement and discharge of debris flows on mountainous rivers in the Northern Caucasus (Russia)

LAND DEGRADATION AND RESILIENCE (LDR)

1. Afana A., Del Barrio G. & Solé-Benet A. - Landform delineation using semivariograms in real dataset structures
2. Barreiros A.M. & De Oliveira D. - Study of the genesis of a Red Ferric Latosolic Nitisol in an area of lithological interface, in the Municipality of Floraí, State of Paraná, Brazil
3. Munro R.N., Mitiku Maile, Nyssen J., Virgo K.J., Wilson R.T., Poesen J., Deckers J., Frankl A. & Lewis J.G. - Landscape recovery and resilience in a badly degraded region – Tigray (Ethiopia) 1974 - 2006
4. Prokop P. - Soil degradation along rainfall gradient on the Meghalaya Plateau (NE India)

GEOHERITAGES AND GEOARCHAEOLOGY (GGA)

1. Migoń P., Billi P., Ciampalini R. & Ferrari G. - Geomorphology of nephelinite syenite stocks around Aksum, northern Ethiopia - adding earth science value to the Aksum world heritage site
2. Skovitina T. & Angelelli F. - Geoheritage of Baikal Lake coast zone

LANDSLIDE HAZARD ASSESSMENT AND ZONING (LHAZ)

1. Kassa Amare, Kurkura Kebato & Assay Gebremichael - Landslide hazard and risk assessment: a case study from Keyhi-Tekeli village Adi-Shu area, southern Tigray
2. Aringoli D., Bisci C., Dramis F., Farabollini P., Gentili B., Materazzi M. & Pambianchi G. - Disturbances to buildings as indicators of slope gravitational processes: study cases from Central Italy
3. Carvalho Vieira B. & Dias Nery T. - Prediction of shallow landslides using SINMAP model in Serra do Mar, Brazil
4. Fort M & Cossart E. - Landslide hazards, settlements sites and development in the Nepal Himalayas
5. Fubelli G., Leoni G., Dramis F. & Puglisi C. - GIS methodology to assess landslide susceptibility: application to the piedmont of the Sila Greca (Calabria, Italy)
6. Lajczak A. - Neogene-Quaternary relief development of a highly elevated monoclinal flysch range modelled by huge landslides: case study from the Babia Gora Massif, Western Carpathian Mts.
7. Falconi L., Lentini A., Leoni G., Puglisi C. & Ramirez C. - Geomorphological approach to assess debris flow risk in the catchment of Alcamayo creek (Aguas Calientes, Cusco, Perù)

GEODIVERSITY AND GEOTOURISM (GGT)

1. Junqueira Villela F.N. - Geological, geomorphological and climatic aspects of the Serra Geral do Tocantins ecologic station, Brazil
2. Strat D. - Geodiversity and geoconservation in the lagoonal littoral of Romanian Black Sea coast

3. Piotr Migoń, Paolo Billi, Rossano Ciampalini, Giovanni Ferrari - Geomorphology of nephelinite syenite stocks around Aksum, northern Ethiopia - adding Earth Science value to the Aksum World Heritage site
4. Tatiana Skovitina, Francesco Angelelli - Geoheritage of Baikal Lake coast zone

February 21/2011
Venue: Hall 1; Time: 16.00 – 16.40

MORPHOTECTONICS, ACTIVE TECTONICS & VOLCANIC GEOMORPHOLOGY (MATVG)

1. Coltorti M., Pizzi A., Bekele Abebe, Disperati L., Firuzabadì D., Pomposo G., Pontarelli L., Sacchi G. & Salvini R. - Geology and tectonic setting of Dire Dawa (southern Afar, Ethiopia)
2. Gaki-Papanastassiou K., Karymbalis E. & Papanastassiou D. - Uplifted marine terraces in Greece, their spatial distribution and morphotectonic implications, a synthesis
3. Mège D., Le Deit L., Rango T., Jourdan F., Tesfaye Korme, Lopez-Gonzalez T. & Purcell P. - Large-scale gravitational spreading in Southeast Ethiopia
4. de Pavia Reis J.P. & Ramos Tomazzoli E. - Geomorphological and geophysical procedures in neotectonics research at Vargem Do Braço River, Southern Brazil
5. Shchetnikov A. & Filinov I. - Tectogenic lakes of the Baikal rift zone

FLUVIAL GEOMORPHOLOGY AND FLOODING HAZARD (FGFH)

1. Yonas Tadesse Alemu - Socio-economic impacts of flooding in Dire Dawa, Ethiopia
2. Yonas Tadesse Alemu & Girma Moges Meshesha - Flood triggering factors and the efforts to mitigate flood disaster in Dire Dawa
3. Bezerra dos Santos A.H. & de Oliveira D. - Drainage derangement by a probable meteoritic impact in southwestern Brazil: the crater of Colônia and the Capivari River
4. Douvinet J. & Delahaye D. - Flash flooding in northern France, Europe
5. Gogoi B. - Fluvial geomorphology and flood problems in the Brahmaputra Valley
6. Karymbalis E., Gaki-Papanastassiou K. & Ferentinou M. - Geomorphic analysis of fan deltas and their contributing drainage basins along the Southern coast of the Gulf of Corinth, Central Greece
7. Lajczak A. - River training vs. flood exposure. Case study of the Nida River, Poland
8. Lamour M.R., Domit C. & de Paula E.V. - Geomorphologic estuarine characteristics regarding biodiversity conservation on south Brazilian coast
9. Lóczy D. - Flood hazard and floodplain management
10. Mahato R.K. & Shukla J. - Geohydrodynamics and sedimentation in the Kosi River basin
11. Pasa V. & de Oliveira D. - Review on the possible stream piracy drainages between the Middle Paraiba do Sul and High Tietê: the case of Guararema's elbow – Brazil
12. Pandey Pramod K. , S. S. Das - Drainage pattern and linear morphometry of Barakar -Usri confluence region, Giridih, Jharkhand using G.I.S. technique

DRYLANDS GEOMORPHOLOGY AND DESERTIFICATION (DGD)

1. Munro R.N., Abuzeid H.M., Abdel Mahmoud M., el Hassan B. & El Siddig E. - Aeolian geomorphological, soil and ecological applications for sand dune stabilization in Arabia and North-East Africa – 1970s to present

QUATERNARY STRATIGRAPHY AND PALAEOCLIMATES (QSP)

1. Pelle T., Scarciglia F., La Russa M.F., Natali E. & Tinè V. - Multidisciplinary study of Holocene soils in the archaeological site "Piani della Corona" (SW Calabria, southern Italy): paleoenvironmental reconstruction
2. Wachecka-Kotkowska L. & Górska-Zabielska M. - Extent of the Middle Polish Glaciations (Warta Stadial, Late Saalian, MIS 6) in Central Poland in the light of a petrographic analysis

3. Osadczuk K., Borówka R.K., Osadczuk A., Witkowski A. & Duda T. - Stages of post-glacial evolution of the Odra River mouth area, Poland-Germany

February 22/2011
Venue: Hall 1; Time: 14.20 – 15.20

GEOMORPHOLOGICAL MAPPING (GM)

1. Tigist Araya, Nyssen J., Nurhussen Taha, Mitiku Haile, Atkilt Girma, Amanuel Zenebe, Poesen J., Mintesinot Behailu, Deckers J. & Baert G. - Conceptual modeling of soil-landscape relationships for soil classification and mapping on the Atsbi horst, Tigray, Ethiopia
2. Bondesan A., Francese R., Coren F., Busoni S. & Wardell N. - The average shear wave velocity map of the Province of Treviso: a geomorphological-geophysical integrated project
3. Borgatti L., Coratza P., Corsini A., Ghinoi A., Keim L., Marchetti M., Panizza M., Pasuto A., Piacentini D., Silvano S. & Soldati M. - Geomorphological map of the Alta Badia Valley (Dolomites, Italy)
4. Abd Elbasit M.A.M. & Yasuda H. - Close-range photogrammetry for soil microtopography evaluation
5. Grecu F., Zaharia L., Carcimaru E., Comanescu L., Dobre R., Ghită C. & Ioana-Toroimac G. - Hydro-geomorphological vulnerability mapping (central sector of the Romanian Plain)
6. Guida D., Dramis F. & Cestari A. - From geomorphological mapping to geomorphological map modeling: a new GIS based, object-oriented, multi-scale mapping system
7. Miura Thiesen G. & de Oliveira D. - A geomorphologic description of the High Juqueri drainage basin (Southeast Brazil) as a contribution to comprehend the occupied areas inside of it
8. Paron P., Vargas Rojas R. & Omuto C.T. - Integrated landform mapping: methodology and application for digital soil mapping in Somalia
9. Perotti L., Giardino M. & Alberto W. - Geomatics applications for reliable geomorphological field mapping: examples from the Western Alps
10. Zwoliński Z. - Geodiversity maps for the western coast of Admiralty Bay, King George Island, Maritime Antarctica

GEOMORPHOLOGICAL ENVIRONMENTS AND ENVIRONMENTAL GEOMORPHOLOGY (GEEG)

1. Bruschi V., Coratza P., Devoto S., Piacentini D., Soldati M. & Giovanni Tosatti - Multidisciplinary investigations for the environmental rehabilitation of mining areas in the Rio della Rocca valley (Reggio Emilia Province, northern Italy)
2. de Bélizal É. & Lavigne F. - The part of human activity on volcanic valley dynamics and morphology: case study from block and sand mining, Gendol Valley (Merapi Volcano, Indonesia)
3. Efremov Yu.V. - Lacustrine morpholithogenesis on plains and foothills of the northern Caucasus
4. Gaki-Papanastassiou K., Karymbalis E., Maroukian H. & Tsanakas K - Geomorphological study of Cephalonia Island, Ionian Sea, western Greece
5. Florek W., Łęczyński L. & Majewski M. - Morphology of the beaches of Cape Verde Archipelago
6. Raczkowska Z. - Some remarks on granitic relief of the Meghalaya Plateau
7. Sánchez-Cañete E.P., Serrano-Ortiz P., Kowalski A.S., Oyonarte C. & Domingo, F. - CO_2 ventilation in karst systems
8. Solé-Benet A., Contreras S., Miralles I. & Lázaro R. - Soil reconstruction in limestone quarries in semiarid SE Spain
9. Alemayehu Regassa Tolossa - Formation and characteristics of nitisols in South - West Ethiopia
10. Vespremeanu E. - Geomorphology of the western continental margin of the Black Sea
11. de Souto M. M. F., Ross J. L. S. - Geomorphology of the coastal plain of São Paulo, Brazil: a dynamic equilibrium study

Close-range photogrammetry for soil microtopography evaluation

Abd Elbasit M. A. M.[1,2], Yasuda H.[1]

[1]*Arid Land Research Center, Tottori University, Tottori 680-0001, Japan*
(mbasit@alrc.tottori-u.ac.jp, m_abdelbasit@hotmail.com)
[2]*National Center for Research, Desertification Research Institute, Khartoum, Sudan*

Soil microtopography is a dynamic soil property, which has great effects on all processes involving the soil-surface and water. It has been used as an indicator to characterize the impact of rain/flow kinetic energy on soil structure. Also, sediment transport can, theoretically, be derived from the soil morphological changes alone. Other soil surface features, such as rills, have been used to characterize soil erosion status and sediment transport. Although the importance of soil microtopography has been recognized for long time, yet limited available literature can be found. In this study, the potential of using consumer-grade camera and close range photogrammetry procedures to quantify soil microtopography were assessed. Five fabricated gypsum surfaces with different roughness were used simulating the soil surface conditions with different aggregates. The surfaces digital elevation model (DEM) was generated using the photogrammetry system (PHM) involving consumer- grade camera, and pin-microrelief meter (PM). The DEM generated using the photogrammetry system was assessed for accuracy, roughness indices (RI), percentage depression area (DA%), depression storage capacity (DSC), and micro-rills delineation in comparison with the direct measurement method using the pin-microrelief meter. The accuracy was evaluated visually using the 3D vision of the DEM generated by the two methods, and numerically using the root mean square error (RMSE) in the x-, y-, and z-directions. The visual comparison between the 3D-visions of the DEM showed high agreements between the DEM generated by the PHM and the PM on one hand, and between the PHM and the 2D images for the different gypsum surfaces on the other. On the other hand, the average RMSE in the x-. y-, and z-direction were 2.08, 1.52, and 0.82 mm for the rough surfaces, and 4.42, 1.65, and 3.22 mm for the smooth surface. The RIs calculated from the two methods were highly correlated. However, the little discrepancy between the two methods was due to the high sampling resolution of the photogrammetry system compared with the pin-microrelief meter. The DA% and DSC (mm) calculated from the DEM generated by the two methods were poorly correlated. The micro-rills delineation was also similar for the two methods regarding the network density with some differences, which can be attributed to the sampling resolution. The grid size was not effective in the RI calculation, and has a high influence on the DA%, DSC, and the delineated micro-rills orders. Accordingly, the consumer-grade camera and the close range photogrammetry have good potential to quantify the soil microtopography and it can be used effectively for field survey and instantaneous monitoring of the soil microtopography changes due to tillage practices and rainfall impact.

Spatiotemporal variability of rainfall erosivity in Loess Plateau, China

Abd Elbasit M. A. M.[1,2], Yasuda H.[1], Kimura R.[1], Fan J.[3]

[1]*Arid Land Research Center, Tottori University, Tottori 680-0001, Japan*
(mbasit@alrc.tottori-u.ac.jp, m_abdelbasit@hotmail.com)
[2]*National Center for Research, Desertification Research Institute, Khartoum, Sudan*
[3]*Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resources, Yangling, 712100 Shaanxi, China*

Rainfall and runoff represent the main driver of land degradation by soil erosion in large areas of the Loess plateau, China. Rainfall and runoff erosivity are assessed using the "R" factor in the universal soil loss equation (USLE). Several indices have been developed to assess the R factor particularly under conditions where meteorological data are scarce. The aim of this study is to assess the spatiotemporal patterns resulting from using various estimation methods under arid and semi-arid condition. First, the rainfall erosivity was evaluated using monthly Fournier Index (FI) and the annual Modified Fournier index (MFI) as a macro-structural rainfall erosivity indicators. Second, the R factor has been calculated using historical rainfall data and dominant rainfall intensity observed at representative meteorological stations. Several rainfall intensity and kinetic energy relationships have been used to analyze the impact of these relationships on rainfall erosivity time and space patterns.

Reading the field: geoarchaeological codes in the Israeli landscape

Ackermann O.

The Institute of Archaeology, The Martin (Szusz) Department of Land of Israel Studies and Archaeology, Bar Ilan University, Ramat Gan, 52900 Israel, and Kinneret College on the Sea of Galilee, Emek-Hayarden, Zemach, 15132, Israel (orenack@gmail.com; orenack@kinneret.ac.il)

The land of Israel has been subject to human activity for thousands of years. This activity was influenced by the landscape, and left its mark on the landscape. Over the years, landscape recovery processes such as natural vegetation regeneration have occurred. Sometimes, these processes have covered evidence of ancient human activity. This lecture will present select case studies in which 'geoarchaeological codes' have been deciphered. Understanding these 'codes' can be critical for identifying phenomena that are invisible at first glance. This can add insight and enrich future field surveys and archaeological excavations. The influence of ancient human activity on the current vegetation pattern will be presented in two case studies: (i) Oak tree distribution in the Golan Heights, which was determined by the distribution of tombs (dolmans) constructed 5000 years ago; and (ii) *Sarcopoterium spinosum* L. (thorny burnet) distribution in Tell es Safi/Gath, influenced by an artificial earth embankment. The lithological/pedological structure has a significant effect on the location of ancient agricultural activities. In many cases, lithological boundaries between hard and soft rock determined land use. Studies of ancient land use show that dwellings, oil presses, wine presses, and olive trees were located on rocky surfaces; vineyards and agricultural fields were located on soil and sediment surfaces. The location and spatial distribution of agricultural terraces changes with the transition from the sub-humid to the semi arid / arid zone. Widespread terrace distribution in sub-humid areas becomes a concentrated terrace pattern attached to rock outcrop in the semi arid / arid zone.

Landform delineation using semivariograms in real dataset structures

Afana A., Del Barrio G., Solé-Benet A.

Dept. of Desertification & Geo-Ecology, EEZA-CSIC, Almeria, Spain (albert@eeza.csic.es)

Mapping and detection of discrete surface features (i.e. *landforms*) is an essential task in earth science applications, e.g. hydrological modeling, hillslope forming processes, soil erosion and denudation, etc. In these disciplines, a landform type comprises a geomorphological unit that may be defined by its surface form (i.e. shape), dimension (i.e. scale), location in the landscape (i.e. contextual position relative to adjacent features), statistical frequency of its geomorphic attributes and the physical processes that were involved in their formation. In this work, we propose a geostatistical framework for landform definition, mainly stream channels and hillslope structures, which allows for geomorphic concepts to be incorporated into the terrain modelling process. The proposed approach has three key objectives. The first is to fully take advantage of the geometric information contained in the multispatial Terrestrial Laser Scanner (*TLS*) dataset acquired over a given area in order to maximise measurement sensitivity to semivariograms. The second is to verify the capacity of spatial analysis procedure in detecting landform structure. The third is to look for changes in structure relief forms that allow for channel-initiation detection. In order to achieve these aims a geostatistical analysis of semivariograms was performed to define the exact spatial patterns that control landform types and to verify scale effect (i.e. scaling-up and -down) over the topographic structures and limits between them. Thus, a comprehensive set of sample data analysis was performed to verify spatial-domain effect in landform structures using the captured data of the *TLS*. First, within the domain structure itself, several samples of varying dimensions have been selected to check for the directional effect, i.e. anisotropy. In each sample data, several semivariogram parameters were defined and compared. In addition, another group of sample datasets that contain more than one structural formation were analysed. Such sample data allows for a comprehensive understanding of semivariogram behaviour under multiple landform conditions. Finally, a sample dataset of stream-hillslope transect was used to identify convergent and divergent topography (i.e. channels and hillslopes), as well as the transition zone between them (i.e. channel initiation area). Results of the semivariogram analysis highlighted two important points. The first one is the presence of a clear domain pattern in each structure formation that could be used to identify similar landform structures and limits between adjacent ones. Secondly, such prevailing patterns are highly sensitive to the scale of the sample data set; that is the dimension of the landform structure. Results reveal that semivariograms were capable of accurately identifying a dominant pattern in each structure formation and the corresponding scale for such pattern. The semivariogram parameters of anisotropic ratio and sill variance consistently reflect the presence of pattern- and scale-dependent structures that should be taken into account in spatial variation analysis for landform structures. Direct applications of these results include a reliable validation approach for channel network extent in the landscape.

Determination of soil erosion using Laser scanners

Afana A.[1], Solé-Benet A.[1], Pérez J.L.[2]

[1]*Estación Experimental de Zonas Aridas, CSIC, Almeria, Spain (albert@eeza.csic.es)*
[2]*Universidad de Jaén, Campus Las Lagunillas, Edificio A3, 23071, Jaén, Spain*

Recent advances in laser scanning techniques have allowed for a wide variety of applications and therefore the adaption of laser scanners (LS), both airborne laser scanners (ALS) and terrestrial laser scanners (TLS), is increasing in many scientific disciplines. Geomorphology and specifically soil erosion are not an exception, where advances in soil erosion detection and measurement techniques are crucial steps in the reduction of errors and uncertainties in soil erosion models. In this presentation, topographic datasets captured by different laser scanning devices (ScanStation2 by Leica, Ilris by Optech and LS-800 by Faro) were tested in order to quantify soil erosion by water using different software-types (Polyworks, I-Site Studio, Cyclone, Faro-Scene and JRC-3D-Reconstructor). An experimental protocol based on iterative processes of data capturing and processing on field plots are the essential points of the methodology. In the selected experimental site, a 20° hillslope in the Tabernas Desert badlands in SE Spain, five micro-plots were defined and scanned before (surface *a*) and after (surface *b*) removing manually some soil volume, about 1 L, as would occur during any soil erosion process. The removed (eroded) materials were weighted at the laboratory and their volume calculated considering known maximum and minimum bulk densities. The scanned datasets (i.e. point clouds) were also adjusted and calibrated at the maximum possible resolution in relation to instrument capacities (i.e. accuracy and spot size divergence). Soil erosion in each plot was calculated as the difference between the two surfaces (*a* and *b*) assuming that this volume provides a good estimate of the manually extracted volumes (i.e. eroded plots). The generation of soil surfaces and their subtractions to provide the eroded volumes were done with the five software-types mentioned and both laser-calculated and manual-weighted results were compared from each scan using the different software-types. Results revealed that TLS offer a highly effective method for collecting massive volumes of precise, high-resolution 3D information for microtopographic detection, and hence surface variations. The datasets obtained from a given instrument (TLS) but modelled by different software-types are slightly variable, which highlights the importance of the algorithm used in the surface construction process (i.e. triangulation process), a crucial step in the volumetric calculation of the eroded surfaces.

Socio-economic impacts of flooding in Dire Dawa, Ethiopia

Yonas Tadesse Alemu

Department of Geography and Environmental Studies, Dire Dawa University, Ethiopia (tadesse.yonas@gmail.com)

Dire Dawa, the second largest city of Ethiopia, has been suffering from disastrous floods in it history. The flooding of 6 August, 2006 was unprecedented and caused severe impacts in the city. This study focused on finding out flood causative factors and the impacts of flooding on the socio-economic sectors of Dire Dawa. To achieve the objectives the study employed trend analysis; soil conservation service curve number method (SCS-CN); inundation analysis and ECLAC methodology. Results of the analysis showed that high intensity of rainfall accompanied by severe forest degradation has caused increased flood damage in the impact area. Moreover, the inundation result showed residential areas and business centers experienced the worst socio-economic damages among the different sectors in the city. It has also an enormous impact on the economic foundation of the city due to expenditure for rehabilitation and reconstruction. Absence of early warning system and land-use policy has contributed to the increased impact of the disaster.

Flood triggering factors and the efforts to mitigate flood disaster in Dire Dawa, Ethiopia

Yonas Tadesse Alemu, Girma Moges Meshesha

Department of Geography, Dire Dawa University, Ethiopia (Girma_mo2005@yahoo.com)

The city of Dire Dawa was established in 1902 at the foot hills of eastern *Harerge* highlands, It has been repeatedly hit by powerful flash floods of Dechatu River that caused several casualties and destroyed properties, infrastructures and livestock. The unprecedented August 6, 2006 flood was worst of all cases; it surpassed all the flood of past in loss of human life, and property damages. Yet, on April 22, 2010, flooding had moderate effects on human life but damage on property was again high. While also for the Dechatu R. the primary cause of flooding is unusually high rainfall, other man-induced causes, such as land degradation, deforestation, increased population density along riverbanks, poor land-use planning and zoning and a progressive vanishing of flood risk consciousness due to the sporadic occurrence of flash floods, play a relevant role as well. Droughts and floods are very common occurrences in Ethiopia and this situation of contrasting extremes is being exacerbated by the global climate change. Analysis of the rainfall data for the Dechatu catchment indicates an uneven distribution of precipitation and though the area is undergoing a general decreasing trend for both rainfall amount and rainy days exceeding 24 mm, peaks of rainfall extraordinarily higher than usual may still occur and generate destructive flash floods. On August 2006, the rainfall on the Dechatu catchment was about 93 mm, i.e. equivalent to 2/3-3/4 of the long term average amount for August. In the recent decades, the upland catchment of Eastern Harerge has experienced great pressure of population settlement and land-use change. A comparison between the 1985 and 2006 land use maps (Daniel, 2006) show that a remarkable change as occurred in the area, namely urbanized area + 44%, bare land +3%, cultivated land +16 %, shrub land -78% and open woodland -38%. Expansion of agricultural land at the expense of shrub land and open wood land has a direct correlation with surface runoff generation potential. Before 1985, when the status of land cover was in a good condition, large floods had a return interval of 15-30 years. As the area experienced serious land-use/land cover change, the flood frequency in Dire Dawa and the damages associated to it increased as four destructive floods hit the town since 1994. People concentration along flood plain affected river morphology by narrowing the channel and increasing vulnerability. The rapid population growth is due to the large number of migrants from poor rural areas, mainly attracted by the booming business and establishment of some industries. As the flood plain is wrongly perceived as "vacant space" greater proportions of these migrants settled in flood prone areas, increasing the vulnerability to flash floods. River rehabilitation practices, flood mitigation structures and recommendations were properly designed and partly implemented. In this presentation they are illustrated and their effectiveness is discussed.

Landslide hazard and risk assessment: a case study from Keyhi-Tekeli village in southern Tigray, Ethiopia

Kassa Amare, Kurkura Kabeto, Assay Gebremichael

Department of Earth Sciences, Mekelle University, Mekelle, Ethiopia

Landslides and rock falls have resulted in numbers of causalities and huge economic loss in the hills and mountainous areas in the Keyhi-Tekeli village and its surrounding, southern part of Tigray. The aim of this paper is to assess the active landslide sites and hazard zoning in this affected area and describing the type and cause of landslide and to generate basic database for future and remedial measures. The methodology employed in assessing the hazard areas is mainly field investigation which includes geological, geophysical, hydrogeological, geotechnical techniques, GIS and laboratory tests. The hazard area is covered by the Mesozoic sequences and overlain by trap volcanic series. The area is highly deformed and affected by two major sets of faults, the EW and NS and are responsible for the present topographic features. Factors that are critical in the active hazard area are identified and are considered, mainly (1) tectonic, such as major and minor faults, joints and fractures (2) topography and slope (3) lithology and drainage pattern (4) river incision and (5) huge rock fall on top of the slope which increase the stress pressure down slope. The slope failures in the area occurred when the strength of the loose material forming the slope, exceeds the pressure. Water pressure in the pore spaces of the loose material increases to the point that the internal strength of the lose material is drastically weakened. The loose material reduced its resistance easily and overcome by gravity, changing the lose material into a flow of mud down slope of the area. After assessing the vulnerabilities of the hazard through the risk assessment processes, we recommend as mitigation measures, rotational land use planning, water management mainly during irrigation, afforestion, terracing and soil drainage, taking retaining structure where the villagers are living and use check dams in the streams by using geo-textiles.

Geomorphological map of the Forefield of Tungnaárjökull (Iceland)

Andrzejewski L.

Institute of Geography, NCU, TORUN, Poland

The geomorphological research carried out at the forefield of the Tungnaárjökull, Iceland (including Andrzejewski, Molewski, 1999, 2000; Andrzejewski, 2002) enabled the scientists to study its relief in details. The results include a geomorphological map. The studies undertaken in 2004 and 2005, financed by the Polish Committee for Scientific Research aimed at reconstructing the course of the glacial, glaciofluvial and glaciolacustrine processes in the key areas of the above forefield zone. The reconstruction referred to the period between the end of the Little Ice Age and modern times. Detailed geomorphological, sedimentological and palaeogeographical analyses were used to reconstruct the range and the dynamics of the glacier's snout, directions of the melt-water outflow, as well as glacial and fluvioglacial erosion/accumulation processes in the marginal zone of the Tungnaárjökull. The reconstruction of the changes in the glacier snout's range also considered the analysis of both historical and modern cartographic materials, aerial and satellite photographs and field research. Reconstruction of the character of individual advances of Tungnaárjökull, from the end of the 19th century using geomorphological and sedimentological evidence within the ice marginal zone, suggest that they are consistent with surge-type advances (Andrzejewski, 2002). The forefield of the Tungnaárjökull (western part of the Vatnajökull) is located at the altitude of 700-900 m a.s.l. It spreads from north to south for over 28 km, while its width ranges from about 1 km in the northern part to over 2.5 km in the middle and southern parts. The snout of the glacier shows a lob character. The orography of the volcanic basement of the glacier's forefield, especially the NE-SW course of the Upper Pleistocene volcanic ridges, determines significantly both spreading and dynamics of the glacier's snout. The analysis of the development and correlations of glacial and fluvioglacial forms/deposits as well as their relation to the volcanic relief became the basis for distinguishing six diverse morphogenetic zones at the Tungnaárjökull forefield. The research carried so far enables the authors to reconstruct partially the above processes in the three key areas located within the distinguished zones. They include the following: (i) in the 1st zone, which is an extra-marginal zone from the Little Ice Age located in the northern section of the glacier's forefield. From the north-west this area is bordered by a volcanic range of the Jökulgrindur. This area includes a lake with distinct traces of a higher water level (abrasion shelves) and fossil lacustrine deltas, outwash levels of varied elevation as well as numerous forms of dead and stagnating ice forms; (ii) in the 2nd zone, which is bordered by the volcanic range of the Jökulgrindur from the west, the range limit was crossed by the glacier in some places during the Little Ice Age. This area contains numerous forms and deposits of the ice-contact, including kame terraces, which are found where the area nears to the eastern slope of the volcanic ridge. Currently, numerous blocks of buried glacier ice are recorded there; (iii) in the 3rd zone, which shows the increasing width towards the south-west, and is limited on the west by the volcanic ridge of the Jökulgrindur. A significant number of the old outwash levels, partially on the dead ice, are found from the glacier's side where the zone meets the ridge. They are separated by patches of ground moraine with the isolated kame hummocks and hills. This zone concentrates modern subglacial outflow of the melt-water from the north.

Effects of resource-conserving tillage in the Ethiopian highlands, a sustainable option for soil and water management and crop productivity. A case study from Dogua Tembien

Tesfay Araya[1,2], Cornelis W. M.[2], Nyssen J.[3], Govaerts B.[4], Fekadu Getnet[5,7], Bauer H.[6], Raes D.[6], Kindeya Gebrehiwot[7], Teklit Yohannes[8], Deckers J.[6]

[1]*Mekelle University, Department of Crop and Horticultural Science, POBox 231, Mekelle, Ethiopia*
[2]*Ghent University, Department of Soil Management, Coupure Links 653, B-9000 Gent, Belgium*
[3]*Ghent University, Department of Geography, Krijgslaan 281 (S8), B-9000 Gent, Belgium*
[4]*International Maize and Wheat Improvement Centre (CIMMYT), A.P. 6-641, Mexico D.F. 06600, México*
[5]*Ethiopian Institute of Agricultural Research, Pawe research center, Ethiopia*
[6]*K.U.Leuven, Department of Earth and Environmental Sciences, Celestijnenlaan 200E, B-3001 Heverlee, Belgium*
[7]*Mekelle University, Department of Land Resources Management and Environmental Protection, POBox 231, Mekelle, Ethiopia*
[8]*Haramaya University, Department of Natural Resource and Environmental Science, Haramaya, Ethiopia*

In the Ethiopian highlands, croplands yield extremely high volumes of storm runoff and are the major contributor to sediment load in the rivers. Resource-conserving tillage is one of the options to curb these problems of high runoff response and sediment transport. Hence, a long-term tillage experiment has been carried out (2005 to 2009) on a Vertisol to quantify changes in runoff, soil loss and crop yield due to Conservation Agriculture (CA) in the sub-humid Dogua Tembien district of the Northern highlands of Ethiopia. The experimental layout was implemented in a randomized complete block design with 3 replications on permanent plots of 5 m by 19 m. The tillage treatments were (i) permanent raised bed (PB) in a furrow and bed system with 30% standing crop residue retention and no-tillage on top of the bed, (ii) reduced tillage, locally called *terwah* (TER), with ploughing once at sowing with 30% standing crop residue retention and contour furrows made at 1.5m distance interval, and (iii) conventional tillage (CT) with a minimum of 3 tillage operations and removal of crop residues. All ploughing, as well as refreshing of the furrows of the permanent raised beds when sowing, was done using the local ard plough *mahresha.* Crops planted during the five years were wheat, grass pea, wheat, *hanfets* (wheat and barley sown together) and grass pea. Glyphosate was sprayed starting from the third year (2007) at 2 L/ha before planting to control pre-emergent weed in PB and TER. Runoff and soil loss were measured in plastic sheet lined collector trenches, which were located at the lower end of each plot. Crop stands were evaluated with local farmers and NDVI was measured on the spot at several phenological stages, using green seeker. Significantly different ($p<0.05$) soil losses of 12.7, 16.2 and 27.3 t ha^{-1} y^{-1} were recorded for PB, TER and CT, respectively. Similarly, the mean runoff was 931, 1011 and 1041 m^3 ha^{-1} y^{-1} from plots with PB, TER and CT treatments, respectively. The farmers' evaluation of crop performance in two years (2008 and 2009) showed a significantly higher score for PB (7/10) and least for CT (4.2/10). The NDVI of *hanfets* (2008) was significantly higher in PB (0.31) as compared to CT (0.27) 84 days after planting, while there was no difference at 59 days after planting. Although improvements in crop yield were observed, a period of at least four years of cropping was required before they became significant. Overall, the permanent raised bed and *terwah* tillage systems significantly reduced sediment loss and runoff, and increased crop yield. It is suggested that these tillage techniques, using the local plough without modifications, be implemented widely.

Conceptual modeling of soil-landscape relationships for soil classification and mapping on the Atsbi horst, Tigray, Ethiopia

Tigist Araya[1], Nyssen J.[2], Nurhussen Taha[1], Mitiku Haile[1], Atkilt Girma[1], Amanuel Zenebe[1], Poesen J.[3], Mintesinot Behailu[1], Deckers S.[2], Baert G.[4]

[1]*Department of Land Resources Management and Environmental Protection, Mekelle University, Ethiopia*
[2]*Department of Geography, Ghent University, Belgium*
[3]*Physical and Regional Geography Research Group, K.U.Leuven, Belgium*
[4]*Hogeschool Gent, Belgium*

Soil survey interpretation and soil information systems help to predict potentials, limitations, problems and management needs for soils. However, high expert input, difficulty of producing a large-scale soil map and financial constraints, especially in developing countries like Ethiopia, are major problems to undertake detailed surveys and have available data for different applications. As a result, developing a soil-landscape relationship model for an area helps surveyors to extrapolate results to other areas with similar soil forming factors. The study area, Ruba Feleg catchment in Tigray, Ethiopia at 2747 - 3065 m a.s.l. comprises Precambrian meta-sediments with small patches of Meta volcanic Precambrian rock, and Ordovician Enticho Sandstone, overlaying the Precambrian rock. A geopedologic map was produced with the help of topographic maps, aerial photograph interpretation and field data. The soil data were obtained from a grid auger survey and standard profile pits. A conceptual discrete model of spatial variation was developed, which was then validated in the nearby Kuret catchment, which has similar soil forming conditions. The study showed that the different soil types within the landscape result not only from the difference in position along the catena but also from differences in lithology and land cover. In areas having Precambrian rock or Enticho Sandstone, the occurrence of different soils such as Lithic Leptosols, Leptic Cambisols and Leptic Regosols is mainly due to topographic conditions (steepness and curvature). In the area where thin colluvium of Enticho Sandstone covers the soils developed from Precambrian, complexes of Haplic Cambisols, Haplic Regosols and Skeletic Regosols are observed. In addition to this, the land cover also contributed to the formation of different soils. The verified results furthermore indicated that the soil landscape relationship modelling should strongly consider the slight variations in lithology (facies) and degree of land degradation to extrapolate the model successfully to other areas.

Disturbances to buildings as indicators of slope gravitational processes: study cases from central Italy

Aringoli D.[1], Bisci C.[1], Dramis F.[2], Farabollini P.[1], Gentili B.[3], Materazzi M.[1], Pambianchi G.[1]

[1]*School of Environmental Sciences, University of Camerino, Italy (marco.materazzi@unicam.it)*
[2]*Department of Geological Sciences, "Roma Tre" University, Rome, Italy*
[3]*School of Architecture and Design "Eduardo Vittoria", University of Camerino, Italy*

The disturbances suffered during time by buildings and other man-made works (such as, walls, roads, bridges, tunnels, monuments, etc.) may provide valuable contributions to the study of large-scale landslides and landslide complexes affecting built-up slopes. In particular, the analysis of historical documents (such as maps, photographs, technical reports, restoration plans, remedial works, etc), providing information of landslide-induced damages to buildings, may allow outlining the spatial-temporal evolution and the future tendency of the investigated unstable slopes. This approach was applied to the study of some landslide-affected built-up areas of the Adriatic hilly belt of Central Italy. In this context, geological/geomorphological field survey, supported by hydrological/geotechnical/geophysical investigation and stratigraphic logging from exploration boreholes, was performed, including the detailed mapping of landslide-induced ground features (scarps, fractures, trenches, counterslopes, bulging, etc.). In addition, systematic field observations on damaged buildings, coupled with in-depth analysis of documents preserved in public and private archives was carried out. The GIS intersection of field and archive data made it possible to define the surface kinematics of the slope movements. These data were reported on large-scale geomorphological maps, with legend symbols describing the different types of disturbances ("faulting", fracturing, tilting, translation, sinking, disruption, etc.). These documents may be definitely helpful to decision makers and land managers allowing them to better understand the landslide evolutionary trend and plan the possible remedial interventions.

Geomorphology of limestone terrain of Tigrai, northern Ethiopia: implication for cave formation and speleothem growth

Asfawossen Asrat[1], Baker A.[2], Agazi Negash[3]

[1]*Department of Earth Sciences, Addis Ababa University, P. O. Box 1176, Addis Ababa, Ethiopia (asrata@geol.aau.edu.et)*
[2]*The University of New South Wales, Australia*
[3]*Department of History and Heritage Management, Addis Ababa University, P. O. Box 1176, Addis Ababa, Ethiopia*

Extensive limestone beds with great potential for caving are exposed in three regions in Ethiopia: the Mekelle Outlier in the North (Tigrai), the Blue Nile Basin in central Ethiopia, and the Ogaden Basin in southeastern Ethiopia (Mechara karst). Our studies of speleothems recovered from the Mechara karst system gave high-resolution, multi-proxy palaeohydrological and palaeoclimatic records of the late Quaternary. The results of our investigations in the Mechara karst have been encouraging to extend our studies to other limestone terrians in Ethiopia. A thick succession of limestone beds forms part of the "Mekele Outlier", a near circular 8000 km^2 area Mesozoic Sedimentary Basin. The Antalo Limestone conformably underlying the Agula Shale (both Oxfordian-Kimmerdgian), and overlying the Adigrat Sandstone (Triassic) consists of white (and rarely black) limestone, finely crystalline to lithographic, thinly-bedded, fossiliferrous, typically well-indurated, and interbedded with yellow marl and sandy limestone. It has a maximum thickness of 700 m and forms steep cliffs and gradual terraced slopes. Our investigation in this limestone terrain revealed (i) numerous entrances into short caves on thinly bedded limestone cliffs, most of which are dry and relict; (ii) that irrespective of similar climatic conditions with those of the Mechara karst system, this limestone terrain is less karstified; and (iii) some longer caves formed into relatively massive crystalline limestone beds, the longest explored being 330m, which contain numerous relict and active speleothems. Though the thinly- (2-3 m on average) bedded limestone hinder the formation of extensive karst systems, the speleothems collected from these caves show continuous and regular laminae sequences with no periods of indistinct or discontinuous laminae, indicative of annual growth. These stalagmites are suitable for high-resolution palaeoclimate studies and have the potential to expand our understanding of the climate variation in northern Ethiopia, one of the most drought prone regions in the country.

Geo-Scenery based on geo-diversity in Ethiopia

Asfawossen Asrat[1], Metasebia Demissie[2], Aberra Mogessie[3]

[1]*Department of Earth Sciences, Addis Ababa University, P. O. Box 1176, Addis Ababa, Ethiopia (asrata@geol.aau.edu.et)*
[2]*Geo-Information and Landscape Gardening, Addis Ababa, Ethiopia*
[3]*Institute of Earth Sciences, University of Graz, Universitaetsplatz 2, A-8010 Graz, Austria*

Geology is often the most important factor controlling natural scenery and landforms and hence diverse geomorphologic features characterize the Ethiopian landform. The Cenozoic volcanic and tectonic episodes by uplifting and subsequent outpouring of huge quantities of lava cover on a peneplained Precambrian surface or over the Palaeozoic-Mesozoic sedimentary successions determined the current landscape of Ethiopia. The current landform of the country is one way or anther, a direct manifestation of long and continuous physical, geological and tectonic processes that have been occurring since the Precambrian era and still continuing to the present day. The active Ethiopian Rift System trending NNE-SSW is part of the East African Rift System extending from the Middle East to Mozambique. The Rift cuts through the highlands of the country into north-west and south-east plateaus endowing the country with some spectacular features that range from hot, dry, and barren places to a string of beautiful lakes and hot springs. The active tectonics and multiple faults are precursors for the formation of escarpments, horsts, and grabens adding up to another kind of morphological scenery. The Ethiopian rivers, sometimes referred to as "water tower of Africa" mostly aligned along faults start their journey from the highlands winding down the slopes and travel to the lowlands feeding the neighboring countries and on their way forming spectacular water falls, gorges, ravines and caves. Continuous volcanic activities and an ongoing continental rifting and faulting coupled with river courses gave rise to a diversified geological, complex geomorphologic set up, and fascinating and diversified geo-sceneries. These sceneries vary from mountain ranges and peaks (e.g. Ras Dashen and The Bale mountains at more than 4000 m a.s.l.) which are suitable for hiking and trekking, to some of the lowest, hottest and most inhospitable places on Earth, like Dallol depression and the Ert'Ale volcano, which are suitable for the most adventurous. Some of these geo-sceneries of Ethiopia are ideal for geo-parks in addition to the traditional national parks, and sanctuaries. The Ethiopian geo-scenery is also home for diversified ethnic groups and interesting culture, language and religious beliefs. It is also a land of legends, whose culture and traditions date back over 3,000 years, but human habitation began here much, much earlier, as evidenced from the numerous hominid fossil kinds in the Afar and Omo rifts. This paper deals with the results of the second phase of the project "Geotourism in Ethiopia: Natural Sceneries" we have been undertaking since 2004. During this phase three field seasons of geo-traverse were conducted to the NW and SE Highlands and the Rift Valley. The third and fourth phases of the project will cover Geotourism on Archeological, Anthropological and Historical places and Modern Cities.

Study of the genesis of a red ferric Latosolic Nitisol in an area of lithological interface, in the municipality of Floraí, state of Paraná, Brazil

Barreiros A.M., de Oliveira D.

Department of Geography, University of São Paulo (USP), Brazil (barrerinho@usp.br, debolive@usp.br)

Soils are dynamic, complex and organized systems, and have been used by mankind since ancient times as a vital resource, especially in terms of food production. Despite of that, it´s easily noticed that humanity very often uses this natural resource without a clear knowledge about its characteristics, which is a premise to consider the soil as a renewable resource. In order to accomplish a better understanding of the soils, it´s important to comprehend under which circumstances its pedogenetic horizons were formed and its present stage of evolution. The present work intends, by its completion, to provide theoretical and methodological subsides to understand the pedogenetic processes that are responsible for the genesis of a Red Ferric Latosolic Nitisol in an area of lithological interface between basic rocks from the Serra Geral Formation and the sandstones of the Caiuá Formation, both in the Paraná River sedimentary basin, in the municipality of Floraí, state of Paraná, Brazil. The observation of the morphological aspects of the soils should precede any human intervention, since the fertility and usage conditions strictly depend on such characteristics. With the expansion of the agricultural borders in Brazil, such as the current processes taking place in the North and Central-West regions of the country, and also due to the modification of the property structure of traditional rural areas, it´s imperative to know the pedological covertures of such areas in detail. In a revision of the contribution of the pedology studies in tropical areas, Ruellan teaches that in the present days we should take more that the "soil-individual" (pedon) in consideration for the studies on genesis, classification and fertility, among other themes. From the moment the soil is understood as an organized and structured body, all of the pedological coverture should be studied in its four dimensions (three spatial and one temporal), thus analyzing the historic evolution of the studied coverture, allowing the researcher to achieve a prognostic that will allow an interpretation of the soils within the landscape in which it´s inserted - also considering the human actions, which are, according to the author, "[...] a powerful agent in the transformation of the soil." From the data raised in field trips to this area, it was possible to identify a pedological system which can also be found in all of the extension of the referred lithological contact, being: Red Latosol (on the top of the hills), Red-yellow Argisol (beneath the Latosols), Red Ferric Latosolic Nitisol (in the first segments within the basaltic coverture), Red ferric Nitisol and Gleysols, these last two in the final section of the slopes, near the water courses. Based on the previous knowledge of the area and bibliographic references on the theme (pedogenesis, morphogenesis and geology), it´s possible to raise some hypothesis on the genesis of the Latosolic Nitisols: (i) a possible increase of the clay fraction, mechanically transported by leaching from the top segments of the hills, covered by a sandstone formation, in altitudes above 450 meters to the inferior third section (basalt), transforming the micro-aggregated structures of a typical Latosol into angular structures, with signs of cerosity. Such process is possible due to the differential erosion between the sedimentary and basaltic structures; the last one being more resistant than the first to the weathering processes. This characterizes this pedological system as a pedobioclimatic unbalanced one, with a front of transformation that advances from the bottom to the top of the hill (eluvial-iluvial system), a similar process to the ones studied by Boulet in Burkina Faso by Boulet; and (ii) the second hypothesis would be the mobilization of the iron by a physical-chemical process related to the dissection, releasing part of the clay fraction which was initially trapped in the crystalline structures, similar process to those described by Chauvel in Casamansa, Senegal, which would indicate a transformation system without lateral internal transfers. Further studies that are being developed about the pedological systems within the Gurupá river basin, using the Pedological Coverture Structural Analysis should reveal which are the processes that acted or still act on the pedological differentiation on the two lithological provinces.

Drainage derangement by a probable meteoritic impact in southwestern Brazil: the crater of Colônia and the Capivari River

Bezerra dos Santos A. H., de Oliveira D.

Department of Geography, University of São Paulo (USP), Brazil (andresantos@usp.br, debolive@usp.br)

The crater of Colônia is a probable impact crater located in south-eastern Brazil, near São Paulo. With 3.6 km in diameter, it is estimated that the crater has been formed between the Oligocene and the Pliocene. Since, to the moment, minerals as coesite and stishovite, considered diagnostic of meteoritic impacts, has not been identified in the area, the feature does not appear on lists of recognized impact craters. The impact structure (geological counterpart of the geomorphological "impact crater") is developed on Precambrian metasedimentary rocks whose faults, fractures and folds line up in the ENE direction. These are partially covered by sediments of the Basin of São Paulo which, after reaching a maximum extension in the Tertiary, has been degraded by denudation. To the south of the structure, 12 km away, lays the Serra do Mar, 800 m in average height, a probable fault line scarp generated in response to distension of the crust in the context of separation America-Africa. Recent tectonic movements, responsible for reactivation of dip-slip faults and strike-slip faults, influenced the development of relief and drainage in the region. We investigated the relationship between the formation of the impact structure and the development of the drainage of its surroundings, specifically the possibility of faults and fractures radial and concentric to the impact crater have been superimposed on the influence of regional structures for the development of the drainage pattern, based on the framework provided by studies that investigated the formation of impact structures. We also examine the origin of a conspicuous shift in the course of Capivari. This river, which rises on the back of the Serra do Mar, deviates sharply as it approached the crater, being led back to the escarpment, which runs through finding large altitudinal gradients. Such a shift would have been produced by impact or by stream piracy. In the first case, the river would necessarily be older than the impact, whereas in the latter case later ages are possible. Moreover, if the typical evidences of fluvial captures as: capture elbow, misfit river, dry valley with gravel deposits, knickpoint in the longitudinal profile and resemblance of gravel between the drainages involved are identified, it supports the hypothesis of capture at the expense of the hypothesis of fluvial disturbance. For the investigation, we applied GIS techniques to the analysis of digital elevation models (DEMs), and remote sensing, field work and laboratory analysis. A detailed description of landforms of the area has been made, together with descriptions of fluvial deposits and soil materials on selected portions of the watersheds surrounding the crater. From DEM data, we generate hypsometric, slope and lineaments maps, and topographic profiles combined with geological information. From the photo interpretation and data obtained from analysis of digital models, were planned and executed field work, in which were held drillings and description of soil profiles. In laboratory, were characterized particle size, morphology and mineralogy of the sandy fraction of materials belonging to the floodplain of the upper course of the river Capivari and the so-called dry valley, for purposes of comparison. The data obtained indicates the occurrence of a rough annular drainage surrounding the crater, which would indicate possible structural control, although the structures themselves have not yet been identified in the field. For the case of Capivari river, the lack of terraces and the small width of the valley indicated as pre-impact former exit, north of the crater, suggests their relatively recent formation (or at least newer than the impact of Pliocene age or earlier). We identified: the elbow of capture, the misfit of the river over the valley, the rupture in the longitudinal profile and the similarity of sands (gravels were not identified) between stretches of drainage involved. However, we did not identify gravel deposits in the dry valley, which by no means refutes the possibility of capture. With more evidence favorable to capture than to the disruption of Capivari directly by the impact, it is proposed that the impact was not directly responsible for the inflection of the river.

Sediment transport of a flash flood stream in Tigray, Ethiopia

Billi P.[1], **Aklilu Amsalu**[2]

[1]*Department of Earth Sciences, University of Ferrara, Italy*
[2]*Department of Geography & Environmental Studies, Addis Ababa University, Ethiopia*

Arid and semi-arid landscapes are incised by river systems in which water flows for no more than 20% of the time. Dryland rivers have an intermittent and impulsive flow, as it is generated by sporadic, short and high intensity rainstorms. Ephemeral streams floods deploy a large quantity of energy that is dissipated through the entrainment of large amounts of sediment, channel scouring, avulsions and downstream water loss for infiltration. Both suspended and bed sediment transports of ephemeral streams are reported to be very high. Though sediment transport processes such as erosion and deposition can increase the frequency of overbank flooding, causing many casualties and infrastructure damages, field measurements of sediment transport of ephemeral streams are very scant. This paper illustrates the flow and sediment transport data measured during a field work undertaken during the rainy season (July-August) of 2008 on Gereb Oda river, a steep, sand-bed ephemeral stream, draining the western margin of the Kobo structural basin in northern Ethiopia. Information about hydraulic and sediment transport processes in steep sand-bed ephemeral streams is very poor and, though only two flash floods occurred during the field survey, the data gathered may contribute to improve our knowledge on these rivers processes. Froude numbers were calculated in order to verify the occurrence of supercritical flow conditions as postulated by a few authors from the analysis of sediment structure characteristics. Flow data are also compared to simple models to predict flow velocity and discharge since flow recording systems are seldom installed on ephemeral streams in remote areas and developing countries. Dryland Rivers are known for their very high suspended sediment transport, but very little bedload data exist for sand-bed ephemeral streams. The variation of suspended sediment concentration with discharge is analysed and simple rating curves for both suspended and bed load transport are derived. A few equations to predict bedload are tested against Gereb Oda data and the relationship between *en masse* bedload transport processes as thin sand sheets and the development of horizontal lamination through the migration of leaf-shaped, sheet-like bedforms is investigated. Individual, large boulders were observed to move at flow depths of the same order of magnitude of their size. A few functions to predict the threshold conditions for large particles entrainment are used to verify if and to what extent they match Gereb Oda field conditions. The increased density of the water-sediment mixture, for the very high suspended sediment concentrations ranging from 100,000 to 200,000 ppm, is considered as well.

Geomorphological study of the El Alamein battlefield (Egypt): a military geology approach

Bondesan A.[1], Francese R.[2], Coren F.[2], Fabbrucci L.[3]

[1]*Dipartimento di Geografia, Università degli Studi di Padova (Italy) (aldino.bondesan@unipd.it)*
[2]*Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS, Trieste (Italy)*
[3]*Italian Society of Military Geography and Geology, Italy*

In 1942, between the end of June and the beginning of November, a series of battles and war actions took place in the Egyptian Desert (namely, Western Desert), near the location known as El Alamein. The third, and final, El Alamein battle began at 20.40 on October 23rd when the awaited British offensive started. After 12 days of hard fighting Montgomery's VIII Army broke into Rommel's defenses, and the Axis troops began a long and difficult retreat which finally ended-up in Tunisia, in May 1943. During the battle, which lasted until November 4th, and the next few days, about 30,000 Italian and German prisoners were captured, while, as a whole, the Axis had 9,000 men killed or missed and 15,000 wounded. On the British side, Montgomery's VIII Army losses accounted for 13,560 killed, missed, or wounded men. The study is devoted to the geological-historical analysis of the reciprocal relationships between the terrain and the development of military operations. The interested area encompasses the sites of the Egyptian sector of El Alamein (Western Desert), were three battles took place in 1942. Investigations were performed according to a multidisciplinary approach, in tight collaboration with researchers having different expertise from military history to archaeology, from geophysics to topography, from geopolitics to sociology, etc. A Geographical Information System was implemented in order to document and reconstruct the battlefield by mean of remote sensing and geological-geomorphological field survey and mapping. The study was integrated by an historical analysis of the battle and of the North African Campaign. By a comprehensive study of the battlefield it has been possible to analyze the geological and geomorphological factors that influenced the military operations and the environmental consequences on the actions of war.

The average shear wave velocity map of the province of Treviso: a geomorphological-geophysical integrated project

Bondesan A.[1], Francese R.[2], Coren F.[2], Busoni S.[3], Wardell N.[2]

[1]*Dipartimento di Geografia, Università degli Studi di Padova (Italy) (aldino.bondesan@unipd.it)*
[2]*Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS, Trieste (Italy)*
[3]*Provincia di Treviso, Italy*

An experimental geomorphological-seismic survey was undertaken to target the shear wave velocity in the near surface layers of a large area of the Veneto region. The main objective of the survey was to define and to map the average velocity in the uppermost 30 m as required by the EN1998 Eurocode 8: "Design of structures for earthquake resistance". This parameter, generally indicated as VS30, provides important information for the structural engineers to adequately design or refurbish buildings. Low local values of theVS30 parameter require the application of specific safety coefficients. In the seismic experiment the VS30 parameter was mapped in an area of approximately 2000 km² in the plain of the Province of Treviso. The experiment attempted to address two major issues: the definition of a reference velocity map to guide the geotechnical studies and the assessment of a low cost technique to investigate the elastic properties of large areas that could also be used for seismic hazard assessment. The survey was carried out using the Refraction Microtremor (ReMi) technique capable of estimating the 1-D shear velocity model by means of analysis of the dispersion of the surface waves. The major advantage of this method is the recording of the surface waves in passive mode without the need of an active seismic source. In order to optimise and minimise the number of field stations used, the existing geomorphological data were reprocessed to construct an accurate map of the surface depositional units. The VS30 seismic network was then designed based on the geometry of the different depositional units obtained by a detailed geomorphological survey, thus assuring an adequate number of stations in key locations. The investigated area is part of the Venetian-Friulian Plain, which corresponds to the eastern portion of the Southern Alps foreland basin, consisting of several, coalescent alluvial megafans. The existence of these large-size sedimentary systems is allowed by the tectonic setting, while their evolution during the Upper Pleistocene and Holocene has been controlled mainly by climatic change and eustasy. From a stratigraphic point of view fluvioglacial and alluvial deposits are several hundreds of meters deep showing a change in texture from the massive gravel and sand belonging to the high plain to the stratified silty-clayey low plain. The surface sediments are mostly continental; they are organised along fluvial ridges connected with the main river directions, both abandoned and still active. The VS30 map showed a close correspondence between velocity and the geomorphological textures of the surface deposits. In the upper plain region, where the subsurface is homogeneous down to a depth of several hundreds of meters, the 500 m/s VS-contour clearly marks the boundary of the gravel domain. High VS bodies are clearly visible also along the fluvial axes of the major rivers cutting the middle and lower plane indicating coarse textures due to high depositional energy. The final data synthesis provided a comprehensive insight into the understanding of the relationship between the near surface textures of the alluvial deposits and the associated shear wave velocity field.

Geomorphological map of the Alta Badia valley (Dolomites, Italy)

Borgatti L.[1], Coratza P.[2], Corsini A.[2], Ghinoi A.[2], Keim L.[3], Marchetti M.[2], Panizza M.[2], Pasuto A.[4], Piacentini D.[2], Silvano S.[4], Soldati M.[2]

[1]Dipartimento di Ingegneria Civile, Ambientale e dei Materiali DICAM, Alma Mater Studiorum Università di Bologna, Viale Risorgimento 2, 41036 Bologna, Italy (lisa.borgatti@unibo.it)
[2]Dipartimento di Scienze della Terra, Università di Modena e Reggio Emilia, Largo S. Eufemia 19, 41121, Modena, Italy (paola.coratza@unimore.it, alessandro.corsini@unimore.it, ghinoialessandro@gmail.com, mauro.marchetti@unimore.it, mario.panizza@unimore.it, daniela.piacentini@unimore.it, mauro.soldati@unimore.it)
[3]Ufficio Geologia e prove materiali, Provincia Autonoma di Bolzano, Via Val d'Ega 48, 39053 Cardano (BZ), Italy (lorenz.keim@provincia.bz.it)
[4]Istituto di Ricerca per la Protezione Idrogeologica, CNR, Corso Stati Uniti 4, 35127, Padova, Italy (alessandro.pasuto@irpi.cnr.it; sandro.silvano@irpi.cnr.it)

The geomorphological investigations carried out in the Alta Badia Valley (Dolomites, northern Italy) have lead to the elaboration of a geomorphological map at 1:20,000 scale. The method used for the survey and mapping follows the guidelines issued by the Italian National Geological Service for the 1:50,000 Geomorphological map of Italy. The research has also enabled to reconstruct the geomorphological evolution of the area and to outline the spatial and temporal occurrence of landslides, which are the most spread geomorphological features in the area. The geomorphological mapping process took advantage of the output of a series of investigations carried out during more than ten years in the Alta Badia Valley within national and international projects, such as multitemporal analyses of aerial and terrestrial photos and maps, field survey and mapping, as well as instrumental sampling and monitoring of several landslides. Particularly significant to reconstruct the geomorphological evolution of the area were about 50 radiocarbon organic samples – generally collected from either landslide accumulations or lacustrine deposits – which gave significant radiocarbon ages related also to pollen analysis. The Alta Badia Valley is located in the eastern Dolomites and surrounded by high plateaus such as Sella Group (Piz Boè, 3110 m a.s.l.), Gardenaccia Group (Col Dala Sone, 2633 m), Contourines (Piz Dles Contourines, 3064 m), Settsass and Lagazuoi Groups (Piz Lagazuoi, 2762 m). The area is linked to surrounding alpine valleys by famous alpine passes: Gardena Pass towards west (2150 m), Campolongo Pass towards south (1875 m), Valparola and Falzarego Passes towards southeast (2109 m). Water courses flow towards north and the main stream is Rio Gadera. The geological structure of the area, characterised by an alternation of dolomite rocks and successions of prevalently pelitic components, has markedly conditioned the morphological evolution of the slopes after the retreat of the Last Glacial Maximum (LGM) glaciers. The stratigraphic sequence outcropping in the Alta Badia valley covers a period of time ranging from Middle and Upper Triassic to Lias. The Triassic rocks outcrop especially in the peripheral parts where the highest mountain groups are located. As a result, the slope morphology is softly degrading in the medium and lower parts where pelitic formations outcrop, while at higher altitudes subvertical dolomitic cliffs rise up, eventually interrupted by typical ledges, thick scree slopes, located in correspondence with more erodible formations. During the LGM, the whole area was covered by a thick ice cap, till about 2300 m, flowing from north and partially linked to contiguous ice tongues through the main Alpine passes. During the Late Glacial, ice masses in the area were confined among the main dolomite groups and flux changed from Falzarego, Campolongo and Gardena Passes towards the north. Most of the Quaternary deposits consist of landslide accumulations, which have widely involved and deleted glacial deposits. Actually, the whole area has often been affected by landslide phenomena of various types and of sometimes notable dimensions, some of which are still active today. The favourable morphological conditions of the valley have lead to progressive urbanisation, strictly connected to intensive tourist development.

Development and application of a methodological tool for landscape impact assessment in mining areas: application as a decision-support tool for impact mitigation

Bruschi V.M.[1], **Otero C.**[2], **Manchado C.**[2], **Arias R.**[2], **Cendrero A.**[1]

[1]*DCITIMAC, Faculty of Sciences, University of Cantabria, Spain (viola.bruschi@unican.es)*
[2]*Department of Geographical and Graphical Engineering, EGI-CAD Group, Civil Engineering Faculty, University of Cantabria, Spain*

One of the effects of mining activities, particularly open cast, is the profound alteration of landforms, through excavation and accumulation. This, together with land-cover changes, produces a variety of impacts, among which visual landscape impact is perhaps the most widely objected to by the general public. Visual landscape is increasingly valuated by the public as a cultural, aesthetic and recreation asset. Prevention or mitigation of impacts on landscape are therefore more and more necessary. The "quality" or "value" of a landscape is determined to a great extent by three characteristics: geomorphology/relief, vegetation, human structures. Visual effects of new human actions on landscape are therefore related to the degree of modification on the above, as well as by the perception of those changes by people. The latter, in turn, can be analysed from a quantitative and a qualitative perspective. A methodological tool has been developed for measuring (quantitative perspective) visual impacts due to existing or projected mining exploitations and for simulating potential new landscapes (qualitative perspective), on the basis of the projected landform and land cover changes The same tool can be used to simulate and assess the efficiency of different mitigation measures. Examples of the tool's application and results obtained in several mining/quarrying areas will be presented. The same basic principles underlying the design of this tool can be applied to the analysis and assessment of any other landscape modification. Building on the experience obtained through the former work, a technological decision support tool has been developed to measure, simulate and assess visual landscape impacts at much large scales, and to use it as a social participation tool. Examples of its application to the assessment of wind energy parks, at local level and for a 5,200 km^2 province will be shown and discussed.

Multidisciplinary investigations for the environmental rehabilitation of mining areas in the Rio della Rocca valley (Reggio Emilia province, northern Italy)

Bruschi V.M.[1], Coratza P.[2], Devoto S.[2], Piacentini D.[2], Soldati M.[2], G.Tosatti[2]

[1]*Departamento de Ciencias de la Tierra y Física de la Materia Condensada, Universidad de Cantabria – Avda. De Los Castros s/n, 39005 Santander, Spain (viola.bruschi@unican.es)*
[2]*Dipartimento Scienze della Terra, Università di Modena e Reggio Emilia – Largo S. Eufemia 19, 41121 Modena, Italy (paola.coratza@unimore.it, stefano.devoto@unimore.it, daniela.piacentini@unimore.it, mauro.soldati@unimore.it, giovanni.tosatti@unimore.it)*

The landscape modifications induced by human activity in the past 50 years, due to quarrying in the small catchment of Rio della Rocca (Province of Reggio Emilia, northern Italy) and its environmental rehabilitation are illustrated. The study area is located in the northern Apennines margin, specifically in the municipality of Castellarano, and is characterised by a great variety of abiotic environments and high biodiversity. As regards the geological aspects of the area, the main lithological outcrops consists of yellow sandstones belonging to the Epi-Ligurian Sequence (Upper Eocene - Lower Oligocene) and grey clays (Lower Pliocene - Lower Pleistocene) of the marine units of the Apennine margin. From a geomorphological viewpoint, the landscape of this valley has been deeply influenced by the presence of rocks with different mechanical behaviour, gravitational processes and, more recently, human activities. The latter have played a fundamental role in modelling the physical landscape of the area in recent times. In the Sassuolo area (Province of Modena), very close to the study area, there is the largest tile making district in the world, which was developed during the ’60s and ’70s of the 20th century, partly thanks to the wide availability of clayey raw materials with suitable technological properties. Since the mid-1950s the study area has been affected by intense quarrying activities which have largely modified its environmental and, in particular, geomorphological features. In the 1970s, three clay pits and four sandstone quarries were active in the area. The clay pits were used for tile production whereas the sandstone materials were utilised in large part for the building industry. This production scenario has radically changed during the past twenty years, with the abandonment of four quarries for the progressive introduction of ever-more restrictive environmental policies, imposing rigorous planning on mining activities. At present only one quarry is active in the catchment of Rio della Rocca. Considering the high scenic and environmental value of the study area, multidisciplinary investigations concerning the main geological, botanical and faunistic aspects were carried out in order to plan the environmental rehabilitation of the whole valley. Specific attention was given to assessing slope instability and identifying the geosites of the area. On the basis of the results attained, proposals of territorial upgrading have been developed by taking into account also appraisal measures for geotourism and recreational purposes. A series of specific proposals have been presented for the protection and use of sites of geological interest in the valley. These proposals include the design of physical protection measurements, the formulation of traditional itineraries, aiming at integrating geological-geomorphological elements and information on flora and fauna, and the appraisal of geosites as basis for fostering tourism and recreation and contributing to economic activities. The aim is to show the link between Man and the geological environment with respect to exploitation of raw materials which are particularly abundant in the area studied.

Key variables of soil crusting involved in their hydrological and erosive response

Cantón Y.[1], **Chamizo S.**[2], **Rodriguez-Caballero E.**[1], **Miralles-Mellado I.**[2], **Lázaro R.**[2], **Domingo F.**[2], **Calvo-Cases A.**[3], **Sole-Benet A.**[2]

[1]*Department of Soil Science, University of Almería, Spain (ycanton@ual.es; rce959@ual.es);*
[2]*Experimental Station of Arid Zones, CSIC, Almería, Spain (schamizo@eeza.csic.es; isa@eeza.csic.es; lazaro@eeza.csic.es; poveda@eeza.csic.es; albert@eeza.csic.es)*
[3]*Geography Department, University of Valencia, Spain (adolfo.Calvo@uv.es)*

Soil surface characteristics (microtopography and soil crusting, stone and vegetation cover) have a very strong influence on local hydrologic regimes, controlling infiltration rates, runoff generation and also affect erosion. In dryland ecosystems, where plant cover is scarce, other surface components such as soil crusts or stones acquire a very relevant role affecting runoff generation and water redistribution, flow velocity and soil erosion. In these ecosystems, soils in open areas among sparse shrubs are very often crusted with both biological soil crusts (BSC) and physical soil crusts (PSC). BSCs are a combination of cyanobacteria, algae, fungi, lichens and mosses that occur on every continent and account for up to 70% of the life cover in arid lands. BSCs have been demonstrated to be very vulnerable to disturbance which in turn can lead to accelerated soil erosion and other forms of land degradation. Incorporation of the response of different type of soil crusts and the effects of their disturbance is highly likely to improve the prediction of runoff and water erosion models in dryland catchments. The main purposes of this work are (i) to examine how crust characteristics influence infiltration and erosion, (ii) to identify the most influential crust characteristics on runoff and erosion processes and (iii) to analyse the effects of crust disturbance on the hydrological and erosional response of PSCs and BSCs. Two semiarid areas, where soil crusts are well represented, were chosen and the most representative PSCs and BSCs were identified at both sites. For each crust type, four repetitions were considered and physical and chemical characteristics of the soil underneath the crust were analysed. Other crust properties such as cover, roughness, soil storage capacity, hydrophobicity and resistance to penetration were considered. Moreover, their runoff and erosion responses of intact and disturbed crusts were examined by means of rainfall simulation in both areas and in one of the areas open plots of about 1 m^2 on cyanobacteria, lichen crusts and PSC were set to examine the hydrological response to natural rainfall. Millimetric resolution DEMs were built on those plots from laser scan height records, and soil storage capacity (SSC) was obtained. Results show that some properties of the soil material below crusts, like organic carbon and texture, partly control the open porous system and are the most discriminating variables explaining the differences between sites. The cover (species composition) of the crust is a key factor controlling runoff and erosion. Infiltration rates are lower in the PSCs than in BSCs and increase with crust development, with the exception of the lichen crust where different factors (cover, hydrophobicity, pore clogging or roughness) interact together resulting in lower infiltration rates. Hydrophobicity also appears as useful characteristics to discriminate the hydrological response of crusts. The resistance to penetration of BSCs decreases as crust development increases due to the influence of the underneath material, highlighting the limitations of some penetrometers to provide adequate BSCs resistance values. Crust roughness influences the hydrological response of the plot by its effect on SSC. The SSC appears as a potent predictive variable of annual runoff coefficient. At event scale, SSC is also related with the runoff coefficient but the variance is higher depending on the rainfall intensity. The SSC is also related with the timing of runoff for small intensity rainfalls. The disturbance of crust characteristics by scraping and trampling promoted significant higher erosion rates than undisturbed crust, but no significant differences were found between both treatments, except for the lichen-dominated crust. Trampling the crust causes not only the crust disruption but also soil compaction, inducing the lowest infiltration rates. The effect of crust disturbance is less remarkable in areas subjected to frequent grazing or livestock trampling.

Evidences of major changes in Earth's surface processes. Should the Anthropocene be considered as a new period in geologic history?

Cendrero A. & CAMGEO Group*

DCITIMAC, Faculty of Science, University of Cantabria, Spain (antonio.cendrero@unican.es)

A few years ago Crutzen (2002) proposed to define a new period of Earth's history, the "Anthropocene", characterised by the strong human influence on natural processes. The beginning of that period should be the end of the 18th century, when ice core records show evidences of increasing CO_2 concentration, as a result of human activities. In our opinion the proposal is clearly justified, but as we are dealing with geologic history we feel that it would be better to define the new period on the basis of differences in geologic processes. Evidences will be presented, from different parts of the world and at different scales, showing that important changes in surface geologic processes seem indeed to have occurred after the start of the Industrial Revolution. Those changes affect landslide and flood frequency or denudation/sedimentation rates and could have global extent. The magnitude of the changes observed – one order of magnitude or more in less than a century- is much greater than could be expected from changes experienced by climate during the same period. A plausible explanation of the cause of those changes is the very considerable modification of land surface which has taken and is taking place, very especially after mid-twentieth century. The importance of that '*global geomorphic change* (GGC)' is shown by the growing '*human geomorphic footprint* (HGF)' we produce or by the increasing frequency and severity of hydrogeomorphic hazards. The main driver of such changes appears to be growing human pressure on land surface and geomorphic systems, which could be named '*human geomorphic pressure* (HGP)' and expressed as GDP/km^2. Data will be presented that suggest human influence on geomorphic processes surpassed that of natural agents around the end of World War Two. If this were so, from a geomorphic point of view perhaps it would be better to consider that date as the beginning of the Anthropocene. The implications of the changes described for natural hazards and, therefore, human wellbeing, are considerable. This makes the issue of much more than academic interest. It is probably worth to test the ideas presented, through analyses and gathering of new evidences in other areas and by other research groups.

The CAMGEO Group is formed by the following persons:
V.M. Bruschi, J. Bonachea, J. Remondo, V. Rivas, A. Cendrero (Universidad de Cantabria, Spain); G. Méndez (Universidad de Vigo, Spain); J.M. Naredo (U. Politécnica de Madrid, Spain); M. Dantas-Ferreira, O. J. Pejon, L. V. Zuquette (Universidade de Sao Paulo, Sao Carlos, Brasil); M. A. Hurtado, L. M. Forte, J. L. Cavallotto (Universidad Nacional de La Plata, Argentina).

Reconstructing the early/mid Holocene landscape evolution of the Thyamis delta (Greece): implications for human populations

Chabrol A.[1], **Fouache E.**[1, 2], **Lecoeur C.**[1], **Apostolopoulos G.**[3], **Pavlopoulos K.**[4]

[1]*UMR CNRS 8591, Laboratoire de Géographie Physique, Université Paris 1 Panthéon-Sorbonne, Paris, France (Antoine.chabrol@cnrs-bellevue.fr)*
[2]*Université Paris-Ouest Nanterre, IUF, EA 375 GECKO, UMR CNRS 8591, France*
[3]*National Technical University of Athens, Section of Mining Engineering, Zographou Campus, GR-15780 Athens, Greece*
[4]*Harokopio University, Department of Geography,* Athens, Greece

Across the Mediterranean Basin, the glacial-interglacial transition (15000-6000 cal. BP) 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. The study we are conducting as part of a PhD in geoarchaeology tries to better understand the response of the deltaic areas in northwestern Greece. Our study focuses on two specific areas: the delta formed by the Thyamis River (also called Kalamas R.), and the inlet between the island of Corfu and the mainland. The first was not yet investigated for palaeoenvironmental reconstructions. Likewise, archaeological research in the watershed is lacking. The second study area is of paramount importance to understand the impact of the post-glacial rebound on the prehistoric and archaeological maps: initial investigation indicates that this space was occupied by a lake that ceased to function around 10 000 BP. The paper presents preliminary results on the paleogeographic evolution of the delta Thyamis. In June 2009, combined measures of Electrical Resistivity Tomography (E.R.T.), seismic refraction and Ground Penetrating Radar (G.P.R.) profiles have established the thickness of the Holocene sedimentation: around/circa 15 meters at the upstream of the delta. To better understand the prehistoric and historical evolution of this space, a series of 15 cores was conducted in conjunction with the geophysical investigations. Preliminary results of sediment analyses and microfauna identifications allow us a first reconstruction of the delta that still needs to be dated. The results will be compared with against the existing data from Greece and Italy. We will also present the advantages of expanding this type of study across the lower valley of Thyamis.

Long-term soil erosion analysis on the terrace systems of the archaeological area of Axum (Ethiopia)

Ciampalini R. [1], **Billi P.** [2], **Follain S.** [1], **Le Bissonnais Y.** [1], **Ferrari G.** [3], **Borselli L.** [4]

[1]*UMR – LISAH, Laboratoire d'Étude des Interactions Sol-Agrosystème-Hydrosystème, INRA–IRD, SupAgro Montpellier, Bat. 24-2 place Viala-34060 Montpellier, France (ciampali@supagro.inra.fr)*
[2]*Dipartimento di Scienze della Terra, Università di Ferrara, Italy*
[3]*Dipartimento di Scienza del Suolo e Nutrizione della Pianta, Università di Firenze, Italy*
[4]*CNR-IRPI, Sesto Fiorentino, Italy*

Landscape evolution in agricultural contexts is primarily the result of soil redistribution processes. The analysis of such soil dynamics in archaeological areas is useful to account for the pattern and evolution in space and time of landscape structures. This study is focused on the area of Aksum (Tigray, northern Ethiopia), one of the most relevant archaeological site in East Africa, where the flourishing and decay of the Aksumite Kingdom (400y AC, 800y BC), took place. It provided favorable conditions for long term approach to the study of soil conservation techniques since they have been maintained from ancient times to present. The area surrounding the city of Aksum has been used since the antiquity for agricultural purposes and stone bounds terrace systems have been put into effect for soil conservation and water harvesting. Archaeological data allowed tracing the evolution pattern of such conservation practices since 4th century BC (Butzer, 1981; Fattovich, 1997). Terraces were and are ploughed by the "*maresha"*, an ard plough pulled by animals that is present in the Ethiopian culture since before the development of the Aksumite kingdom. The ard plough carves deep scratches on the upper face or on the sides of shallow buried and protruding field stones, respectively. By measuring the elevation of these plough marks above the present ground, Ciampalini *et al.* (2008) found that for the Aksum area the rates of soil loss are surprisingly low (2-4 Mg ha-1 y-1) in terraced crops, whereas their abandonment and/or land use changes causes a rapid increase of erosion, leading to severe land degradation up to 90 Mg ha^{1} y^{-1}. In the present study, three terrace systems have been surveyed and analysed in terms of soil loss across the last two millennia by physical and archaeological evidences. Tillage and water erosion has been evaluated by a long term expert-system model (Landsoil) (Ciampalini *et al.*, 2010) based on a raster distributed-approach taking into account the principal components in soil erosion-deposition processes. The results of model analysis, integrating tillage erosion, diffusive and concentrated erosion have been compared and calibrated with the plough marks technique (Ciampalini *et al.*, 2008), soil loss computing procedures such as the recalibrated PSIAC model for Ethiopian Highlands (Negussie *et al.*, 2005) and a re-parameterisation of P factor (USLE) for stone-bounds (Desta *et al.*, 2005) and experimental tillage transport coefficients for Ethiopian Highlands traditional cropping (Nyssen *et al.*, 2000). This analysis provides new values for tillage soil displacement and water erosion complying with data reported in the literature accounting for the relative influence of both mechanical (tillage) and hydrological processes, and confirms the high efficiency of these traditional soil conservation practices.

Modelling interactions and feedback mechanisms between land use change and landscape processes

Claessens L. [1,2], **Schoorl J.M.**[1], **Verburg P.H.**[1], **Geraedts L.**[1], **Veldkamp A.**[1]

[1]*Wageningen University, the Netherlands*
[2]*International Potato Center, Kenya*

Land use changes and landscape processes are interrelated and influenced by multiple bio-physical and socio-economic driving factors, resulting in a complex, multi-scale system. Consequently in landscapes with active surface processes such as erosion, land use changes should not be analyzed in isolation without accounting for both on-site and off-site effects on landscape processes. To investigate the interactions between land use, land use change and landscape processes, a case study for the Álora region in southern Spain is carried out, coupling a land use change model (CLUE) and a landscape process model simulating water and tillage erosion and sedimentation (LAPSUS). First, both models are run independently for a baseline scenario of land use change. Secondly, different feedbacks are added to the coupled model framework as 'interaction scenarios'. Firstly effects of land use change on landscape processes are introduced by means of a 'changed erodibility feedback'. Secondly effects of landscape processes on land use are introduced stepwise: (i) an 'observed erosion feedback' where reallocation of land use results from farmers' perception of erosion features, and (ii) a 'reduced productivity feedback' whereby changes in soil depth result in a land use relocation. Quantities and spatial patterns of both land use change and soil redistribution are compared with the baseline scenario to assess the cumulative effect of including each of the interaction mechanisms in the modelling framework. The results of this study provide insight into the interactions between different processes occurring within landscapes and the influence of feedbacks on the development of the landscape. The interaction between processes goes across various spatial and temporal scales, leading to difficulties in linked model representation and calibration and validation of the coupled modelling system.

Geology and tectonic setting of Dire Dawa (southern Afar, Ethiopia)

Coltorti M.[1], **Pizzi A.**[2], **Bekele Abebe**[3], **Disperati L.**[4-1], **Firuzabadì D.**[1], **Pomposo G.**[2], **Pontarelli L.**[2], **Sacchi G.**[1], **Salvini R.**[4]

[1]*University of Siena, Earth Sciences Department, Siena, Italy (coltorti@unisi.it)*
[2]*University of Chieti, Earth Sciences Department, Campus Universitario, Italy (pizzi@unich.it)*
[3]*University of Addis Ababa, Earth Sciences Department, Ethiopia (babebe@geol.aau.edu.et)*
[4]*University of Siena, Centre of GeoTechnologies, San Giovanni Valdarno (AR), Italy (disperati@unisi.it)*

During two field seasons in 2006 and 2007 we realized a geological map at the scale of 1: 50,000 scale of the Dire Dawa area (Ethiopia). The area is located at the border of the main escarpment separating the Somalian Plateau from the southern margin of the Afar. In order to map not easily accessible areas: 1) we integrated field data with aerial photos and satellite data; and 2) we distinguished only the main sedimentary/volcanic units bounded by major unconformities, as well as the pre-Cambrian metamorphic basement. A first sedimentary unit is made up by the Late Triassic sandstones (Adigrat Formation) whose thickness greatly changes locally. This formation is buried under the Upper Jurassic carbonate sequence (Antalo Group). This formation includes the Antalo Limestones, the Dire Dawa Limestones and Marls, the Daghani Shales and the Gildessa Limestones. The third unit is made up by the Early Cretaceous continental and transitional sandstones and conglomerates of the Amba Aradom Formation. Finally, a further unconformity preceded the emplacement of a thick sequence of flood basalt (Trap series) during the Oligocene associated with the intrusion of many doleritic dikes, sills, necks and laccolites. Sub-horizontal, 200-300 m thick layers of flood basalts are exposed only at the top of the plateau at an elevation of 3500 m asl, while they have been eroded in the rest of the area. The whole sedimentary sequence resting on the metamorphic basement is exposed in many location along the Rift escarpment, displaced by a series of closely spaced extensional faults mostly oriented ca. E-W. Faulted blocks are commonly tilted in counter slope up to 60° suggesting a domino-style rotation extension above a shallow crustal detachment. The occurrence of footwall anticline-hanging-wall syncline pairs, adjacent to many of the block-bounding and intra-block faults testifies to fault-propagation folding in an extensional regime. Kinematic indicators measured along the fault planes usually show a slight left-lateral component providing a ca. NNW-SSE direction of extension, most probably as a consequence of the propagation of the Aden rift toward the Afar. During a period of quiescence in the activity of the faults, most probably during a long lasting arid period of the Early-Middle Pleistocene, a pediplain was generated over 25-30 km in width. It connected the main escarpment to the Afar depression. It bevelled all the existing fault escarpments and its distal part was buried under the Afar Stratoid Basalts. The intermediate part of the pediplain, deprived of any younger deposit is now preserved on top of the faulted blocks. In a successive time some faults were reactivated cutting and tilting the remnants of the pediplain and allowing a distinction between pre and post-Afar Stratoid Basalts tectonics. Therefore, despite the common idea that this border is actually a passive margin, fault activity continued into the Mid-Pleistocene. The pediment was later deeply dissected by stream erosion that mostly run along pre-existing lines of weakness represented by the major faults. Inside the valleys the sedimentation is mostly represented by Late Pleistocene and Holocene alluvial sediments and Holocene calcareous tufa.

Geomorphology of the southern border of Afar in the Dire Dawa district (Ethiopia)

Coltorti M.[1], Pizzi A.[2], Bekele Abebe[3], Disperati L.[4-1], Firuzabadì D.[1], Pomposo G.[2], Sacchi G.[1], R. Salvini[4-1]

[1]*University of Siena, Earth Sciences Department, Siena, Italy (coltorti@unisi.it)*
[2]*University of Chieti, Earth Sciences Department, Campus Universitario, Italy (pizzi@unich.it)*
[3]*University of Addis Ababa, Earth Sciences Department, Ethiopia (babebe@geol.aau.edu.et)*
[4]*University of Siena, Centre of GeoTechnologies, San Giovanni Valdarno (AR), Italy (disperati@unisi.it)*

The geomorphology of the Dire Dawa area is representative of the processes that occurred after the continental break-up along the southern border of the Afar. We investigated the area during two field seasons in 2006 and 2007. The bedrock has been subdivided according to the main rock units that are separated by major unconformities. From the bottom upward we distinguished: (i) pre-Cambrian metamorphic basement; (ii) Late Triassic sandstones (Adigrat Formation); (iii) Upper Jurassic carbonate sequence (Antalo Group made by Limestones, Dire Dawa Limestones and Marls, Daghani Shales, Gildessa Limestones, Bosellini *et al.* 2001); (iv) Early Cretaceous continental and transitional sandstones and conglomerates (Amba Aradom Formation); (v) Oligocene Flood Basalts (Trap Series) with associated doleritic dikes, sills, necks and laccolites; and (vi) Early-Middle Pleistocene Afar flood basalts. The different subunits of the Late Jurassic Limestones are laterally discontinuous do not create major erosional contrasts. On the other hand, selective erosion is usually very effective on the Cretaceous shales, generating saddles and locally also large valleys. The geomorphology is conditioned by the occurrence of a closely spaced (2-3 km apart) staircase of faults mainly oriented in a E-W direction. However, many fault segments rotate and progressively turns to NE or NW subdividing obliquely the EW blocks. There are also some faults oriented approximately NNW-SSE but the occurrence of doleritic dikes along these lineaments indicate their pre-Oligocene age. The morphology of the plateau that occurs at the south-western border of the area is very flat. The later deepening of the valley network generated large mesas that testify to the previous continuation of the Trap series and the importance of erosion. A large pediplain developed during the Early-Middle Pleistocene before the emplacement of the Afar Flood Basalts. It bevelled the existing faults and allowed us to distinguish between pre and post-pediplanation fault activity. The older faults can be recognised mostly based on geological field evidence whilst the latter are associated with faults escarpments, usually with a reduced geomorphological downthrown in comparison with the geological displacement. Moving along the various faulted blocks, tilting up to 60° affected the sub horizontal sedimentary rocks of the plateau. Tilting up to 10° also affected the remnants of the pediplain confirming the continuation of the fault activity in the Middle Pleistocene. After pediplanation a general deepening of the valleys occurred. They are nowadays mostly parallel and normal to the orientation of the faults. The incision favoured selective erosion and the modelling of stepped slopes. A series of river captures is also documented during this recent downcutting. However, a greater process of river inversion occurred after the emplacement of the Oligocene flood basalts and the later onset of the fault activity. Initially the rivers drained to the south but when erosion was no more able to keep the rate of fault activity they were diverted to the north inside the rift. During the Late Pleistocene, after a period of pedimentation, coarse fluvial sediment were deposited inside the valley but they were largely removed during the river downcutting at the end of the Last Glaciation. During the Early Holocene the area was covered by a thick forest cover and almost every valley was affected by the deposition of calcareous tufa. This process ended diachronically and by the 6th millennia BP it was replaced firstly by deposition of sandy and gravelly sediments and later by a general incision.

The 1:200,000 scale geomorphological map of the Siena province (southern Tuscany, Italy)

Coltorti M., Firuzabadì D., Pieruccini P.

Department of Earth Sciences, University of Siena, Italy (coltorti@unisi.it, firuzabadi@unisi.it, pieruccini@unisi.it)

In the last few decades many detailed geomorphological mapping projects have been performed in different regions of Italy. However, the synthesis of the data might be somehow puzzling due to the complexity of the Italian geomorphological setting and therefore few 1:200,000 scale geomorphological maps have been published. The geomorphological map of Siena Province (exceeding 3500 km^2) has been obtained starting from a 1:25,000 scale geomorphological field and aerophotographical survey. The survey has been carried out following the legend proposed by the Italian National Geological Survey for the 1:50,000 scale geomorphological maps of Italy. The legend classify punctual, linear and polygonal landforms and related deposits according to the prevalent geomorphic process (in this case selective erosion, volcanic, superficial running water, gravity, karst, anthropic, polygenic) The original manuscripts have been digitalized in ESRI ArcGis© environment creating a database structured following the legend. In order to build up the Geomorphological map of the entire province we analysed the distribution and frequency of the landforms and their relations with the factors responsible for landscape modelling such as geology, morphology and land use. These data have been based on the Tuscany Region 1:10,000 scale geological map, a slope classification from a 20m DTM and the Corine Land Use Cover (1995). By the overlapping of these themes have been obtained the relationships between the various landscape elements. After the generalisation due to the scale t 7 main landscape units, some of them subdivided into landscape elements have been recognised. They are: (i) MOR - landscapes of the mountain ridges, steep mostly forested slopes, local deep seated gravitational movements: a) Chianti Ridge type area, sandstone bedrock, steep and locally stepped slopes, relatively dense drainage network, deep valleys and gorges; b) Cetona - Rapolano Ridge type area, calcareous bedrock, steep usually short slopes and summit planation surfaces, small catchments and low drainage network density; c) Montagnola Senese Ridge type area, metamorphic bedrock, steep slopes and summit planation surfaces, low drainage network density, deep valleys and gorges; (ii) PLB - landscapes of the Pliocene marine and transitional basins, gentle slopes, land use mostly arable and permanent crops: a) landscape of the sandy dominated bedrock, selective erosion dominant, stepped slopes, common rotational slides; b) landscape of the clay dominated bedrock, gentle sloping, severely denudated hills with badlands, strong soil erosion processes and widespread earth- and mudflows; (iii) KAL – karstic dominated landscapes, land use mostly arable and permanent crops: a) landscape of the travertines successions, almost flat surfaces bounded by stepped slopes or steep escarpments; b) landscape of the flat karstic depressions filled with reddish polygenic sediments; (iv) VOL – landscapes of the Monte Amiata volcanic relief, steep forested slopes of the past volcanic conduct, flat and gently dipping surfaces bounded by few steep escarpments in the front of the lava flows, local deep seated gravitational movements; (v) LIL – landscapes of Ligurian Units bedrock, steep to gentle slopes, mostly undulated and affected by a large number of gravitational movements, local deep seated gravitational movements; strong soil erosion processes, land use arable and permanent crops; (vi) VAL – landscapes of the arable valley bottoms: a) landscapes of the inner valleys, flat alluvial plains with entrenched active channel and hanging alluvial terraces b) landscape of the reclaimed Valdichiana, flat plain with artificial hanging channels network; and (vii) MIB – landscapes of the Miocene continental and marine basins (gravelly, sandy and clayey sediments), steep and stepped slopes, frequent landslides and strong soil erosion processes, land use mostly arable and permanent crops.

Geomorphologic Information Systems, why not?

Coltrinari L.[1], **Reis J. P. P.**[2]

[1]*Departamento de Geografia, Faculdade de Filosofia, Letras e Ciências Humanas - Universidade de São Paulo, São Paulo, Brazil (lylian@usp.br)*
[2]*Programa de Pós-Graduação em Geografia, Departamento de Geociências, Centro de Filosofia e Ciências Humanas – Universidade Federal de Santa Catarina, Florianópolis, Brazil (jppaiva.reis@gmail.com)*

Advances in computer systems, occurred in the last decades, have been increasing the amount and quality of geospatial information available to scientific research and, especially, to private/public management as this kind of information becomes more strategic for decision makers. Nowadays the knowledge about geographic information systems (GIS) is essential to many geoscientists and technicians like engineers, urban planners, etc. Geomorphologic mapping tools or modules have been incorporated in most GIS as the understanding of landscape dynamic is essential to regional and urban planning, environmental assessment, and agriculture and infra-structure projects. The main purpose of these geomorphologic mapping tools is the generation of cartographic information based on supposedly consolidated concepts derived from scientific research. In addition to other thematic maps (geologic, pedologic, land use, etc.) provided by GIS, geomorphologic maps are viewed as a part of the big picture of the area where it is working on. As other thematic mapping tools, geomorphologic mapping in GIS are built mainly by the integration of relational database over remote sensing imagery, involving complex statistical analysis and testing provided by geomathics. The most common features of geomorphologic mapping tools provided by GIS can be summarized as: i) wide range of work scale, from medium (1:250,000) to large (1:10,000 or more); ii) wide range and detailed morphometric information based on quantitative data related to geometric and/or measurable attributes of landforms and drainage network (slope inclination, channel length, etc.) calibrated by field survey, if possible; iii) qualitative data related to structure/geology, climatic conditions, soils, vegetation and land use, ordered in hierarchical series defined by the "weight" of each of these factors on erosive and/or depositional processes, adjusted by field conditions by surveying ; iv) surface modeling tools for 3D simulation (digital elevation models or digital terrain models) to allow different visualization of landforms, gaining additional information about geomorphic processes; v) cartographic tool for surface features representation and the correspondent legend for quick perception and understanding of the geomorphologic phenomena in the area expressed by the map, as final product or output. Usually, geomorphologic mapping provided by GIS emphasizes two aspects of geomorphologic research: morphometry, defined as the geometrical or measurable linear and areal attributes of landforms and morphodynamics defined as present-day geomorphic processes occurring in landscape and changes as a result of the interaction between different factors intervening in these processes (rock types, precipitation, soil sequences, vegetal cover, etc.). Compared with the first proposals presented mostly by European geomorphologists between the '50s and '70s, contemporary geomorphologic maps seem to be easier to read but poorer in information. Is it a symptom of evolution of geomorphology as knowledge field towards a more scientific standard or is it an excess of simplification which overrides the complexity of natural processes for practical purposes and fast answers to non-geomorphologists? In this paper the authors review concepts related to cartographic representation of geomorphic features and processes since the middle '50s until the late '70s in Europe -especially in humid tropical environments not considered by European geomorphologists, and suggest new approaches to issues concerning the development of geomorphologic information systems inside GIS.

Locational controls of landslides: where will the next one occur?

Crozier M. J.

Victoria University, Wellington, New Zealand (Michael.crozier@vuw.ac.nz)

This question of defining the effective locational controls of landslides is explored with reference to pre-conditions, preparatory factors, and triggering factors. These factors are defined and illustrated. It is argued that the validity of any answer depends on the scale of the area under consideration; whether of regional, catchment, or site dimensions. Observations suggest that at the regional scale, the spatial distribution of intensity of the triggering factor manifest during an event, whether climatic of seismic, is of primary importance in controlling landslide occurrence. At the catchment and site scale, pre-conditions and preparatory factors emerge as primary controls of location. However, at these scales, precedence becomes less reliable as a factor in determining future landslide susceptibility owing to time dependent changes brought about by the history of previous landsliding in an area. Time variable locational controls are particularly evident in the case of rainfall-triggered regolith failures. At the site scale, the location of deep-seated bedrock failures, on the other hand, is primarily controlled by rock structure and topography, with certain stratigraphic sequences, especially competent over incompetent rock, being particular susceptible to failure.

The part of human activity on volcanic valley dynamics and morphology: case study from block and sand mining, Gendol valley (Merapi volcano, Indonesia)

de Bélizal E., Lavigne F.

Université Paris 1, Panthéon-Sorbonne, UMR 8591 Laboratoire de Géographie Physique, CNRS (edouard.dbelizal@gmail.com)

Thousands of workers and hundreds of trucks come every day to Gendol valley to take block and sand from the thick volcanic deposits. Thus the valley is characterised by a high erosion rate, both natural, due to heavy rainfall generating volcanic debris flows (lahars), and also artificial. The aim of this poster is to show (1) different methods used to understand the part of the extractions in the morphology and dynamics of the valleys, and (2) the related assumptions which can be made. First, the valley bottom has been modelled at a very fine scale with a DEM and characterised with aerial photos, in order to characterise precisely the different micro-reliefs shaped by block and sand mining (artificial holes and levees). Second, volumes of taken materials have been estimated from field observations and with photo interpretation, and can be confronted with the total volume of the volcanic deposits, to estimate the artificial erosion rate. Third, these different measures allow to pose some hypotheses concerning the influence on the valley's dynamics: rainwater runoff and infiltration, lahars triggering, or rockfall increase on the valley slopes.

Highland peatland evolution in southern Brazil, since the late Pleistocene, as depicted by Radar Stratigraphy, Sedimentology and Palynology

de Oliveira M. A. T.[1], Porsani J. L.[2], de Lima G. L.[3], Jeske-Pieruschka V.[4], Behling H.[4]

[1]*Departamento de Geociências, Universidade Federal de Santa Catarina (UFSC), Brazil (maroliv@cfh.ufsc.br)*
[2]*Universidade Federal da Fronteira Sul (UFFS), Brazil (giselelima99@gmail.com)*
[3]*Departamento de Geofísica, Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo (USP) (porsani@iag.usp.br)*
[4]*Department of Palynology and Climate Dynamics, Albrecht-von-Haller Institute for Plant Sciences, Georg-August-University of Göttingen, Germany (vjeske@uni-goettingen.de; Hermann.Behling@bio-uni-goettingen.de)*

Despite their common use in Quaternary studies as sources of proxy data, peatlands evolve as stratigraphic units which deserve comprehension and classification on its own. Application of ground penetration radar (GPR) to peatlands had been made for several years in northern hemisphere, revealing varied stratigraphic settings and well established reflective patterns. We present results of surveys carried out on a highland peatland (860 m a.s.l.), at the Serra do Tabuleiro range, in the Santa Catarina state, Southern Brazil. Geophysical, sedimentological, palynological and geochronological data had been analyzed in order to test the potential of radar stratigraphy as a basis for the interpretation of peatland evolution and classification. GPR data were acquired by 400 MHz and 200 MHZ antennae (GSSI, Inc.). Data processing was performed by RADAN-6.5 and ReflexW-5.0.8 softwares, which enabled a processing sequence including migration and topographic correction. Relative permittivity ε_r was calculated as 61.43, while EM waves propagate at 0.038 m/ns in the study peatland. Radar stratigraphic analysis was performed by observation of reflection configuration and description of radar surfaces, packages and facies. Routine sedimentological analysis was performed to define proportions of sand/gravel and mud. A 165 cm long core of peat was sampled at 4 cm intervals, and material was processed by standard pollen analytical methods, using HF (78%) and acetolysis. Geochronological data was obtained by AMS radiocarbon analysis and by optically stimulated luminescence (OSL). Radar stratigraphy enables division of the mire deposits in four major stratigraphic zones, revealing a relatively complex local history of erosion and deposition since about OSL 64.5 ka BP and 14C 53.5 ka BP. Independent stratigraphic interpretation fits well with paleoenvironmental interpretation based upon palynology. For instance, the existence of shallow water ponds is advocated to explain radar reflections and sediments found at the base of the depositional set. Coincidently, the pollen record also indicates the presence of fern taxa commonly found in seasonally wet to aquatic habitats, since at least 39.4 ka BP, at the base of the sampled peat core. Instead of the random distribution of radar reflections commonly reported in applications of GPR analysis to peatlands, the study of mire enables subdivision of each stratigraphic zone in a number of radar facies, suggesting that materials had been reworked during the entire evolution of the mire, since the Late Pleistocene until historical times. This complex local history of erosion and deposition may be considered as a problem to account for in palynologic studies, as supposition of lentic environments is crucial for palynologic achievement. Based on the gathered evidence, classification of the study of mire points to a particular case of minerotrophic soligenous peatland, in what concerns its hydromorphologic evolution, as some areas of the peatland would better match to the raised bog type.

Geomorphological and geophysical procedures in neotectonics research at Vargem Do Braço River, southern Brazil

de Paiva Reis J. P., Ramos Tomazzoli E.

Programa de Pós-Graduação em Geografia – Departamento de Geociências – Centro de Filosofia e Ciências Humanas – Universidade Federal de Santa Catarina, Florianópolis, Brasil (jppaiva.reis@gmail.com)

High elevations bordering coastal plains in Southern Brazil are remnants of rifts developed by Gondwana break-up and the opening of South Atlantic Ocean during Cretaceous period. Nowadays it is a passive margin likewise eastern and south-eastern Brazilian coast. Despite many earthquake records in adjacent continental shelf, the onshore margin is thought as stable area that has been modelled by geomorphic processes related to climatic and sea-level changes along Cainozoic Era, especially in Pleistocene, as indicated by marine terraces near the coast and alluvial fans at the base of elevations. No previous report about neotectonic activity exists, but the strong relationship between topography, drainage and structure in geological-geomorphological surveying and mapping carried out in surrounding area (Santa Catarina Island) provided the first evidences of recent tectonic activity. The authors have been studying the Vargem do Braço river basin, east of Santa Catarina State, Southern Region in Brazil, which is located in the Florianopolis batholith, the inner domain of the Dom Feliciano Belt, a strike-slip shear zone developed during West-Gondwana continental collage. In this basin, the Florianópolis batholith is composed of Archean/Paleo-Proterozoic granite-gneiss (Aguas Mornas Complex), Middle Proterozoic phyllite and quartzite (Queçaba Formation/Brusque Metamorphic Complex), Neo-Proterozoic/Cambrian granites (Serra do Tabuleiro Granite) and Ordovician volcanics (Plutono-vulcanic Cambirela Suite); there are narrow and discontinuous floodplains with shallow sandy/gravel deposits of supposedly Holocene age. Faults and fractures control drainage network, even in floodplains. The authors have been using fluvial geomorphology and morphometric indices in search of recent reactivated faults. Drainage analysis based in satellite images and aerial photos besides morphometric indices calculated over data extracted from topographic map (scale 1:10,000) has revealed the existence of anomalies that could be ascribed to neotectonic movements in the area. Field survey along exposed floodplain deposits provided additional evidences. The most important evidences of recent tectonic movement in Vargem do Braço Basin are: river deflexions and captures, channel pattern changing, while abrupt discontinuities in sedimentary sequences at floodplains indicate that base level had been rapidly changed along Holocene. As no direct observation of faults in recent deposits was possible due to intense weathering in sedimentary sequences and dense vegetal cover at the river banks, the authors carried out geophysical surveys using ground penetrating radar (GPR) along profiles located according to structural and geomorphologic analysis. The results are shown in a poster.

Geomorphology of the coastal plain of São Paulo, Brazil: a dynamic equilibrium study

de Souto M. M. F., Ross J. L. S.

Geography Department of São Paulo´s University, Brazil (msmattos@usp.br; juraross@usp.br)

The principal aim of this research is to evaluate, using the Systems and Dynamic Equilibrium approaches, the geological and geomorphologic configurations and environmental fragility of the several topographic features in the coastal plains of Peruíbe-Itanhaém area, in central southern coast of the São Paulo State. These differences in the morphological configurations are results of the past geologic processes and the active geologic structures that controlled the resulting landscape forms. These behave as modeling agents and for maintenance of the dynamic equilibrium of these forms. The dynamic equilibrium by ecogeography principles of Tricart (1977) is maintained by the vegetal cover that prolong constantly the process of morphogenesis and pedogenesis for all the coastal plain that is mainly formed by thin to very thin sand particles, giving the region characteristic intensive fragility. The dynamic equilibrium on the geomorphologic models of Hack (1960, 1965) is maintained by the materials' resistance variation that composes the relief's forms. Both these examples help in the determination of the environmental fragility that is identified and represented, mainly by the variations of the resistance among the various geomorphologic compartments or subsystems mapped throughout the coastal plain. In some parts of the coastal plain, mainly in the south shore, where the kind of soil is Espodossoil presents level B espodic, which is hardened by the composition of the humic and fulvic acids, retained there by the podzolization process. In these places the resistance tests resulted in few or null impact penetration. The hardened level B espodic, regardless of its classification of the environmental fragility, showed direct interferences in the process of the changes on the topographic levels.

Evaluation and mapping of the volcanic hazards related to the ignimbritic eruption by AMS in mount Bambouto, west Cameroon

Dedzo M. G.[1], **Nono A.**[1], **Kamgang P.**[2], **Njonfang E.**[3], **Zangmo Tefogoum G.**[1], **Nédélec A.**[4]

[1]*LGE, Department of Earth Sciences, University of Dschang, B.P. 67 Dschang, Cameroon (merlinodedzo@yahoo.fr)*
[2]*Department of Earth Sciences, University of Yaoundé I, B.P. 812 Yaoundé, Cameroon*
[3]*Laboratoire de Géologie, Ecole Normale Supérieure, Université de Yaoundé I, B.P. 47, Yaoundé, Cameroon*
[4]*UMR5563-LMTG-OMP, University of Toulouse-CNRS-IRD, 14 Av. Edouard-Belin, 31400 Toulouse, France*

Mount Bambouto, characterized by an elliptic collapse caldera (8 x 13 km), constitutes the third largest volcano (in volume) of the Cameroon Volcanic Line (CVL) after Mounts Cameroon and Manengouba. This volcano is considered to be still active since the recent discovery of quaternary basalt (0.5 Ma) at Totap near the Bambouto caldera. The Bambouto volcano covers an area of about 500 km^2 with Mount Mélétan (2740 m) as its highest point. It is made up of volcanic products dated from 21.12 Ma to 0.5 Ma comprising basalts, trachytes, phonolites, rhyolite and ignimbrites locally covered with sedimentary and surface residual formations. Ignimbritic flow deposits which derived from pyroclastic density current are scarce and mainly observed in the central part of the CVL, especially in Mounts Bambouto (and in Mount Bamenda, its NE extension) covering approximately 20% (≈100 km^2) of the massif surface with thickness ranging from 30 to 120 m representing a total volume estimated at 10 km^3. The volume of these pyroclastic deposits is actually much larger because they are covered by generally lateritized basalts in the southern part of the massif. Their high aspect ratio (3.2×10^{-2} to 1.5×10^{-2}) characterized the concentrated flow which permits the moving of pyroclastic density current in contact with the soil making them potentially catastrophic. Soil fertility has fostered an important population growth (more than 450000 people) in this area. This population has agropastoral and economic activities within the caldera and on the flanks of the volcano estimated at about $US2.2 billion. In order to evaluate and map the volcanic hazards related to ignimbritic eruptions which are most disastrous in term of volcanic process in such region, anisotropy of magnetic susceptibility (AMS) has been used as a tool for the determination of flow directions in ancient ignimbritic deposits which are visually nearly isotropic in most outcrops. The AMS data reported from the Mounts Bambouto ignimbrites yield important information about the depositional system of the pyroclastic flow. In most stations, magnetic foliation planes (and sometimes magnetic lineations) consistently parallel downhill directions, commonly with an upslope imbrication. Flow directions interpreted from these data indicate distinct transport directions and deposition from pyroclastic gravity currents that traveled downhill. Magnetic fabrics obtained helped us bringing out palaeoflow pyroclastic density current and then connect discontinuous ignimbritic deposits to the Bambouto caldera which represent their source so as to have an idea of a nowdays ignimbritic eruption scenario.

Seasonal activity within Martian dune gullies

Diniega S.[1,2], **Bridges N.T.**[3], **Byrne S.**[2], **Dundas C.M.**[2], **Hansen C.J.**[4], **McEwen A.S.**[2]

[1]*Jet Propulsion Laboratory, Pasadena, CA (serina@math.arizona.edu)*
[2]*Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ*
[3]*Applied Physics Laboratory, John Hopkins University, Laurel, MD*
[4]*Planetary Science Institute, St. George, UT*

Martian slope gullies (composed of an alcove, channel, and apron) have been the focus of much controversy in recent years, as scientists seek to understand how they develop and what they imply about the martian environment. Formation theories have involved a wide range of environmental conditions and processes, such as groundwater eruption, the melting of snow or ice following climate change, or dry granular flow. However, a dearth of observations or information about the environmental setting of slope gully formation has made it difficult to evaluate among competing theories. In our studies, we focused on gullies found on Martian dunes. These features are primarily found in the mid-latitudes in the southern hemisphere and in the polar erg in the northern hemisphere. Using MOC, CTX, and HiRISE images, we identified dune gullies and tracked changes in gully appearance (such as alcove/channel widening and/or apron extension) within the last six Mars years. Based on comparisons between images, we constrained the times of definite morphologic changes as well as signatures of recent activity (albedo and textural signatures that were associated with recent apron deposition, and which faded soon after appearing and did not re-appear in subsequent years) and found that activity is tightly constrained to winter. This implies the existence of a seasonal control on current dune gully activity, such as CO_2 frost accumulation and sublimation. As this timing is consistent with activity seen within slope gullies, we hypothesize that CO_2 frost plays a role in general gully formation in the present Martian climate. Furthermore, recent HiRISE images show that fresh gully deposits are remobilized and form wind ripples [2]. The widespread nature of these rapid changes, and the pristine appearance of most dunes in the area, is consistent with active sand transport in Mars' current climate.

Flash flooding in northern France, Europe

Douvinet J.[1], **Delahaye D.**[2]

[1]*Equipe d'Avignon, UMR ESPACE 6012 CNRS, University of Avignon and Lands of Vaucluse, 74 rue Louis Pasteur, Case n° 17, Avignon Cedex 1 (johnny.douvinet@univ-avignon.fr)*
[2]*Geophen, UMR LETG 6554 CNRS – Université de Caen-Basse Normandie, Esplanade de la Paix, F-14032 Caen, France (daniel.delahaye@unicaen.fr)*

This poster presents characteristics of flash flooding occurring at the end of the spring or during summer on the plateaus of the Parisian Basin, in northern France (Europe). Classically named "muddy floods", such hydrological hazards present single features quite different from others. Even if they cause losses of life and significant damage on buildings and infrastructures, they still remain poorly documented and so we decide to precise geomorphic conditions by studying flash floods events i) at the local scale thanks to several systematic investigations on various catchments and ii) at the regional scale using a specific database recording 269 events on 189 catchments between 1983 and 2005. We focused on material and human damage but not on triggering factors that could explain their occurrence. Results highlight that rapid streamflows are characterized by sub-torrential dynamics, with high sediment contents and time-responses to high rainfalls (>50 mm in less than 15 h) of less than one hour. Most of the basins (<40 km²) are dry valleys where permanent flow does not normally exist during normal periods. Diffusive runoff rapidly shifts to concentrated runoff, generating some high-incised gullies over short distances. Erosive forms with a depth of several meters and a lateral extension exceeding 10 m are observed in compact loamy soils but the major incisions generally appear at the outlet of first or second order basins. The morphological component explains this paradox. Due to high-slopes and rapid steep sidedness, runoff energy compensates the low amount of water. Thalwegs of third or fourth order basins are therefore more adapted to evacuate important discharges (low slope, large channel). Consequently, they decrease the erosive capacity of streamflows. High specific discharges (ranging from 1 to 2 m^3 s^{-1} km^{-2}) and high specific stream powers (from 22 to 511 W/m²) are linked to major morphogenic impacts on these small-sized basins. During this communication, we also discuss the risk generated by flash floods on local human settlement. If events and damage are rarely observed on similar catchments, they are frequent on a regional scale as between eight and nine events are observed yearly in the studied areas.

Linking surface flow concentration and geomorphic forms in dry valleys: what kind of information the CA model RuiCells supports?

Douvinet J.[1], Delahaye D.[2], Langlois P.[3]

[1]Equipe d'Avignon, UMR ESPACE 6012 CNRS, University of Avignon and Lands of Vaucluse, 74 rue Louis Pasteur, Case n° 17, AVIGNON Cedex 1 (johnny.douvinet@univ-avignon.fr)
[2]Geophen, UMR LETG 6554 CNRS – University of Caen-Basse Normandie, Esplanade de la Paix, 14032 Caen cedex, France (daniel.delahaye@unicaen.fr)
[3]MTG, UMR IDEES 6266 CNRS – University of Rouen, Rue Thomas Becket, 76130 Mont Saint Aignan cedex, France (patrice.langlois@univ-rouen.fr)

Simulating potential surface flow concentration in dry valleys is needed i) to better assess the spatial dynamics of stream flows; ii) to improve knowledge in areas where permanent rivers do not exist; iii) to prevent the extent of probable flooding; iv) to help the risk managers to reduce soil erosion losses or damage and consequently, to cut off increasing erosive capacity of stream flows coming from the upstream parts. Many erosion models have been developed but our aim is to map the potential surface flow concentration in a simply and automatic way, linking topographic variables without implementing various parameters for realistic simulations. The cellular-automaton (CA) model RuiCells has been built using rules derived from the traditional concept of CA (Wolfram, 2005) and hydrologic rules (Tarboton, 1997). Results highlight that several points of concentration emerge at the outlets of basins presenting different morphologies. Similar efficiency is also observed at outlets whereas networks, slopes and basin forms change, indicating one non-dimensional "cauliflower" effect. Scientific and local expert advise that studied basins present in reality this efficient runoff concentration. Geomorphic forms are also linked in the analysis: high-incised gullies are well observed as high-slopes combined with weak-dissipative networks; as one evidence, specific stream power reveals to be the most important value at the basin scale. This approach can be used in a second time to anticipate exposed urban areas. Houses located near points of efficiency endanger the population and reduce its time to evacuate if high-rainfall intensities fall in the upstream parts. Experiences are finally carried out in other dry valleys, where hydrologic response and damage are not known before running the simulations. Generating maps in a few minutes, such approach gives satisfying results.

Aggradation/erosion of tufa and paleoclimatic implications: the Nera River dam at Triponzo (central Italy)

Dramis F.[1], **Fubelli G.**[1], **Mazzini I.**[2]

[1]*Department of Geological Science – "Roma Tre" University, Rome, Italy (dramis@uniroma3.it)*
[2]*IGAG-CNR, via Salaria km 29.3, C.P. 10 - 00016 Monterotondo Stazione, Rome, Italy*

Investigations made in different parts of the world indicate that significant aggradation of tufa (fresh water travertine) dams occurred during the warm stages of the Quaternary. In the Holocene, the deposition rates of tufa attained their maximum values in the early part of the period and generally declined in its late part. This last event was differently interpreted making reference to minor climate changes or to the impact of human activities. Considering that the deposition rates of tufa are essentially controlled by the concentration of organic CO_2 in the soil layers, it comes out that warm/wet climates with dense vegetation covers and well developed soils are more favourable to the aggradation of tufa dams. Conversely, forest degradation and soil erosion due to colder/drier climate conditions, and the consequent decrease of CO_2 in soils, cause a decrease of tufa deposition rates and the erosion of dams by streams. Comparable effects were produced in the Late Holocene by man-made forest clearing. An additional explanation for increasing/decreasing deposition rates of tufa makes reference to climate induced reverse thermal gradients in the limestone aquifers. Because of the extremely low thermal conductivity of rocks, differences of temperature up to several degrees between the surface and the underlying bedrock may be produced over timescales up to thousands of years, in relation to the rock mass depth: with climatic changes to warmer conditions, such as that occurred at the Pleistocene-Holocene transition, water percolating through progressively colder layers may become more and more enriched in dissolved $CaCO_3$. At the emergence, higher air temperatures, water turbulence and the activity of aquatic plants cause loss of CO_2 and travertine precipitation, even at significant distance from the spring. This process may continue for a long time until the ground thermal disturbance is exhausted. Significant details on the evolution of tufa deposition rates are provided by the Triponzo tufa dam, built up across Nera River at the confluence with the Corno River (Tiber River basin, Italy). Here, three main episodes of tufa dam aggradation gave rise to three orders of terraces. The highest terrace, on top of which the village of Triponzo lies, is located at 450 m a.s.l., 80 m above the present river bed, the second one at 420 m a.s.l., and the last one at 400 m a.s.l. The river catchments are part of a vast mountain area (Sibillini Mts.) with altitudes exceeding 2000 m a.s.l., mean annual air temperatures ranging between 14 °C and 5 °C, and annual rainfall ranging between 800 and 1500 mm. The bedrock is mostly composed of Mesozoic limestone and marls (Umbria-Marches succession). The dam has grown over a riverbed knickpoint caused by a lithology change from limestone to marls. The Corno River is fed by high discharge springs, flowing from the channel bottom upstream from the dam. The first episode of tufa aggradation seems to have occurred around 46000±5000 yrs BP ($Th/^{234}U$ - $^{234}U/^{238}U$), causing the formation of a vast dammed area with swampy backfill deposits, whose remnants are unfortunately very limited. This period of aggradation could correspond to a milder climatic interval characterized by several Dansgaard-Oeschger events inducing abrupt, increases of air temperature up to several degrees. The second episode started before 8240±175 ^{14}C yr BP (9470-9020 yr cal BP) giving rise to a more than 10 m thick swampy/lacustrine backfill. After around 5390±70 ^{14}C yr BP (5050-5310 yr cal BP) a 5-6 m sequence of alternating alluvial (sand and gravels) and swampy levels (silt, clay with scattered wooden fragments and leaves). These changes of sedimentary facies seem to indicate the occurrence of short lived alternating stages of dam incision/aggradation. At the base of the upper sequence, buried channels mark the end of the swampy-lacustrine environment. Around 2800±60 ^{14}C yr BP (2780-2960 yr cal BP), the river deeply cut the dam down to the present valley bottom. A brief interruption of the stream incision, due to a minor aggradation stage of the dam, likely occurred around 2500 yr BP as in other sites of Central Italy (Ricci Lucchi *et al.,* 2000), caused the formation of a the third terrace, hanging by 20 m above the modern river and largely topped with travertine sand. The paleoclimatic implications of this sequence of events are discussed with reference with the evolution of other tufa dams of the Mediterranean region and the rest of the world.

Hillslope and river responses to climate change – analyses from inland Australia

Dunkerley D.L.

School of Geography and Environmental Science, Clayton Campus, Monash University, Victoria, Australia 3800 (david.dunkerley@monash.edu)

Non-anthropogenic climatic change, spanning at least Tertiary, Quaternary and Holocene times, has left many imprints on the landscapes of the global drylands. Currently, anthropogenic climate change appears likely to drive additional landscape adjustments on decadal timescales. In general, climate change is superimposed on the current marked climatic variability seen in drylands, and this will complicate the identification and attribution of the impacts of climate change. It is desirable that landscape responses to climate change in the drylands be understood to permit the effects of human occupation (agriculture, pastoralism, mining, urban settlement) to be resolved and managed. A question that arises in this context is how the sensitivity of landscape features to climate change varies among the various hillslope and channel environments. Differing sensitivity or vulnerability may be reflected in several aspects of landform change, including the timing, magnitude, and rate of change. Conventional analytical frameworks, such as the analysis of thresholds and of complex response chains, may prove helpful. Additionally, however, there may well be components of landscape response that are distinctive of drylands, and which could usefully be distinguished from the changes expected in other climate zones. The rocky uplands of the Barrier Ranges in arid western New South Wales, Australia, seem likely to be resistant to changes in rainfall or temperature, even if reinforced by vegetation change, owing to the coarse rocky debris that mantles them. An increase in tunnel erosion and collapse, and hence in gully development, is however likely if storm period or annual rainfalls increase. This would increase the extent of channelisation of hillslope runoff. Gentle colluvial footslopes on the other hand appear highly vulnerable to sheet, rill and gully erosion if climate change brings greater rainfall variability or increase storm depth or intensity. Unlike the gullies on the rocky hillsides above, footslope rills and gullies could readily connect to, and form ephemeral extensions of, the stream channel system. Changes in the abundance and distribution of vegetation on footslopes will provide critical feedback links and may drive non-linear erosional responses to climatic change. In ephemeral stream channels, responses to climate change are likely to arise from direct effects (e.g. on the volume and timing of runoff, on the abundance of in-channel and riparian vegetation) and from 'knock-on' effects from the landscape responses of hillslopes in the catchment area. Conceptual analysis of these effects, supported by field analyses of some of the factors and processes that affect ephemeral channel form, suggest that stream channel response will be complex and non-linear. Inwashed silts and clays will affect transmission loss via the clogging of channel margin sediments; in turn this may reduce bed and bank recharge and so drive reductions in channel-associated vegetation, and so in coarse woody debris. In concert, processes such as these may lead to increases in flood discharge, flow speed, and stream power in the distal reaches of ephemeral channels, and so drive channel enlargement there. It is therefore possible that the changes in ephemeral streams caused by climate change will involve significant channel instability, with implications for riparian vegetation and habitat, as well as for fauna (and notably for avifauna). At landscape scale, the kinds of changes envisaged here seem likely to constitute an increase in the efficiency of channelised runoff connections between hillslope, footslope, and channel, with the consequence that there will be increased bypassing of surfaces that might currently carry unchannelised overland flow. Mosaic landscapes, including contour-aligned grove and intergrove structures, may exhibit reduced access to key resources (water, nutrients, organic matter, propagules) in the landscape, and so drive further non-linear responses to climate change. In light of the likely spatial and temporal complexity of landscape changes in drylands in coming decades, collection of baseline data is needed, in order to support efforts to understand their susceptibility to climate change, and the nature, direction, and rate of landscape responese.

Promoting the geomorphological heritage of the plain of Xanthos and Letoon (Turkey): issues, practices and problems

Ecochard E.[1], Fouache E.[2], Kuzucuoğlu C.[3], Carcaud N.[4], Ekmekçi M.[5], Ulusoy I.[6], Çiner A.[5], Cavalier L.[7] & des Courtils J.[7]

[1]*Paris – Est Créteil – Val de Marne University, UMR 8591 (France)*
[2]*Paris – Ouest – Nanterre University, UMR 8591, EA 375 Gecko (France)*
[3]*Laboratoire de géographie physique, CNRS UMR 8591 (France)*
[4]*Agrocampus Ouest, UP Paysage (France)*
[5]*Hacettepe University (Ankara, Turkey)*
[6]*Lund University (Sweden)*
[7]*Bordeaux 3 – Michel Montaigne University, UMR 5607 (France)*

Xanthos and Letoon, yet jointly included on the World Heritage List of UNESCO since 1988, could not be more opposed. The first is an ancient Lycian then Hellenistic city, located on a rocky promontory on the left bank of the river and at the apex of the delta of the river Xanthus in the south of Turkey. The second is a Hellenistic shrine, backed by only a small limestone island on the right bank of the river in the middle of the plain. Xanthos is out of reach of the river and slope dynamics; Letoon was built amid swamps and has struggled since Antiquity against gradual sinking under the alluvial deposits. To understand how the Lycians occupied this plain from the VIIth century BC and what kind of representations they attached on it, their relationship to their environment must be reconstructed. In such an unstable plain as the end plain of the river Xanthe, it is an important component of any archaeological understanding to highlight the differences between the environmental context in which the sites developed and its current appearance. The changing face of landscapes, even if it is only partially man-made, must be incorporated into the writing of history. Letoon and Xanthos are not only the subject of scholarly study: they also welcome visitors attracted by their cultural values. In this presentation, an attempt is made at promoting the geomorphological heritage of the plain of Xanthos. Educational panels are proposed for Letoon, which aim at introducing visitors to the history of the landscape of the plain. They present different studies (historical, archaeological, literary and geomorphological studies), each providing a specific point of view at different angles into the environmental history of the site. Together, they tell a comprehensive story of Letoon. The geomorphological approach, which is generally not given a lot of emphasis on archaeological site, plays the role of a connecting thread in this pedagogical effort of presentation of a geomorphosite. This communication concludes with developments on the issues and problems raised by the specificities of the object of pedagogical efforts, the intended public and the very characterisation as a geomorphosite.

Lacustrine morpholithogenesis on plains and foothills of the northern Caucasus

Efremov Y. V.

Chair of Geology and Geomorphology, Kuban University, Russia

Plain and foothill lakes were studied using a conceptual model of lacustrine morpholithogenesis (LMLG). This model takes in exam their initial stages, further changes, and the accumulation of mineral and organic substance within their basins. According to the LMLG model plains and foothill lakes show essential features, different from those of mountain lakes. Plains and foothills have insignificant relief energy and are characterised by weaker exogenic processes, lower accumulation rates and a complex combination of fluvial and coastal environments. The majority of lakes in the Northern Caucasus are located in the lower segments of the rivers Cuban, Terek, Sulak, Kuma and in the Manych Valley where fluvial and sea processes are interconnected. As a result of such interaction lagoons, limans, and relic reservoirs are formed. Depending on climate changes, the hydrological model, the intensity of modern processes, and the anthropogenic influence, these lakes increase (transgressive phase) or decrease (regressive phase) in sizes, change configuration, volume and quality of fresh water. Finally, these lakes are filled with deposits of various genesis, turning to bogs and dry plains. Land subsidence and soffusion processes lead to the formation of flat-bottom stepped depressions which, being filled with water, form ephemeral lake reservoirs. Thus, the LMLG model opens a way for a complex research approach to the flat and foothill lake systems, capable to explain the transformations occurring in their basins and to neutralize the negative consequences of human activity.

The importance of landuse and landcover changes in the Austrian Alps

Embleton-Hamann C.

Department of Geography and Regional Research, University of Vienna, Austria
(Christine.embleton-hamann@univie.ac.at)

The major direct drivers of environmental change in mountains are relief, hydroclimate and land use. These three drivers of change have an impact on geomorphic processes, on hazards and risks related to them and on biodiversity. One of the greatest challenges facing mountain scientists is to separate environmental change caused by human activities from change that would have occurred without human interference (i.e. relief and hydroclimate). In the Austrian Alps a central location on the European continent and long history of human occupancy have produced cumulative impacts. Good documentation of population density, land use, anthropogenic landscape change and handling of mountain hazards is available from medieval times onwards and can help in the assessment of the relative importance of human activity as a driver of environmental change. Landscape changes caused by typical forms of mountain land uses from AD 1100 until today will be discussed. These include forest depletion versus forest protection, agriculture, extractive industries and public utilities, dam construction, tourism and the establishing of natural reserves. Both negative and positive aspects of human impact on the environment in the Austrian Alps alternated in time and space, depending on population development, land use practices and technological advancements, with an overall positive trend characterizing the last two decades.

An upland farming system under transformation: proximate causes of land use change in Bela-Welleh catchment (Wag, northern Ethiopian highlands)

Getachew Eshetu[1], **Nurhussen Taha**[2], **Nyssen J.**[3]

[1]*Ethiopian society of soil science (ESSS), Addis Ababa, Ethiopia*
[2]*Department of Land Resources Management and Environmental Protection, Mekelle University, Ethiopia*
[3]*Ghent University, Department of Geography, Krijgslaan 281 (S8), B-9000 Gent, Belgium*

A possible way out of the 'low-level equilibrium trap' in the Ethiopian Highlands is agricultural intensification. To characterise and quantify current transformations in these permanent upland cultivation systems, a detailed study on land use changes and its proximate causes was carried out in the 41 km^2 Bela-Welleh catchment (2050–3682 m a.s.l.) in the Wag zone of Amhara Region, Northern Ethiopia. Land use maps were obtained through aerial photo interpretation (1965 and 1986) and detailed field mapping (2005–2006). Interpretation of topographic maps and field mapping gave knowledge of the spatial distribution of possible explanatory factors. Major land use changes are (1) a gradual abandonment of mountain agriculture which was replaced by woody vegetation (now covering 70% of the upper catchment) and (2) the widespread introduction of irrigation agriculture, wherever water is available (from 0% in 1982 to 5% of the catchment in 2006). Whereas both changes are favoured by government policies, they have now at least partially been taken up by the farming communities. The study demonstrates these land use changes and their influencing factors. Changes of crop- and rangeland into forest occur on the steeper slopes in higher topographical position. Changes from rain fed cropland into irrigated cropland (two harvests) depend obviously on the availability of water, but also on population density, and inversely on distance to Sekota town. We are here in presence of an almost classical example of the mutation of a ''permanent upland cultivation system'' into a system with irrigated agriculture.

Geomorphological approach to assess debris flow risk in the catchment of Alcamayo creek (Aguas Calientes, Cusco, Perù)

Falconi L.[1], Lentini A.[2], Leoni G.[3], Puglisi C.[1], Ramirez C.[4]

[1]ENEA - Italian national agency for new technologies, energy and sustainable economic development, Italy (luca.falconi@enea.it);
[2]GSF – Geology Without Borders, Italy; [3]Consultant geologist, Italy; [4]INC –National Institute of Cultural Heritage, Peru

A method to assess landslide risk has been applied in the area of the Aguas Calientes village, close to the historical site of Machupicchu (Cusco, Perù). The geographical location makes this village a strategic part of the Cusco touristic circuit and a key area for the entire Peruvian economy. Aguas Calientes (Machupicchu Pueblo, 1020 inhabitants in 2002, excluding the 2000 daily tourists) is located on an alluvial fan and is regularly hit by floods and debris flows (huaycos in Qechua, local tongue) coming from the creeks upstream (Aguas Calientes and Alcamayo). In consequence of the recent urban expansion, part of the structures and infrastructures of the village are placed in areas subject to high geomorphological hazard. Particularly the new worker neighbourhood (Barrio Orquidea) grew strictly close to the banks of the Alcamayo creek. In the recent past debris and mud flow phenomena affected this area producing eleven victims in April 2004 and severe damage in January 2010. Landslides hazard for the archaeological structures as well as for residents and visitors of the site was recognized by UNESCO, which in 2008 has threatened to expel Machupicchu from the list of World Heritage Sites, unless measures are taken to limit the potential damage. A study carried out into a capacity building project (FORGEO) was focused in localizing source and run-out areas of debris flows originated in the Alcamayo catchment and in evaluating their intensity. All the study starts from an inventory of several phenomena occurred in the area, an evaluation of their predisposing factors and an assessment of debris flow's triggering areas susceptibility leaded trough GIS elaboration. Alcamayo river basin is prone to recurrent debris flows, considering the high and steep slopes covered by thick tropical residual soil and intense rainfall that constitute the main triggering factor of this typology of landslides. Debris flow susceptibility is widespread throughout the basin and phenomena involve large volumes of debris material. Triggering of areas with high and very high susceptibility values allow the displaced material to reach the village of Aguas Calientes. Nevertheless smaller phenomena can dam the river of Alcamayo increasing effects in the village below. Different formulas, pertaining to different contexts from those of this study (Alps, Pyrenees), has been used to estimate the run-out distance. Application to the Alcamayo catchment showed that the Rickemann (1999) formula better approximates events that occurred in the past. Major run out susceptibility occurs where structures are placed in correspondence of present or old river beds, where the fan is topographically lower. In particular houses located in the morphological depression near the railroad station are in the higher risk areas (class 4). On this basis, hazard evaluation of Machupicchu Pueblo used in the current plan of civil defence, does not appear to take well into account the depressed areas between the river Aguas Calientes and Alcamayo creek. This study provides an example of quantitative assessment of the intensity of potential debris flows that can contribute to the definition of risk mitigation measures. Results can be a useful but not exhaustive tool for administrative authorities involved in natural risk management in Machupicchu area. Spatial susceptibility evaluation and intensity evaluation of potential events represent only two of the three components of landslides hazard. Temporal occurrence of phenomena through rainfall data analysis constitutes an indispensable step to reach to threshold identification. Territorial planning, strengthening of civil protection plans and designing of defence works, as river bank walls and dissipation areas, are indispensable measures to be taken for the safety of human beings, structures and infrastructures. Providing an assessment of landslide hazard and risk condition of the village, project outcomes can support local governments involved in land use planning policies and natural risk mitigation. On these bases, it seems necessary an updated protection plan of the village taking into account the run-out routes identified in this study but also based on rainfall thresholds linked with different levels of alert.

Morphology of the beaches of Cape Verde Archipelago

Florek W.[1], **Łęczyński L.**[2], **Majewski M.**[1]

[1]*Department of Geomorphology and Quaternary Geology, Pomeranian University in Słupsk, Partyzantów 27, PL-76-200, Słupsk, Poland (florekw@apsl.edu.pl; marekmajo@o2.pl)*
[2]*Institute of Oceanography, Gdańsk University, Marszałka Piłsudskiego 46, PL-81-378 Gdynia, Poland (ocell@univ.gda.pl)*

This poster presents the findings from morphological and structural research of several beaches located on some of the Cape Verde Islands. These beaches are composed of granulometrically and petrographically varied rocks, mostly originated from Mesozoic and Tertiary volcanites. They are also influenced by semidiurnal tides which reach a height of 0.5-1.5 m, by wave action and by steady trade winds which blow from the north-east. The beaches in question, in terms of their morphological and lithological features, can be classified as environments characterised by considerable energy of coastal processes.

Evolution of south Baltic Sea cliff near Ustka (Poland): natural and human impact

Florek W., Kaczmarzyk J., Majewski M.

Department of Geomorphology and Quaternary Geology, Pomeranian University in Słupsk, Partyzantów 27, 76-200, Słupsk, Poland (florekw@apsl.edu.pl; kaczmarz@go2.pl; marekmajo@o2.pl)

The aim of the research is to determine the rate of evolution of the cliff and beach in seasonal cycles and in the study period, taking into consideration the role of extreme hydrodynamic phenomena and hydrotechnical development. The basic method chosen by the authors to accomplish the research goals are geodetic measurements of selected cliff profiles, identification of the geological structure of cliffs, application of other forms of record (topographic charts, aerial photography, geodetic measurements performed by other authors) and analysis of meteorological and hydrological data. The research area includes the cliff and beach near Ustka, east and west of the mouth of the River Słupia. It has a diverse character, mainly cliff, abrasion type. The thickness of the Quaternary sediments ranges from about 120 m on the line of Lake Wicko sandbar, to 40 m in Ustka to over 130 m east of the mouth of the Łupawa River. The height of the cliff ranges from about 3-5 m in Ustka, 12-15 in the area of Orzechowo-Poddąbie, 25 m in Dębina to 4-5 m in Rowy. The whole base of the cliff (except for the mouth sections of the Słupia and Łupawa) is built of lodgement and flow tills and glaciolimnic sediments formed mainly in the Late Vistulian (after the Pomeranian phase). The lodgement till contains everywhere a considerable admixture of gravel-stone material, sometimes heavily weathered (especially crystalline schists). Numerous are fragments of Palaeozoic limestones, often with fauna. In the till there are visible joints, with a domination of vertical cracks. Above it there are Late Pleistocene limnic sediments and peats and the cliff is usually crowned by upper Holocene aeolian sands with fossil soils. On the surface of cohesive sediments (tills and Late Glacial and Holocene peats), numerous seepages and springs are formed, which is favourable for the occurrence of rockfalls and landslides. This stimulated the evolution of the cliff. A similar role is played by the presence of the breakwaters of the Ustka port. A comparison of cartographic and cadastral materials of the years 1862-1938 revealed that the shore east of Ustka retreated over that time by 150 m, thus at a rate of about 2 m/year; during the last 100 years the rate was about 1.6 m/year; east of Ustka it was 1.0-2.3 m/year, while near Dębina – 0.2-1.8 m/year). The performed measurements revealed that the rate of cliff retreat measured by the movement of their crown changes irregularly, similarly to the intensity of the abrasion process measured by the loss of rock mass in m^3 per linear metre of shore. The latter is bigger where the cliff is made to a greater degree of non-resistant aeolian sands (e.g. Ustka) or limnoglacial sands (Dębina) and where the cliff is simply higher. Exceptions include the sections where significant mass movements (landslides) have occurred recently, which isolate the cliff from the direct abrasion activity of waves. The measurements performed so far revealed that in the examined profiles: (i) the least destruction resistant part of the cliff is its crown, most often built of aeolian sands which easily undergo the process of coming off, especially in summer and with an active participation of holidaymakers. The material which comes off from the upper part of the cliff forms talus cones at its base; (ii) strong storms which occurred in late autumn 2004 and in seasons 2005/2006 and 2006/2007 led to an activation of the cliffs in nine out of ten investigated profiles, however the scope of the observed abrasion was much smaller than expected. The authors' observations indicate that abrasion processes and mass processes form a certain sequence, in which abrasion, connected with storms and high sea levels, leads to "steepening" of the cliff, whereas the role of slope processes (slumping, rockfall and sliding) is revealed in periods without storms and leads to "smoothing" of the cliff profile; (iii) the intensive development of the cliff east of Ustka is determined to a high degree by the presence of breakwaters of the port in Ustka; and (iv) after extreme storms, the phenomenon of beach build-up is observed in sections situated east of the intensively abraded sections.

Landslide hazards, settlements sites and development in the Nepal Himalayas

Fort M.[1], **Cossart E.**[2]

[1] *UMR PRODIG 8586, Université Paris-Diderot, Geography (case 7001) (fort@univ-paris-diderot.fr)*
[2]*UMR PRODIG 8586, Université Paris1-Sorbonne, 2 rue Valette, F-75005 Paris, France (Etienne.Cossart@univ-paris1.fr)*

Landsliding, either rainfall- or earthquake-triggered, is generally considered as the most active process contributing to the denudation history of active mountain ranges. This is particularly true in the Himalayas, where abundant literature reports many examples of landslides occurring at all spatial-temporal scales. Giant rock slope failures represent "formative events" that durably influence the general pattern of rivers and interfluves and constitute main components of Himalayan valley-fills. Medium scale, larger frequency landslides appear as a threat that may impact not only the (forested or not) mountainslopes, but also river valley bottoms, resulting in landslide dammed lake and outburst flooding. Recently, emphasis has been put on "small" size, very frequent landslides affecting the vicinity of major road network, a major threat interrupting traffic and hampering economic development. As a whole, landslides are thus considered as negative features reflecting the "fragility" of the Himalayas and appearing very harmful to the Himalayan populations. This statement cannot be denied, but should be discussed in the light of settlement patterns in these mountains. In fact, in Nepal Himalayas, the traditional village sites are most often located upon "old" landslide material. Despite hazards and induced risks generated by landslides, such locations were positively valued as they provide good opportunities for terracing and farming (gentler slopes, heterogeneous loose debris including soft and fine soils, chemical regeneration, water springs) and house building (quarrying of the largest blocks embedded in the colluvium). In addition, their elevation (≈ 2000 m) corresponds to the tropical-temperate transitional biotic belt, whereas their location at mid-slope, below rocky spurs and above deeply entrenched river thalwegs, also favoured the optimization of the design of old foot-trails linking villages and favouring exchanges of goods between different valleys. Conversely, the economic development of the last two decades is often considered as the cause of an upward trend in landslide occurrences, regardless of the geomorphic setting and "natural" causes of landslides such as monsoon rainfall and/or seismic triggering. Indeed, recent processes such as urbanization, land-use change (particularly in the foothills) and infrastructure development spread spatially without consideration of the potential dangers that may result from landslides and floods hazards, hence increasing the level and nature of vulnerability. In fact, "natural" landslides hazards, combined with demographic growth, make any new settlements and infrastructures much more vulnerable, economically and functionally, as shown by the increasing number of fatalities and economic losses recorded during the recent years. We illustrate this pattern by a few examples selected in the Central Nepal Himalaya.

The fault of Bam (southeastern Iran), regional water resources and human settlements from the Chalcolithic period to present times

Fouache E.[1], **Cosandey C.**[2], **Adle C.**[3] **& Coussot C.**[4]

[1]*Université de Paris Ouest Nanterre la Défense, Institut Universitaire de France, EA 375 et UMR 8591 (eric.g.fouache@wanadoo.fr)*
[2]*Laboratoire de Géographie Physique « Pierre Birot », UMR 8591 CNRS Paris 1, France*
[3]*Laboratoire des langues et civilisations à traditions orales, LACITO, CNRS UMR 7107, France*
[4]*INRAP, Laboratoire de Géographie Physique « Pierre Birot », UMR 8591 CNRS Paris 1, France*

Palaeoclimatic research carried out in the Near East (Kuzucuoglou & Marro, 2007) tends to underline that the climate gradually became more arid from 2500 BC onwards. Caution is required, though, if we want to extend the data to the southeast of the Iranian plateau. However, the archaeological and environmental research carried out in the region of Bam (South Eastern Iran) (Adle, 2006, Fouache *et al.*, 2009) has allowed reconstituting an evolution of the sites of human occupation and of water supply management that is coherent with the idea of an increasing aridification between 2500 and 1900 BC. In Bam, it appears that the decrease in rainfall led to the Neolithic-Chalcolithic and Bronze Age settlements being abandoned. The fault of Bam played a major role in the spatial redistribution of those sites along with their displacements. It is the major tectonic accident in the region and it is still active (Fattahi *et al.*, 2007). According to geologists, the scarp of Bam appeared around 10,000 BP (Talebian *et al.*, 2004). It caused a change in the surface runoff of the alluvial fan common to the wadis of Posht-e Rud and Chelekhnoeh. Prior to 10,000 BP, the alluvial cone was much wider than today. The fault scarp concentrated all the runoff on the northern arm of the Posht-e Rud river. The creation of the scarp connected to the fault of Bam also contributed to ease access to the watertable. The archaeological map resulting from prospections carried out by Chahryar Adle shows that the site of Bidârzin was settled along the Posht-e Rud on an alluvial terrace that was irrigated by gravity well upstream from the fault of Bam in the Chalcolithic (3627-3371 BC). The reverse of the fault scarp of Bam was then settled by men at least from the first millenium BC onwards, before the foot of the scarp was settled thanks to the development of a new irrigation system, the qânats. The reverse of the fault scarp is thus scattered with a large number of qanats whose access wells are clearly marked in the landscape and which all lead to the foot of the scarp. The older qânats are shorter and shallow, as they use the watertable that is trapped behind the fault of Bam, which played a considerable role as far as water supply is concerned.

Assessing gully headcut retreat rates in the semi-arid highlands of northern Ethiopia

Frankl A.[1], **Poesen J.**[2], **de Dapper M.**[1], **Deckers J.**[2], **Mitiku Haile**[3], **Nyssen J.**[1]

[1]*Department of Geography, Ghent University, B-9000 Ghent, Belgium (amaury.frankl@ugent.be)*
[2]*Department of Earth and Environmental Sciences, K.U.Leuven, B-3000 Leuven, Belgium*
[3]*Department of Land Resources Management and Environmental Protection, Mekelle University, Ethiopia*

In the semi-arid Highlands of North Ethiopia, dense gully and river networks dissect the landscape, with gully depth and width frequently exceeding 5 and 15 m respectively. The magnitude of gully erosion is caused by the topography of steep slopes, which are often depleted from vegetation, offering little resistance to the heavy storms which especially strike during August and early September. Gully erosion has been recognized as a serious problem for sustainable development in the Northern Ethiopian Highlands as it reduces agricultural production through soil loss and aridification, disconnects rural areas, and enhances landscape connectivity for runoff and sediment, causing flooding and water pollution by sediment in down stream areas. To counter soil erosion, soil and water conservation measures are being implemented at a catchment scale. Data on gully headcut retreat rates and changes therein is however non-existent for North Ethiopia. This paper presents gully headcut retreat rates over a period of 1 to 45 years. In the 3 km² large catchment of May Bati, 24 gully headcuts were monitored during the rainy season (July – September) of 2010. In order to understand the retreat rates, data were collected on topography (catchment area, slope gradient), climate (daily rainfall) and the environment (lithology, soil) and land use. In addition, gully headcut retreat rates over a period up to 45 years were assessed by identifying the location of headcuts on aerial photographs and on historical terrestrial photographs, and by localizing the previous and current (2010) position of the headcuts in the field. The results serve as input for testing several empirical models that predict headcut retreat rates based on findings from elsewhere in the world. The 2010 field observations show that many headcuts do not retreat further because of improved land management and that especially Vertisol areas are still prone to rapid gully headcut retreat as the occurrence of piping at the gully headcuts makes them difficult to manage.

GIS methodology to assess landslide susceptibility: application to the piedmont of the Sila Greca (Calabria, Italy)

Fubelli G.[1], **Leoni G.**[2], **Dramis F.**[1], **Puglisi C.**[3]

[1]*Department of Geological Sciences, "Roma Tre" University, Rome, Italy*
[2]*Consultant geologist*
[3]*ENEA R.C. Casaccia, Roma, Italy*

This paper illustrates a method for the assessment of landslide susceptibility, defined as the probability that a potentially disruptive event of a given intensity may occur in a given area. The method, based on several work experiences carried out in different parts of Italy, could be effectively employed in environmental planning of areas affected by landslides. The basic materials required to carry out the landslide hazard assessment procedure are: (i) a lithotechnical map of the area with particular reference to bedrock structure and covering materials; (ii) a detailed geomorphological mapping of the area; (iii) a detailed inventory of past events; (iv) a high resolution Digital Elevation Model. Predicting landslide triggering areas involves the following steps: (i) definition of discriminating parameter (detachment zone lithology and slope angle, conditions necessary but not sufficient to trigger a landslide of a given type); (ii) definition of predisposing factors (geological, geomorphological, geotechnical, hydrogeological and land use factors which contribute to induce landslide triggering); (iii) definition of Litho-Morphometric Units (LMU), by GIS techniques crossing discriminating parameters; (iv) definition of Homogeneous Territorial Units (HTU) by GIS intersecting of the LMU and the different predisposing factors for a given landslide type. The weights of predisposing factors, expressed by classes ranging from 0 to 9, are obtained by GIS comparing the distribution of past landslide with that of the different HTU; (v) application of the susceptibility function:

$$S_l = (p_l \times p_s) \times \frac{\sum_n (i_n \times w_n)}{\sum_n w_n}$$

where:
Sl = susceptibility to landslide (for each typology)
pl = index of discriminating parameter lithology
ps = index of discriminating parameter slope
in = index of predisposing factor n n^{th}
wn = weight of predisposing factor n n^{th}
Index (p) corresponds to the presence or absence of a parameter (its value is 0 or 1). It means that, only in case of joint occurrence of both parameter indexes (p), there can be susceptibility to landslides, as much high as higher are index (i) and weight (w). This methodology was applied to the piedmont of the Sila Greca, a 170 km^2 wide area, located in the north-eastern side of the Calabria Region (Southern Italy) at an altitude ranging between 200 and 1000 m a.s.l. The outcropping bedrock includes many lithological units (igneous, metamorphic and sedimentary rocks). Moreover, a census of several hundreds of landslides has been taken. Since the weight of the parameters changes with landslide typologies, eight different maps have been produced, showing the study area susceptibility to: rotational slides in bedrock; rotational slides in debris; translational slides in bedrock; translational slides in debris; earth flows in bedrock; earth flows in debris; debris flow; rock fall. The comprehensive map, obtained from the superposition of the previous ones, shows the study area susceptibility to all landslide types.

Rainstorm-triggered shallow landslides in an urban context: the case of S. Vito Romano (Rome, Italy)

Fubelli G.[1], **Ferrari M.**[2]

[1]*Department of Geological Science – Roma Tre University (fubelli@uniroma3.it)*
[2]*Consultant geologist – Unigeo s.r.l. - Via Idrovore della Magliana 147, 00148 Rome - Italy*

On May 21st 2008, after a period of heavy rainfall, 107 shallow landslides occurred on the eastern slope of the Prenestini Mts. (40 km east of Rome). Many buildings of San Vito Romano (3,500 inhabitants) and most of the surrounding main roads were heavily damaged. All the shallow landslides occurred between 6 and 11 a.m. The pluviometric record shows a total rainfall of 196 mm in the previous three days, and a peak of 72 mm during the above time interval. The study area is characterized by a monotonous outcropping lithology, made of alternating marls and sandstones, upper Tortonian in age. Geomorphological survey and borehole sampling from colluvial/eluvial and landslide heap materials allowed to recognize the predisposing factors of landslides. Fast moving landslides were triggered on steep slopes, where a significant thickness of unconsolidated cover material was present. The thickness (up to 18 m) and stratigraphy of cover materials (clay horizons are frequently present, above all in landslide heap) and their hydraulic conductivity played a decisive predisposing role while geotechnical properties, as recorded in laboratory, were quite uniform and seemed less relevant in discriminating landslide susceptibility. Field investigation allowed to recognize other apparent predisposing factors such as the occurrence of recently coppiced wooded areas (45 debris flows), wildfire raged wooded areas (12 debris flows), and road-cuttings (22 translational debris slides and 12 debris flows). In order to establish a relationship between landslide occurrence and the amount of rainfall, an inventory of all the landslides occurred in the area in the past 30 years has been carried out by field survey and archive investigation. Furthermore, a 30 year historical pluviometric record has been examined. The data analysis showed a strict relationship between rainfall intensity, duration, and the antecedent monthly rainfall. The 30 years data analysis showed that both intensity and duration of precipitation start to play a relevant role after a monthly rainfall of al least 200 mm has been previously recorded (87% cases). Given this threshold, bypassed 16 times in the examined period, the frequency of landslide occurrence appears to be related to the intensity of rainfall. This is clearly illustrated by the May 21st 2008 event when, following a long lasting period of heavy precipitation, a 72 mm/5 hour rainfall (never previously recorded in the last 30 years) triggered a very high number of landslides.

Uplifted marine terraces in Greece, their spatial distribution and morphotectonic implications, a synthesis

Gaki-Papanastassiou K.[1], **Karymbalis E.**[2], **Papanastassiou D.**[3]

[1]*Department of Geology and Geoenvironment, National University of Athens, Athens, Greece, (gaki@geol.uoa.gr)*
[2]*Department of Geography, Harokopio University, Athens, Greece. (karymbalis@hua.gr)*
[3]*Institute of Geodynamics, National Observatory of Athens, GR-11810 Athens, Greece, (d.papan@gein.noa.gr)*

Marine terraces are important landforms of coastal geomorphology. Given that they are the geological records of former sea levels, a steadily and rapidly rising coastline is the best land mark for measuring major long term sea-level fluctuations and tectonic uplift. Their study could provide important information in dating fault activity and measuring rates of recent crustal deformation, which are very critical in establishing earthquake recurrence intervals and resolving the earthquake potential and evaluating the seismic hazard and risk. Greece is located on southern edge of the Eurasian plate, where the African plate is subducting along the well known Hellenic arc. In this area, marine terraces exist in different places which can be separated in two main groups. Those located in gulfs that cut across the Greek mountain belt like the terraces in the southern coasts of the gulfs of Corinth and north Evoikos and those situated along several shores of the Hellenic arc like in southern Peloponnesus and in the islands of Cephalonia, Kythera, Crete, Karpathos and Rhodes. In both sets, the terraces consist mainly of Middle-Late Pleistocene uplifted wave-cut surfaces and thin depositional platforms which are carved mainly on pre-existing Mio-Pliocene marine sediments. However, in some places there are few terraces which have been carved on limestone surfaces. Nevertheless, the mechanism of the uplift is not uniform. The uplift mechanism in the gulfs of Corinth and north Evoikos is the existence of local normal faults, while along the Hellenic arc these are uplifted possibly due to the existence of the nearby subduction zone of the African plate below Eurasia. In this study an overall presentation of the occurrence of the marine terraces located in central and southern Greece is attempted and their distribution in space and time is discussed in order to understand the evolution of the area.

Geomorphological study of Cephalonia island, Ionian sea, western Greece

Gaki-Papanastassiou K.[1], **Karymbalis E.**[2], **Maroukian H.**[1], **Tsanakas K.**[1]

[1]*Department of Geology and Geoenvironment, National University of Athens, Athens, Greece (gaki@geol.uoa.gr, maroukian@geol.uoa.gr, ktsanakas@geol.uoa.gr)*
[2]*Department of Geography, Harokopio University, Athens, Greece (karymbalis@hua.gr)*

Cephalonia Island is located in the Ionian Sea (western Greece) in a particularly tectonically active area. The evolution of the island is depended mainly on the behavior of the Hellenic arc, which lies offshore just west of the island. Geodynamic processes in the region are related to the active subduction of the African lithosphere beneath the Eurasian plate, which progressively becomes continental convergence in north-western Greece. The transition occurs along the Cephalonia fault zone, a prominent dextral strike slip fault, located offshore west of Cephalonia Island. The present geomorphological study aims to the better understanding of the landscape evolution of Cephalonia Island during the Quaternary. The island is composed mainly of Mesozoic limestones with extensive outcrops of Neogene and Quaternary deposits in the south and southwestern parts. The general trend of the faults is mainly NW-SE with some secondary ones having NE-SW direction. The main mountain mass is Aenos (1630 m a.s.l.) occupying the central part of the island having a NW-SE direction. The principal water divide has the same direction with a well developed drainage system in the eastern part of the island where the two largest fifth order networks exist. A detailed geomorphological map of the island was performed with the use of aerial photos, topographical and geological maps at various scales utilizing GIS techniques. The island is intensely karstified with the presence of dolines, uvalas, poljes, sinkholes and caves. There are several planation surfaces ranging in elevation from 20 m up to 1000 m. Concerning the coastal geomorphology, about two thirds of the total coastline length of the island is characterized by steep slopes with the occurrence of a large number of pocket beaches. In general, gentler slopes are found in the southern part of the island, mainly on the Plio-Pleistocene formations. Moreover, in the southern part of the island several uplifted geomorphological features were mapped, including at least seven marine terraces ranging in elevation from 2m to 300m, marine notches, beachrocks and aeolianites.

Fluvial geomorphology and flood problems in the Brahmaputra valley

Gogoi B.

Tinsukia College, Assam, India (principaltinsukiacollege@rediffmail.com)

The Brahmaputra valley is a 750 km long E-W trending valley located in the extreme north eastern India. Along this valley the Brahmaputra River flows for 640 km with a low gradient, endowed with 103 main tributaries. The northern sector of the valley has very steep slopes as it crosses the highest mountain of the world, the Himalayas. Its profile shows a sudden break of slope like a hockey-stick that causes high speed water flow upstream of the nick point and later flush downvalley. The southern sector of the valley has a lower slope and is characterized by meandering river channels with low hillly headwaters supplying slow base flow and spill floods during excess rainfall periods. The rivers of the northern Brahmaputra valley are partially interconnected by branching and distributaries characterized by more or less straight channels. The northern side tributary rivers carry heavy sediment loads forming levees on the banks of the Brahmaputra and forcing it to turn westward. This causes high floods in the areas upstream of the bend. in In the northern valleys dry channels and sandy areas (*char*) are present which are replenished by flush floods during the rainy season. In marshy areas the valley becomes sluggish and frequent shifting of channels is common in the eastern part of the northern valley. The southern side tributaries are characterized by high bank erosion due to meandering. Palaeo-channels and ox-bow lakes are frequent. Flood is a common hazard occurring from historical time due to high rainfall in monsoon season and due to physio-geomorphology of the basin. Flood also occurs due to break monsoon, failure of dams and embankments, absence of embankments and avulsion of rivers channels. Flash floods occur especially in the northern bank valley, and in the south bank valley west of Guwahti. Spill floods occur in the broad south bank valley, east of Guwahati. It is a recurrent event that takes life and property of the valley every year. This situation results from the combined effect of hydro-meteorology, tectonic and anthropogenic causes; it has also distant relationship with the ENSO and the periodic variations of monsoons. For management, regional zonation is made as Northern Flash Flood Zone, Southern Flash Flood Zone west of Guwahati, Moderate Spill Flood Zone east of Guwahati, Active Flood Zone of the Brahmaputra and Flood Free Zone of hills and high lands. Mode of management may vary from zone to zone having of course, some common methods such as embankments, ring-bunds, inter-basin transfer, dams, drainage channeling, spurs, dykes, etc. All these methods are to be judiciously used. A good number of flood protection measures are taken in the valley by construction of embankments about 5000 km long, drainage channellings for about 1000 km, protection and anti-erosion works for more than 500 km, etc. But these are not sufficient as compared to the menace. Flood abatement and adjustment through traditional and modern techniques must be used and developed. Watershed management and disaster management system may be highly effective to flood menace.

The non-diamondiferous rocks occurring in the vicinity of the Mega diatreme (Sidamo, Ethiopia)

Goracci G.[1], Bonavia F.[2], Mottana A.[3]

[1]*Dipartimento di Scienze della Terra, Sapienza Universita' di Roma, Piazza A. Moro 5, 00186 Roma, Italy*
[2]Université Pierre et Marie Curie, Departement de Géotectonique, Paris, France
[3]*Dipartimento di Scienze Geologiche, Universita' Roma Tre, Largo S. Leonardo Murialdo 1, 00146 Roma, Italy (mottana@uniroma3.it)*

The Sidamo area around the North Kenyan Rift shows extensive outcrops of Precambrian metamorphic rocks overlain by Post-Miocene deposits consisting of mainly basalts and pyroclastic rocks with their sedimentary derivatives. The Precambrian basement and, to a lesser extent, the overlying rocks show evidence of NW- to NNW-extensional tectonics. The same orientation is shown by numerous volcanic vents spread all over, but mostly in the basaltic and pyroclastic cover. Moreover, the same orientation is shown by a few diatremes that pierce the area at random, the explosive products of which are to be found as xenoliths at great distance from the source. Most xenoliths are ultramafic in composition (spinel lherzolites, spinel harzburgites, spinel dunites, wherlites, clinopyroxenites), thus suggesting a possible derivation from Upper Mantle depths. Moreover, in the area surrounding Mega, where the largest diatreme (3 km diameter) crops out, a wide variety of metamorphic xenoliths (granulites, gneiss, amphibolites, pyriclasites) can be sampled. We studied 45 xenoliths sampled around Mega by a variety of methods: OM, PM, P-XRD, EMPA, structural and crystal chemical analysis: 23 of them are granulites of different type (alaskite, charnockite, granofels); 6 are gneiss, of clear derivation from granulite viz. pyriclasite; 10 are amphibolites, both pyroxene bearing and pyroxene-free; and 6 are pyriclasites. The main minerals are: K-feldspars (perthite and antiperthite), all showing a wide range of Na content and thermal re-equilibration, plus significant strain indices; plagioclases (oligoclase); amphiboles, all calcic, but with Fe/Mg variable thus ranging from actinolites to hornblendes (magnesio-, tschermakitic and hastingsitic-hornblende); pyroxenes, both orthorhombic (enstatite to hypersthene) and monoclinic (diopside to augite and pigeonite). Noteworthy is the presence of feldspar of nearly ternary composition. Accessory minerals are: apatites (fluoroapatite); micas (fluorophlogopite, biotite); ilmenite; hematite and magnetite (both very low in Ti and Cr). Geothermometry and geobarometry have been worked out by a series of intrinsic and extrinsic exchange relationships. The pyroxene geothermometer points out for three equilibrations at c. 1000, c. 630 and c. 450 °C (± 50 °C). The feldspar geothermometer indicates a final re-equilibration ranging from 590 to 360 °C (± 25 °C) that superimposes on an equilibration at c. 1000 °C still detectable at some points. The iron oxide geothermometer cannot be applied because it is well below the calibration temperature. Assuming 1000 and 600 °C as mean reference temperatures, the calculated pressures show two peaks at 20 and 9.7 Kbar, corresponding to 70 and 33 km depth. In the first range, nucleation and growth of diamond would be possible, but there is no evidence of it, nor has any graphite byproduct been detected. As a conclusion, the Mega diatreme appears to be sterile for diamond cultivation, in agreement with the general pattern of diamond distribution in kimberlite diatremes of East Africa, which has its northernmost boundary much to the South i.e., near Dodoma in Tanzania.

Environmental changes in Africa – past, present and future

Goudie A.

University of Oxford, UK

The environmental changes that have taken place in Africa can be considered in terms of their past occurrence, their current activity, and their future. The past climate changes include the initiation of desert conditions at various point since the Cretaceous, the existence of multiple pluvial and interpluvials within the Pleistocene, and the occurrence of some severe and abrupt changes in the Holocene. All of these changes have had a profound influence on the geomorphology of Africa, and particular attention is given to the history of sand seas and of lake basins. Africa is also experiencing climatic fluctuations at the present time, including some related to ENSO and other such periodicities. Finally, with global warming, the moisture conditions of Africa will be transformed with consequences for runoff, flooding, lake level changes, dust storm occurrence and dune mobility.

Hydro-geomorphological vulnerability mapping (central sector of the Romanian plain)

Grecu F., Zaharia L., Carcimaru E., Comanescu L., Dobre R., Ghită C., Ioana-Toroimac G.

University of Bucarest, Faculty of Geography - 1 Boulevard Nicolae Balcescu, Sect. 1, 010074 Bucarest, Romania (grecu@geo.unibuc.ro, lauracomanescu@yahoo.com, dobre@geo.unibuc.ro, zaharialil@yahoo.com, gabriela_toroimac@yahoo.com)

The river hydro-geomorphological dynamics represent a series of natural phenomena which can have negative socio-economics and ecological consequences. The vulnerability to these phenomena is the result of the synergetic actions of several factors, like the hydro-climatic (rainfalls, floods) and human ones. The human factors have a relatively passive influence and they depend on the geological and hydrogeological features of the river basin. This paper aims to analyse the main factors which determine the vulnerability of river dynamics in the Central Sector of the Romanian Plain, a wide sedimentary basin within the Carpathian-Balkan mountain arc. The study area relief includes a variety of landforms resulting from subaerial modeling mostly performed by allochtonous and autochthonous rivers on fluvial-lacustrine deposits. This modeling took place in distinct stages (since the Upper Pliocene and during the Quaternary) and led to the formation of several genetic types of plains (given the variety of deposits, neotectonics and hydrogeology). The most representative deep hydrogeological structures are the Lower Pleistocene deposits, represented by the *Candesti Layers* and the *Fratesti Layers.* The most important rainy hazards are reflected by the amount of precipitation recorded during 24, 48 and 72 hours. At Alexandria, the maximum amount of precipitation reached 110 mm within 24 hours, 121 mm within 48 hours and 129 mm within 72 hours. These values were recorded in July. In the same time, heavy floods occurred in the rivers recording large amounts of suspended sediments. Because of the gentle slopes, the floods affect not only the agricultural lands, but also the inhabited areas. The main example is represented by the meteorological and hydrological events of 2005, which, because of their magnitude, had relevant morphological and socio-economics impacts. In March, June, July, August and September 2005 five important floods occurred in the Vedea River, at Alexandria, with maximum discharges above the corresponding warning level (173 m^3/s). During the July flood, a discharge of 834 m^3/s was reached at Alexandria, much higher than the local danger level (460 m^3/s). This flood led to exceeding the maximum volumes of the reservoir dams, and the water overflowed the dams in an uncontrolled manner. Among other factors that favored the production and amplification of the floods in 2005, the lack of a proper regulation of dam use and deficiencies in the maintenance of dams and ditches should be mentioned. The map of vulnerability is based on GIS overlapping of other maps (morphometric, land use, surface deposits, geomorphological processes) as well as on some meteorological and hydrological data associated to the damages. The classes of vulnerability were established for the main hydrogeomorphological processes: suffosion, floods, and river dynamics (lateral erosion, meandering processes, collapse of the banks, river bed aggradation).

This work is integrated in the project *The hydrogeomorphological system in the geomorphometric and morphological modern theories. Applications for the hazards and risk diagnostics in the Romanian Plain*, 2009-2011 (project financed by C.N.C.S.I.S., codes 1954).

From geomorphological mapping to geomorphological map modeling: a new GIS based, object-oriented, multi-scale mapping system

Guida D.[1], **Dramis F.**[2], **Cestari A.**[3]

[1]*Department of Civil Engineering, University of Salerno, Italy*
[2]*Department of Geological Sciences, Roma Tre University, Rome, Italy*
[3]*CUGRI - Inter-University Consortium for Great Risk Prevision and Prevention, Naples-Salerno, Italy (acestari@unisa.it)*

An integrated, GIS-based, object-oriented, multi-scale geomorphological mapping system, capable to fulfill all of the practical needs of the modern society is here presented. The increasing variety of multi-purpose, applied land projects (geomorphology for land planning and risk mitigation, landscape ecology, hydrology, geoarchaeology, etc.) requires, in fact, a full representation of the spatial properties of landforms, reducing the use of symbols in favor of correctly bounded geometric elements (*full coverage mapping*). Moreover, the extremely wide range of landform sizes requires new mapping systems able to represent the same area at different space-temporal scales. Full coverage object-oriented mapping may be performed by progressive expert judgment-based inter-comparison between "traditional" field mapping and grid- or object-oriented analysis from automatic landform recognition. Object-oriented analysis, based on grid segmentation, allows partitioning DEMs or remotely sensed images into non-overlapping regions (segments), representative of geomorphic entities. Following the above principles, a new GIS-based, full coverage, object-oriented, multi-scale geomorphological mapping system (GmIS_UNISA) has been built-up at the Department of Civil Engineering of the Salerno University (Italy) and CUGRI (inter-University Consortium for Great Risk Prevision and Prevention, Salerno-Naples, Italy). The informative data structure of the different taxonomic levels is organized in terms of "*full-coverage, nested topologic objects*", as multilevel arc-node spatial data structure, supported by an analogous hierarchical attribute list. Levels 1 (*physiographic domain*), 2 (*physiographic region*) and 3 (*physiographic province*) correspond to distinctive land features, respectively significant at the continental, subcontinental and regional scales. Level 4 (*morphological system*) includes prominent landscape components such as plateaus, valleys, plains, and coastal belts. Level 5 (*morphological sub-system*) includes mid-size landscape components such as small ridges, hillslopes, valley floors, and piedmonts. Level 6 (*morphological pattern*) includes large compound landforms (e.g., alluvial terraces, glacial cirques, coastal cliffs, and talus belts). Levels 7, 8, and 9 are essentially based on detailed field survey and monitoring. The identification/delimitation criteria imply the definition of detailed landform topo-position, morphometry and morphogenetic consistency, acquired by automatic landform recognition from fine DEMs (10x10 m to 5x5 m) and the interpretation of large scale air photos. Level 7 (*landform complex*) includes mid-size landforms produced by single or multiple geomorphic processes (e.g. large river channels, coastal arcs, large compound landslides). Level 8 (*landform unit*) includes small landforms (e.g. alluvial terrace scarp, moraine arcs, mid-size landslides) or landform components (e.g. terrace scarp slide, coastal cliff notch, landslide scar). Level 9 (*landform element*) includes non-decomposable landforms with reference to the project purposes. Level 8 usually represents the starting point (*focal level*) for the production of lower-level maps by nested landform composition.

Detailed mapping of landslides in the Gállego glacial valley (Spanish Pyrenees) as a basis for hazard analysis and risk mitigation

Gutiérrez F.[1], Guerrero J.[1], Galve J. P.[1], Lucha P.[1], García-Ruiz J. M.[2], Bonachea J.[1], Carbonell D.[1]

[1]*Earth Sciences Department, University of Zaragoza, Zaragoza, Spain (fgutier@unizar.es)*
[2]*Pyrenean Institute of Ecology, CSIC, Zaragoza, Spain*

Cartographic landslide inventories constitute the basis for landslide hazard analysis and risk mitigation. The reliability of predictions on the future distribution of landslides and the effectiveness of mitigation measures depend largely in the completeness and accuracy of the available landslide databases. A significant proportion of the landslide damage is generally related to the activity or reactivation of pre-existing slope movements. Moreover, mapped landslides provide the clues for delineating the most susceptible areas for the occurrence of new slope failures. A 1:5,000 scale landslide map has been produced in the headwaters of the Gállego glacial Valley (Spanish Pyrenees) within the frame of the European-SUDOE project, "Development of methodologies aimed at monitoring ground movements for the sustainable management of the SUDOE territory". Colour 1:5.000 orthoimages were used for detailed field mapping (~19 working days) after conducting a preliminary geomorphological interpretation on 1:18:000 colour stereoscopic aerial photographs. The mapped sector, covering approximately 57.5 km^2, is located in the Axial Pyrenees. The bedrock is composed of Paleozoic sedimentary and igneous rocks affected by complex contractional structures resulting from the superposition of the Variscan and Alpine orogenies. Slate is the dominant lithology, underlying more than 80% of the mapped area. These highly fissile rocks, when affected by landslides, undergo a rapid reduction in strength (strain softening) and transform rheologically into a plastic soil. Major folds and thrusts show a prevailing S vergence and a WNW-ESE direction parallel to the trunk Gállego Valley. In the northern flank of this glacial trough the slates show a general dip into the slopes, whereas in the opposite wall the strata show a dominant dip towards the valley. The mapped landslides cover approximately 30% of the studied sector (17 km^2). Most of the percentage area affected by landslides corresponds to flow-dominated complex movements developed in slates (91% of the area affected by landslides; 15.5 km^2). These mass movements reach 2050 m in length and 1.5 km^2 in area. They typically form tongued-shaped bodies of highly brecciated slates that grade into translational or rotational slides in the upper part of the displaced mass. The toe and flanks of the flows are frequently affected by secondary failures induced by fluvial erosion caused by the Gállego River and lateral streams and probably also by the building up and oversteepening of the slide mass due to flow propagation. Most likely the initiation of these landslides was related to the retreat of the glaciers and the consequent debutressing of the oversteepened valley walls, underlain by slates with low rock mass strength. Although most of the large landslides may be several thousand years old, geomorphic evidence and damage reported on human structures indicate that a significant proportion of these mass movements are still active. Anthropogenic alterations, mainly excavation at the toe and overloading, have dramatically accelerated the activity of some landslides. Damage caused by landslides in the area include: (1) Deformation in a dam with one of the abutments built on a large landslide. (2) Displacement and damage on lift piles. A ski lift had to be abandoned, some lift piles require continuous corrections and an important ski lift built on an obvious landslide had to be relocated, causing temporary loss of serviceability, permanent reduction in its carrying capacity and financial losses in excess of 5 million euros. (3) Deformation of a bridge over the Gállego River, requiring its demolition. (4) Displacement with limited internal deformation in the main building of the ski resort. (5) Damage in a water pond built on a rotational landslide for artificial snowmaking. (6) Continuous deformation in several road stretches and in a parking lot built after removing the toe of a landslide. The cost of the correction measures applied in a stretch of the A-136 road, with limited success, amount more than 2 million euros. (7) Damage and partial abandonment of water services feeding hydropower plants. The data gathered through the construction of the cartographic landslide inventory will serve as the basis for: (1) Evaluating to which extent the high density of large landslides affect the quality of the geological maps, which obviate most of the mass movements. (2) Assess the cost-effectiveness of detailed geomorphological maps considering scenarios in which this type of information is incorporated in the planning and development process. (3) Analyse and interpret InSAR-derived ground deformation data that will be available in the near future. A major challenge will be to differentiate the contribution of deep-sated and shallow slope movements to the measured surface displacement (4) Develop and evaluate landslide susceptibility maps. (5) Investigate the geomorphic and stratigraphic evidence of the damming episodes caused by large landslides in the main drainages.

The Bolsa phenomenon: a conceptual model of its origin

Haubold F., Faust D.

Dresden University of Technology, Department of Geosciences, Institute of Geography, Chair of Physical Geography, 01062 Dresden, Germany (Dominik.Faust@tu-dresden.de)

Sea coasts as the transition zone between ocean and continent in different aspects represent important geomorphological components. Being home of nearly fifty percent of the world population they cannot be dismissed as insignificant. For this reason sea coasts are both living space as well as a crucial area of economy and trade. Furthermore coasts are regions of important habitats with a respective biodiversity. This particularly applies to the bolsas (see below) with their humus and nutrient-rich soils. Like any other geo-system the coastal region is not a static system but it changes constantly. In terms of the morphological consequences it leads to problems like the reasons or the driving forces, the vulnerability, the frequency, the amount etc. In this respect the so-called *bolsas* represent a perfect object for studies. The term *bolsa*, which comes from Spanish and originally means bag, here stands for a bag-shaped ocean bay and is more or less confined to Central America and the Caribbean. The seaward shore is typically formed by a raised coral reef with a narrow passage. These bottle-necked bays are at the same time mouth of small rivers draining the adjacent coastal area. Because of their relatively small outlet they are destined for a sediment trap. These so far not surveyed mostly fine-grained sediments are of particular interest. There is a wide range of factors that can cause sea-level changes. Raised beaches are not only the result of eustatic changes but isostatic or tectonic processes have also been taken in consideration. There is much evidence that for example uplifts occurred several times during the Quaternary in Cuba and in the Caribbean as well. The number of Quaternary reef terraces in East Cuba, which occur at heights of as much as tens of metres and are often accompanied by several notches, exceeds 15. Though both these processes are important in the Caribbean it leads to a specific problem closely linked with the reconstruction of tectonic uplifts, i.e. it is necessary to differentiate not only regionally but first of all regionally-chronologically. On the other hand these processes can boost each other or neutralize. Anyhow, it finally results in changes of the erosion-basis that on its part has morphodynamic consequences. Hopefully the sediments of the bolsas should keep records from tectonic uplift processes as well as from eustatic medium-term sea-level changes. We assume that the conditions of the sedimentation changed gradually in the course of a bolsa-cycle. Different conditions of the paleo-environment are possible: marine ones in the early stage of the bolsa-development, brackish to limnic ones in the transitional stages, and fluvial ones in times of low sea level and completely raised bolsa, respectively. The bolsas are located in East Cuba, in the province of Guantanamo, which at present is famous for its considerable climatic extremes. Whereas bolsas on the south coast and therefore on the leeward side of the Sierra Maestra mountain range are part of the driest region in Cuba, i.e. the precipitation is below 500 mm, those facing to the east are subject of an amount of precipitation of more than 2500 mm. Thus the bolsas are exposed to two different types of climate that may have also occurred during the paleo-climatic development. Based on an analysis of the bolsas' sediments the project aims at reconstructing the conditions of the paleo-environment. First tests gave us an optimistic view.

Landslide susceptibility assesment in Kilte Awulaelo woreda, Tigray region, Ethiopia

Solomon Hishe[1,2], Adalberto A.[1], Alfred T.[1]

[1]*29th Edition Master of Geomatics and Land resource evaluation students, Ministry of Foreign Affairs, Istituto Agronomic Per L'Oltremare, Firenze, Italy*
[2]*Department of Geography and Environmental Studies, Mekelle University, Ethiopia*

A landslide is defined as, the movement of a mass of rock, debris, or Earth's down a slope (Cruden, 1991). Landslides are a type of "mass wasting" which denotes any down slope movement of soil and rock under the direct influence of gravity. The term "landslide" encompasses events such as rock falls, topples, slides, spreads, and flows (Varnes, 1978). In many parts of the world, the major causes of landslide are related to the instability of slopes. In a single landslide trigger, one or more landslide causes can be identified like geological factors, morphological factors, physical factors and factors associated with the intervention of human activity or any combination of these factors. Therefore, reliable hazard and risk assessment of landslide would help to mitigate the consequences of such landslides. The determination and mapping of areas susceptible to landslides is practically fundamental for land-use management and risk reduction. In the frame work of this study, two methodologies have been used to assess the landslide susceptibility in the study area: Analytical Hierarchy Process (AHP) and Stability Index Mapping (SINMAP). The AHP methodology has been used for the study of susceptibility to landslide as a process of factors that condition it. To identify areas with landslide hazard, there are different factors that can be considered. In Kilte Awulaelo district, the susceptibility of landslide hazard derived from seven maps (slope, geology, vegetation, land use, erosion assessment, population density and drainage) which have been classified into five hazard classes: very low, low, moderate, high and very high using the AHP methodology and in to six classes from stable slope zone to defended using SINMAP methods. In the study area, nearly half of the areal extents of the landslides (42.57%) were classified as susceptible to land sliding ranging in high and very high classes. More over the recent landslide occurrence observed in the steep scarp area lies in the very high susceptible zone.

Extraordinary floods recorded by slackwater deposit during the 4200 a BP climatic event in the middle reaches of the Yellow River, China

Chunchang Huang, Xiaochun Zha, Yali Zhou

Department of Geography, Shaanxi Normal University, Xi'an, Shaanxi 710062, P.R. China (cchuang@snnu.edu.cn)

Palaeo-hydrological study was carried out in the Qishuihe River valley in the middle reach of the Yellow River. Several bedsets of flood slackwater deposit were identified in the Holocene loess-soil sequences on the riverbanks. They were differentiated from aeolian loess and soils by the parallel and waving beddings and the distinctive stratigraphic breaks separating individual palaeoflood events. Chronology of the flood events was established by OSL dating, checked by archaeological identification of the anthropogenic remains retrieved from the sequences. The results show that successive floods occurred between 4300–4000 a BP in association with the abrupt climatic event of 4200 a BP. These overbank floods had a riverbank settlement inundated repeatedly. Another series of extraordinary floods occurred between 3200–3000 a BP when monsoonal climate shifted from the mid-Holocene Climatic Optimum toward late Holocene dry conditions. The climatic event of 4200 a BP and the climatic decline at 3100 a BP were believed to be characterized by droughts previously. This work provides solid evidence that both severe droughts and extreme floods were parts of the climatic variability during abrupt climatic event and climatic decline in the semi-arid to sub-humid zones over the world.

Controls on wetland formation and geomorphic dynamics: the case of Wakkerstroom Vlei, Mpumalanga Province, South Africa

Joubert R., Ellery W.N.

Department of Environmental Science, Rhodes University, P.O. Box 94, Grahamstown, South Africa (rebeccajoub@gmail.com; f.ellery@ru.ac.za)

The formation and common occurrence of riparian wetlands within the semi-arid Highveld interior of South Africa, a landscape setting undergoing extensive long-term fluvial incision, is an enigma and the underlying controls on the formation and hydro-geomorphological dynamics of these wetlands has not been widely investigated. Wakkerstroom Vlei is one such enigma in that it is a large (~1000 ha) Highveld system comprising extensive reaches of unchanneled valley-bottom wetland with considerable (up to 2m deep) peat deposits. Accommodation space for wetland formation is thought to be controlled by the superimposition of the main (Wakkerstroom/Thaka) river upon an erosion-resistant Karoo dolerite sill at the toe of the system, which forms a stable local base-level along the rivers course. As a result, the river has carved broad (up to 1300m), gently sloping (average slope ~0.17%) valleys along softer shale valley reaches upstream of the dolerite barrier. Examination of the valley fill along these valley-bottom wetland reaches, together with analysis of historic aerial photography, reveals that continuous tracts of meandering river and floodplain wetlands formerly existed, and that the wetland experienced an abrupt shift to valley-bottom wetland conditions where surface flow of water is diffusive. Following the creation of accommodation space along the main river valley, lateral tributary streams began to deposit substantial amounts of course sediment into the main valley via alluvial fans. Several of these fans have coalesced to form multiple coalescing alluvial fan complexes that historically were able to extend far across the floodplain from either side of the valley, resulting in main river valley impoundment. This has promoted flood-out formation, along the main valley which, together with the denser growth of vegetation across the floodplain, has created conditions suitable for organic sedimentation and peat accumulation. The formation and evolution of Wakkerstroom Vlei has thus been controlled by the complex interaction between geological, geomorphological and biotic processes. Understanding the role of these factors in shaping both the short- and long-term hydro-geomorphic dynamics of the system is essential in implementing effective management and conservation strategies both within Wakkerstroom Vlei and other large valley-bottom wetlands within the South African Highveld interior.

Landslide hazards of Gangtok, Sikkim (India)

Kalita K.

Geography Department, Tinsukia College, Tinsukia 786125, Assam, India (kamaleshkalita@rediffmail.com)

Landslides are common and major natural disasters in highland ecosystem particularly in seismically active regions like Eastern Himalaya and often disrupt and damage the civic life and property. In fact, whenever the mountain slopes are steep, there is possibility of large disastrous landslides. It is a type of natural phenomena occurred mainly on the steep slopes of hills on mountains due to the gravity of saturated rock debris. The rapid movement of a mass of rock, debris or earth down a slope separated from stationery part of highlands produced disastrous effect on the natural environmental and man-made structures, weakens infrastructural facilities, makes people homeless and disrupts productive bases. Though landslides are local phenomena, the loss of life and properly due to its affect is particularly seen more in recent years. Landslide, mass movements and slope instability are common and serious geo-environmental problems and process in the Himalayas. Gangtok, the tiny capital of Sikkim state has been hit by different kinds of landslides in the last 30 years. Landslides of varied types, degree and intensity have always been damaging the life and property of the area, particularly in the rainy season. Study reveals that recent unplanned and haphazard developmental activities in and around Gangtok have been aggravating the landslides incidence to a disastrous and great extent. The micro-zonation approach or the hazard mapping is one of the most modern options towards the management and mitigation of landslides hazards of highland landscape. The disastrous affect of landslide study of Gangtok has been carried out using data for various geo-environmental parameters viz. lithology, slope, drainage, rainfall and forest. Landslide Susceptibility Index (LSI) also assigned for the purpose. Base on these parameters and their relationships, the hazard zonation map has been prepared to show the different kinds of hazards zones of the region. Study confirm that 54.27 % area of Gangtok falls under high hazard zone, and is always at the edge of high risk. It is important to note that Gangtok is lies on the high seismic belt of India, and the MBT (Main Boundary Faulty) has also passed near the region. At the end of the discussion researchers tries to give some appropriate applied time-bound solution of the problem.

Reconstruction of the environmental changes during the late Vistulian and Holocene (north-central Poland) using kettle-hole sediment analysis

Karasiewicz M. T., Hulisz P.

Institute of Geography, Nicolaus Copernicus University, Torun, Poland (mtkar@umk.pl, hulisz@umk.pl)

One of typical features of the young glacial landscape is occurrence of minor kettle-holes with internal catchments. Those holes are often described as sediment traps (sedimentation basins) and are mainly filled with sediments of biogenic, lacustrine or peaty origins. For detailed studies, three holes were selected that had similar morphological properties, located in the Central-North part of Poland, between the limits of Poznań (18.8 ka BP) and Pomeranian (16.2 ka BP after Kozarski, 1995) phases of Vistulian glaciation. Each site represents different morphogenetic type: site A (Popówka) – outwash plain, site B (Zbójenko) - drumlin field, and site C - in a kettle-hole located on the border of moraine plateau and outwash plain. The aim of the study was to analyse mineral and biogenic sedimentation in such small basins as well as to follow through temporary diversity of their deposition, using interdisciplinary research methods. Following analyses have been performed: palynological, plant macrofossils, elementary CHN, macro- and microelements (ICP-MS). Also, some layers of sediments were dated using the radiocarbon **(**^{14}C**)** method. The thickness of biogenic sediments in the study sites ranged between 5.9 and 7.1 m. Despite various genesis of studied kettle-holes, the general sedimentation pattern was similar. The basins under the study were filled with highmoor peat (thickness from 4.7 to 5.5 m) overlying gyttja (1-2 m). Estimations of the age of biogenic sedimentation beginning in all sites, according to radiocarbon method, go back to the late glacial period. The sedimentation might have begun first in site A, however ^{14}C dating seems old compared to palynological estimations (so called hard-water effect). In this site, the basal peat was found, which was formed on the dead ice block. No sediment of that type was observed in other sites. It might suggest that the sedimentation process after permafrost **was** disappearing**.** The next development stage of studied kettle-holes was a lake stage. After gradual overgrowing of the basin, the development of highmoor peat layers were formed. The transformation of a small lake into a peat bog took place in the Preboreal period, i.e. at the beginning of the Holocene. For the rest of the Holocene period, the peat sedentation followed continuously until the present. It reflected the occurrence of peat-formation plants, such as: *Sphagnum sp., Eriphorum vaginatum, Ledum palustre, Vaccinium uliginosum, and Oxycoccus palustris.* The palaeobotanical data have been confirmed by geochemical analysis**.** It was possible to distinguish a period of intensive catchment denudation and enrichment of the bottom sediments by macro- and microelements during the functioning of small lakes. The results concluded that the analysed sedimentation basins are relevant sites for climate change studies, from the inland deglaciation phase until the present day. Sedimentological records, using interdisciplinary methods, allow reconstructions of not only Holocene climate changes, but also the flora, water relations and denudation within the catchment area. Furthermore, it is possible to determine the times of human activity and effects of his management. The obtained data can also be used for the extrapolation to the environmental change studies in larger regions, e.g. early young glacial areas of Polish or Central European Lowlands.

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Geomorphic analysis of fan deltas and their contributing drainage basins along the southern coast of the Gulf of Corinth, central Greece

Karymbalis E.[1], **Gaki-Papanastassiou K.**[2], **Ferentinou M.**[1]

[1]*Department of Geography, Harokopio University, Athens, Greece (karymbalis@hua.gr)*
[2]*Department of Geology and Geoenvironment, National University of Athens, Athens, Greece*

This study deals with the morphometric analysis of twenty seven Late Holocene fan deltas formed by mountainous streams that deposit their sediment load along the southern coast of the Gulf of Corinth in Northern Peloponnese. The Gulf of Corinth is a major asymmetrical graben in Central Greece characterised by high levels of seismicity and rapid extension rates. The fan deltas of the western part of the study area are developed at the hanging wall of particularly active normal faults while those of the eastern coastline have evolved at the footwall of offshore active normal faults. Selected morphometric parameters of the drainage basins were measured using topographic maps at the scale of 1:50,000 while those of the fan deltas were derived from detailed topographic diagrams at the scale of 1:5,000 utilizing GIS techniques. The morphometric variables of the fans and corresponding drainage basins as well as longitudinal profiles of the main channels of the drainage networks were investigated and discussed. In order to determine the role of the fluvial sediment supply as well as the influence of debris flow processes for the evolution of the fan deltas the correlation between geomorphic features (mainly expressed by morphometric parameters) of the drainage basins and features of their fans was performed. Investigation of the clustering tendency of both qualitative data and morphometric variables of the fans and their basins, was attempted applying artificial neural networks which are computer based models inspired by the structure and behavior of biological neurons. The coupling of morphometric analysis and artificial intelligence methods revealed correlation relationship among these characteristics leading to conclusions about the predominant fan formation processes. On the basis of the primary processes the studied fans were classified into two types: Large stream basins have produced relatively extensive gently sloping fans dominated by fluvial processes while torrents with small rough drainage basins have formed steep debris-flow dominated fans. Differences between the eastern and the western fan delta – basin systems lead to the conclusion that the tectonic status of the area has affected the evolution and configuration of both fans and drainage basins. The morphology of the western fans is also influenced by secondary processes such as destabilization of fan deposits, coastal slumping, liquefactions and ground cracking due to earthquakes.

Geomorphological development of post-peat areas in the Polish Carpathian mts. over the last ca. 200 years

Lajczak A.

Faculty of Earth Sciences, University of Silesia, Poland

In Southern Poland within the Orava – Nowy Targ intramontane basin, located in the Western Carpathian Mts., raised peat bogs occur together with neighbouring valley bogs. These objects developed mainly on glacio-fluvial cones and over-flood terraces on a layer of permeable clay overlying gravels. Presently, the peat bog covered area takes over 60 km^2 in the basin and the domes take 28 km^2 which, with the index of 24% (11%) of peat in the area, exceeds the mean value for the Polish Carpathians and the whole territory of the country. The aim of the paper is to inform about the geomorphic effects of peat exploitation over the last ca. 200 years. The analysis of a vast literature shows that up to the '80s not much attention has been paid to this problem. Geomorphologic mapping of peat bogs, including the interpretation of recent air photographs, and the analysis of maps from the last 230 years allowed to examine the changes underwent during time by peat bogs. Due to the agricultural settlements, which began to occupy the area between the 13th and 16th centuries, the surface previously covered with a thin layer of peat started to shrink. Degradation of vast peat domes started at least by the end of the 18th century as a result of burning the deposit. Excavating fossilized tree trunks from the domes, scything peat plants and large scale excavation of peat for fertilization in the 19th century accelerated the degradation process. Exploitation of peat as fuel, begun in the second half of the 19th century and intensified in the years 1940-1990 (also due to implementation of industrial methods), contributed to accelerate the diminution of domes. The total area of peat bog domes diminished by 34% after 1894. The dominating method of peat exploitation leads to the retreat of the exploitation scarp and shrinking of the domes which, in a few places, take the form of thin remnants with marginal crevasses. At the same time, drainage works accelerate drying of wider and wider sectors of post peat areas and peripheral zones on the peat domes. Industrial exploitation of the peat deposit carried on three peat bogs led to forming vast dehydrated workings. In the next years, mainly due to discontinuous cleaning of drainage ditches, a process of re-naturalization of peat bogs started. Presently, the discussed peat bogs differ significantly among each other when we analyze the level of their morphologic and hydrologic transformation. Possible methods of the peat bogs preservation and re-naturalization are discussed.

Deltas development in dam-retained lakes in the Carpathian part of the Vistula River drainage basin, southern Poland

Lajczak A.

Faculty of Earth Sciences, University of Silesia, Poland

Delta growth rates in dam-retained lakes depend as much on the volume and grain size of the supplied sediment material, as on the lake`s capacity to permanently retain the sediment. The shape of deltas in these water bodies is influenced by the valley floor morphology and also by relationships between seasonal fluctuations in the lake`s water level and the annual river water and suspended and bed load supply pattern. The fastest growing deltas form in long and deep valley lakes featuring a slow water exchange cycle and large amounts of material, mainly suspended. Nearly all of the deltas considered in this study are of the low-energy type, as they mainly consist of sandy and dusty material. The role of gravel can only be expected to grow as the lakes are gradually filled in with deposits. There is a difference between deltas forming in lakes with high water level fluctuations and in lakes with a more stable water level with the former forming a longer, smoother longitudinal profile without a discrete boundary between the topset, foreset and the bottomset. Such a fuzzy boundary is caused by a cyclical shifting movement of a zone with the most intensive process of alternating deposition and erosion which occurs at the boundary of the permanently submerged and periodically exposed part of the delta. The study aims to explain the morphological development of deltas in dam-retained lakes of various size located on the Carpathian tributaries to the Vistula River, Southern Poland.

River training vs. flood exposure. Case study of the Nida River, Poland

Lajczak A.

Faculty of Earth Sciences, University of Silesia, Poland

River regulation leading to shortening their channel and drying the floodplain by ditches is assumed as the most controversial method of diminishing flood hazard. Many years` experience in this matter shows the results which are often contrary to the expected one. The paper summarises research into the geomorphological and hydrological effects of river training and improvement measures taken 50 years ago in the Nida River valley, left upland tributary to the Upper Vistula River, Southern Poland. Positive and negative effects were identified, the latter including an increased flood exposure in the study area. The study aimed to find a feasible solution that would mitigate the flood risk. The investigations were carried out basing on twenty years fieldwork, materials of National Hydrological Survey (years 1926-2008) and maps from the 18th–20th centuries. Prior to the training measures middle and lower stretches of the Nida River ran in an entirely meandering channel with a minimal gradient causing long-term stagnation of the floodwater in the floodplain, especially in spring. The training and melioration measures were aimed at mitigating the flood risk, accelerating flood water drainage and draining part of the marshy valley bottom that had been used solely as meadows and pastures. Vast wet marsh areas prone to cyclical channel avulsion were predominant along the anastomosing reaches. As the engineering project started in the upper river course and continued downstream, the channel reaches directly below the newly deepened reaches became shallower. The observations of regulation and melioration works in the Nida valley indicate many negative results of these activities, both in natural sphere and socio-economic one. Some of these results have an unintended character, as they had not been taken into consideration or even expected during the designing works. As a result, the main aim of the river regulation, i.e. decrease of flood hazard in the whole river course was not achieved. There is one way to effectively mitigate or at least to halt the increase of the flood risk in the middle and lower stretches of the Nida valley that would also be acceptable to the authorities of the local Landscape Parks. This is to revitalise the largest wet marsh area in the middle section of the valley. As soon as this area can resume its role as an effective retention zone for flood water and fluvial material (suspended material and bedload), the Nida channel shallowing process will stop and might possibly be replaced by downcutting, thus shortening the floodplain flooding in the future. The suggestion of possible revitalisation of the former swamps and wet meadows close to the longest anastomosing section of the river channel will give results expected by ecologists and hydrologists. If this task is successful, it will increase natural values of the existing ecological corridor located along the Nida valley.

Neogene-Quaternary relief development of a highly elevated monoclinal flysch range modelled by huge landslides: case study on the Babia Gora massif, western Carpathian mts. (Poland)

Lajczak A.

Faculty of Earth Sciences, University of Silesia, Poland

Babia Gora, the highest elevated massif in flysch Western Carpathians (1725 m a.s.l., on the border between Poland and Slovakia) represents a monoclinal asymmetric range of W-E run. It is 10 km long and elevation differences reach 1100 m. The upper part of the range is built of layers of resistant Magura sandstones inclined south, and its lower part is represented by considerably folded and less resistant Submagura layers. The slopes of Babia Gora are modelled by large-scale landslides, which result in their irregular recession. The shape of the landslide headwalls is closely connected with the run of faults and other fissures in the massif. The lower the headwalls are located, the closer they are connected with the run of fissures in the Submagura layers. The higher the headwalls are located, the more exactly they are connected with the run of fissures in thick layers of Magura sandstones. Considerably faster rate of slope recession is determined within the northern slope of cuesta type (the fastest in its central part) than in the southern slope, which is consistent with the dip of sediment layers. As a result, the run of the main range is zigzagged, closely related to main tectonic directions in the massif. In the northern slope, the headwalls of different age and different limit were determined. The older headwalls are larger, their slopes are more gently inclined, the edge is more gentle (i.e. rounded), and not much debris are left in their bottom. In contrast, younger headwalls are highly located within the slope, they are smaller, the run of their edge is closely connected with the directions of fissures in the massif (this is why there are sharp bends in the edge run), the headwall slopes are steeper, even rocky, and their bottom is covered by thick layer of debris. The location of the headwalls in the northern slope of the massif is connected with geomorphological horizons of different age dated in Western Carpathians as relicts which originated between upper Miocene and lower Pleistocene. This was the base to make an attempt to reconstruct the stages of development of the northern slope of the massif, including phases of valleys' deepening, their widening and development of planation surfaces. These processes were correlated with development of landslide headwalls differentiated in terms of their size and height of location within this slope. Such geomorphological analysis of the southern slope, which is concordant with the dip of sediment layers, is more difficult because of its much slower development. The size of vertical denudation of the massif within the northern and southern slopes was estimated, as well as the size of recession of both slopes since the upper Miocene. The sections of massif of differentiated age of main forms of the relief were determined, with special reference to the oldest elements of the relief, which preserved in the upper part of the southern slope. The results of the investigations are consistent with general knowledge on geomorphological development of Polish Carpathians. However, the results of investigations revealed much larger scale of changes in development of this massif in Neogene and Quaternary. The investigations showed also the preservation of relief relicts of different age, the development of which is closely related to the tectonics of the massif.

Geomorphologic estuarine characteristics regarding biodiversity conservation on south Brazilian coast

Lamour M. R.[1], **Domit C.**[1], **de Paula E. V.**[2]

[1]*Universidade Federal do Paraná – Centro de Estudos do Mar – Pontal do Paraná – CP 50.002 (mlamour@ufpr.br) (cadomit@gmail.com; eduardovedordepaula@yahoo.com.br)*
[2]*Universidade Federal do Paraná – Departamento de Geografia – Curitiba – CP 50.002 (eduardovedordepaula@yahoo.com.br)*

In modern sedimentary environments, such as the Paranaguá Estuarine Complex (PEC; 25°15'S/48°35'W), it is common that the estuarine circulation regulates the distribution of sediment grain size. Similarly, the local bathymetry tends to change in response to human interventions (land development, dredging, coastal protection, etc.). Modification on the estuary characteristics such as shape, topography and particle size distribution of the bottom may lead to changes in the availability and diversity of habitats for marine life. The edges of the PEC has protected areas rich in biodiversity that coexist with port activities developed in the municipalities of Paranaguá and Antonina, which requires effective environmental management plans. Understanding the mechanisms that regulate the dynamics of coastal ecosystems in their physical and biological dimensions is considered a prerequisite for the development of assessment tools, monitoring and management of these ecosystems. The sample design of works that include the distribution of wildlife and habitat analysis depends on the existence of thematic maps on the background characteristics of the region, which might help in choosing sites for the collection of specimens and correlation with distribution and abundance of marine species. This review describes the geomorphological and sedimentological variables around the PEC and makes associations with biological information. The field work consisted of collecting approximately 1000 samples of bottom sediments along the entire PEC, observation of activities developed by dolphins and the identification and quantification of feeding areas for sea turtles. Data were entered into a Geographic Information System in order to integrate information. The results so far show relevant information integrated management of coastal zone of Paraná State, emphasizing the development and application of methods of zoning and management of marine areas, translating complex information into simple indices, represented geographically. The results of physical characterization of the environment brought relevant information about the security for the passage of boats and ships, identifying shallow areas and submerged rocks. The study also detected areas of environmental sensitivity, as accidents related to the port area, showing areas with fine fractions of sediments, which add a higher concentration of chemical contaminants. The determination of sedimentation rates of navigable channels generated information relevant to the management of dredging in the E-W axis of the PEC. Determine the area of occurrence of fine sediment that are exposed at low tide also assist in the demarcation of areas of occurrence of sea grass banks, the main food resource of green turtles (*Chelonia mydas*). Geoprocessing products that were generated form the basis for the choice of research areas with the themes of fish ecology, mariculture, and the benthic fauna monitoring in the face of variations and environmental changes. These products can be used by local communities for navigation and selection of fishing areas, based on preference for different habitat by fish species.

Planation surfaces of South Africa and topographic levels of the Drakensberg

Lebedeva E.

Institute of Geography RAS, Moscow, Russia (Ekaterina.Lebedeva@gmail.com)

High plains with low- and medium-altitude mountains prevail in relief of South Africa. Well-preserved planation surfaces (PS's) are typical here because of the old age of African-Arabian platform and its southern part - Cape-Arabian shield, where no young orogenesis and high-amplitude small-block tectonic deformation took place. Active denudation and planation prevail here from the middle of Paleozoic, sedimentary rocks were transported from the shield and its surface became plain as a result. During periods of tectonic activity (which separated of periods of planation) when the territory went through tectonic deformations (as collapse of Gondwanaland, creation The Great Rift Valley and The Great Escarpment etc.) activity such as cutting of river valleys and dissection territory prevailed here. There are a lot of vast fragments of different-aged PS's in South Africa now: at least 5 exposed and also 3 exhumed PS's we can see in different regions of RSA, Namibia and Botswana. The fragments of these PS's hold different positions in the relief of the region, but primarily they represent undulating or subhorizontal watershed plains with single isolated mountain ridges, inselbergs and/or rock pillars. Old-aged outlook of watershed surfaces contrasts with young valleys that disturb their integrity. The peripheries of uplands are dissected by deep river valleys or dense network of erosion gullies, as a result the older PS's are here often exhumed (basins of Orange and Kuiseb rivers as examples). Peripheral areas of the highest mountains, e.g. the Drakensberg, have also perfectly visible topography due to close neighborhood of PS's of different ages and heights. The forming of stepped relief was caused by gradual mountain uplift during Mesozoic and Cenozoic periods. The main planation phases were identified by the age of exuviaes (F.Dixey) and of correlated deposits of the Indian Ocean shelf area (L. King). The global peneplain of Gondwanaland was created in Jura. In modern landscape of South Africa it persists in the form of flat-topped surfaces of the highest fragment of continental watershed and isolated mountains of the same height. In early – middle Cretaceous, after Gondwanaland collapsed, most uplift fragments of Jurassic PS fell under active dissection with broad flat bottommed valleys about 300m deep and more, i.e. Post-Gondwana pediments began to form. Highlands near the Drakensberg water divide represent one of the highest-uplift fragment of these PS. Elevation of the Jurassic Gondwana PS is about 3200-3300m there, the altitude of the Post-Gondwana planation is about 2600-2800m above sea level. Both of them are framed by young valleys 800-1000m deep. Satellite images show us that the relief of the Gondwana PS is not ideally flat, or concordant to widespread basalt lavas of Early Jurassic: undulating surface with low hills truncate horizontal basalt layers. The main Drakensberg watershed is asymmetric: the south-eastern slope (facing the Indian Ocean) is sharp, dissected with kar-alike catchment basins, and deep valleys with rapid bottom downfalls. Under the impact of different denudation agents, recession speed of this Drakensberg watershed escarpment achieves (as per L.King's calculations) 30.5cm per 100 years. Asymmetry of the ridge and proximity of the erosion base level of the seaside slope provided for more aggressive cutting of the rivers of the Indian Ocean basin. Traces of drainage network alteration can be seen in the highland near the watershed: head waters of the Atlantic Ocean basin rivers are being intercepted. All that leads to progressive displacement of the watershed in this area towards the Atlantic Ocean. The continentside slope has been drained by Orange river tributaries. The valleys of its head waters are flat, rivers have meandering course with sand spits, and swampy meander belt with small lakes - typical tundra. Here, on Jurassic peneplain surface, permafrost actions are active and modern leveling is going on under nivation. However, downstream flows are cutting PS deep, dissecting and destroying its fragments. The mountain periphery is represented by flat-topped ridges up to 1300-1400m high of the African PS (Late Cretaceous – Early Cenozoic) that stretch forward to the main watershed of the Drakensberg (to the piedmont of escarpment with Gondwana and Post-Gondwana PS's fragments) in the form of 1500-1600m high valley pediments along the river valleys of the Indian Ocean basin. The Post-African PS (Neogene) has been preserved in the form of undulating watersheds with top heights of 200-300m lower than those of the African once at the periphery of the Drakensberg, declining towards the shore of the Indian Ocean. At the end of Pliocene – Early Pleistocene active denudation (gully head cutting and pedimentation at first) at the periphery of the Drakensberg and other mountain ridges caused formation of the Quarternary subhorizontal plains. Now, the leveling continues at the most broad fragments of the PS's: inselbergs and rock pillars are destroying under physical and chemical weathering, desquamation, wind carving, gravitational processes and deflation. The highest uplifted fragments of Jurassic peneplain (more than 3000m above sea level) of the Drakensberg suffer nivation. The more active erosion takes place along the periphery of young uplifts and near escarpment separating PS's of different age.

Flood hazard and floodplain management

Lóczy D.

Department of Environmental Geography and Landscape Conservation, Institute of Environmental Sciences, University of Pécs, H-7624 Pécs, Ifjúság útja 6, Hungary (loczyd@gamma.ttk.pte.hu)

The concept of flood hazard has to be re-interpreted in Central Europe. Some decades ago flood hazard only denoted riverine floods, mostly along major rivers (like the Danube, the Elbe and the Oder). Flood control has always been a central task of water management policy in most countries. It is necessarily an internationally coordinated activity since part of river discharge (an overwhelming majority, ca. 95 per cent, in the case of Hungary) is collected by runoff from abroad. Novel solutions for the storage of floodwater (like emergency reservoirs) have to be found. Recent assessments allow to outline an even more diversified picture of flood hazard. Climate change is predicted to bring more frequent drought as well as irregulaties in the water regimes of rivers in Central Europe. Excess water hazard is found to occur over much larger areas than previously thought. Recently, strongly localized cloudbursts point to the increasing significance of flash floods in the region. As opposed to riverine flood and excess water hazard in lowlands, flash flood hazard primarily affects mountainous and hilly regions. In order to illustrate the spatial distributions of the three types of inundation hazard, they are presented by microregions on a map series. Recently, aspects of reducing excess water and flash flood hazard are gaining in importance within floodplain management (building and land-use regulation). As in the past, the adjustment of the population to inundation is required. Although the maintenance of flood-control dyke systems and probably the establishment of emergency reservoirs can alleviate riverine flood hazard, it is practically impossible to avoid inundations from excess water or flash floods induced by local cloudbursts, which may occur with an increased frequency in the future.

Geomorphological mapping of Saturn's moon Titan

Lopes R. M. C.[1], Peckyno R.[2], Stofan E. R.[3], Radebaugh J.[4], the Cassini RADAR Team

[1]*Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA.*
[2]*Oregon State University, Oregon, USA*
[3]*Proxemy Research, Bowie, Maryland, USA*
[4]*Department of Geological Sciences, Brigham Young University, Provo, UT 84602, USA*

Planetary surfaces are shaped by the interplay of endogenic (volcanism, tectonism) and exogenic (impact cratering, erosion and surficial) processes. Understanding the distribution and interplay of endogenic and exogenic processes on a planet is important for constraining models of the interior, surface-atmosphere interactions and climate evolution. Titan's atmosphere is the second densest in the Solar System and present day surface-atmosphere interactions make aeolian, fluvial, pluvial, and lacustrine processes important on a scale previously seen only on Earth. However, while the hydrological cycle operates on Earth, on Titan we see a methane cycle that is a major contributor to the formation of surface features such as lakes, seas, and rivers. We used data from the Cassini RADAR instrument to map the distribution and relative ages of terrains that allow us to determine the geological processes that have shaped Titan's surface. These SAR data cover about ~45% percent of the surface, at a spatial resolution ranging from 350 m to about >2 km. The data are distributed over a wide latitudinal and longitudinal range, enabling some conclusions to be drawn about the global distribution and significance of processes. They reveal a geologically complex surface that has been modified by all the major geologic processes seen on Earth. In terms of global areal distribution, both dunes and mountainous terrains cover more area (respectively 9.2% and 14.6% of the observed area) than other identified geologic units. In terms of latitudinal distribution, dunes and mountainous terrains are located mostly at low latitudes (less than 30 degrees), with no dunes being present above 60 degrees. Channels formed by fluvial activity are present at all latitudes, but lakes filled with liquid are found at high latitudes only (above 60 degrees). Impact structures are mostly located at low latitudes, with no confidently identified craters above 60 degrees latitude, possibly indicating that more resurfacing has occurred at higher latitudes. Putative cryovolcanic features, consisting mostly of flows, are not ubiquitous. We examine temporal relationships between units and conclude that aeolian and fluvial/pluvial/lacustrine processes – all products of the methane cycle – are the most recent, while tectonic processes that led to the formation of mountainous terrains and Xanadu are likely the most ancient.

Titan's lakes, dunes and wadis: an arid landscape shaped by methane weather

Lorenz R.

Johns Hopkins Applied Physics Laboratory, Laurel, MD 20723, USA. (Ralph.lorenz@jhuapl.edu)

Titan's surface, hidden for most of the space age, gave us an opportunity to test our understanding of how planetary landscapes are shaped. Titan, 5150km across, with a gravity of 1/7 that of Earth and a thick atmosphere (1.5 bar, 94K) should be an unfamiliar place, yet it turns out not to be. While some expectations have been borne out, others have not, and few scientists, if any, anticipated the dramatic variety of Titan's landscape with tectonic, impact and (possibly) volcanic features as well as widespread Aeolian and fluvial landforms and seas of liquid hydrocarbons. These latter three classes of features are the focus of this talk. A striking conclusion to emerge from Cassini observations, and in particular mapping with its synthetic aperture radar, is the predominance of latitude as a determinant of geomorphology. The massive sand seas are confined to an equatorial belt, while lakes are confined to the polar regions, with much more extensive liquid cover at the present day in the north (an imbalance that may evolve on ~50,000 yr timescales in an orbit-forced Croll-Milankovitch cycle). In many ways, Titan is to Earth's hydrological cycle what Venus is to Earth's greenhouse effect - a terrestrial phenomenon taken to an instructive extreme. The Earth's hydrological cycle is characterized by ~1m per year of precipitation and evaporation, with the atmosphere holding 1-2cm liquid equivalent of water vapor, with the result that our weather is characterized by rainstorms dropping a few cm of rain, every few weeks. On Titan, the cycle is driven by much weaker sunlight, with a global average of only ~1cm per Earth year of evaporation, but the atmosphere can hold several meters-worth of methane moisture. Thus Titan's atmosphere is an extreme in the direction in which Earth's climate may be presently evolving, with heavier storms separated by longer droughts - in Titan's case dropping meters of rainfall in a few hours, but occurring only at intervals of centuries. With such a cycle, we might expect to see a landscape like that of arid regions on Earth, cut by flowing liquids with canyons and wadis, but with liquid rarely actually flowing. Indeed, canyonlands and river channels are observed widely by Cassini, and the Huygens probe, which parachuted down to Titan's surface near the equator in 2005, observed channel networks and rounded cobbles. The north polar lakes include dozens of small karst-like depressions, some filled with liquid, some apparently not. Additionally there are three seas, with ria coastlines (flooded valleys) in many places. These are Ligeia, Punga and Kraken Mare (~400, ~500 and ~1000km across, respectively). The origin of the basins in which these seas sit is unknown. The most prominent lake in the south is Ontario Lacus, about 240km long, but apparently very shallow and drying up at ~1m/yr. In contrast to the damp poles, the equatorial regions of Titan appear predominantly dry (because Titan rotates slowly, its Hadley circulation desiccates the equator, rather than two mid latitude belts as on Earth). Much of the terrain between latitudes of +/-30 degrees is covered in fields of giant (~km wide, tens to hundreds of km long, and often >100m high) dunes, presumably made of organic - probably photochemically-produced - material. These are predominantly of linear (longitudinal) form and appear to be shaped by unusual strong (>1m/s) westerly winds near equinox, and appear to be spaced by ~3km, likely determined by the thickness of the atmospheric boundary layer. Remarkably for a world so distant, the physical processes shaping much of Titan's surface have a striking resemblance to those shaping Earth today, albeit at different rates and with different materials. Thus we can learn much about what we see (unclearly) with Cassini's instrumentation by studying terrestrial analogs, of which there are many (e.g. Namib and Sahara dunes, river channels and lakes of many sorts).

Land cover resilience and environmental changes during the last 3000 yrs in northern Ethiopia: phytolithic and palaeosols evidences

Machado M. J.[1], **Pérez-González A.**[2]

[1]*Environmental Sciences Centre – Spanish National Research Council (CSIC), Calle Serrano 115 bis, 28006 Madrid, Spain (machado@ccma.csic.es)*
[2]*National Research Centre on Human Evolution (CENIEH), Paseo Sierra de Atapuerca s/n, 09002 Burgos, Spain*

This study aims to contribute to the study of the late Holocene terrestrial record of climate fluctuations in Northern Ethiopia, after the analysis of phytolithic content of a well preserved infilled valley sediment record, during the last three millennia. The processed samples (32) correlate to the upper 13 units of a stratigraphic record published previously and that covers a 4500 yrs period. The earlier sedimentological, stratigraphic and geochronological analysis of this continuous record, enclosed in several infilled valley profiles in the Axum-Adwa area, enabled the identification of three main wet periods and two major degradation ones, in the area, correlating in time with similar major changes at a regional scale (Ethiopia, Sudan, Arabia Peninsula). Fifty silica phytolith morphotypes were identified and categorized into eight categories and named after the International Code for Phytolith Nomenclature. All the samples contained well-preserved phytoliths and their stratigraphic distribution indicates a major abundance both in number and of morphotypes in the lower stratigraphic units, with a sharp change towards the end of the stratigraphic record (ca. XVI AD). The analysis of their type, frequency and assemblages, together with the use of proxy data regarding the charcoal abundance in sediments and the $\delta^{13}C$ on soil organic content, enable the identification of three Phyto-Climatic Zones, at this Northern Ethiopia area: Zone I (ca II millennia b.C. – XI AD), Zone II (XI/XII AD – XVI AD) and Zone III (XVII AD- present). In general terms only Phyto-Climatic Zone I shows a major presence of C3 photosyntethic plants pathway, and includes 3 periods of arboreal expansion episodes. The onset of the Phyto-Climatic Zone II is triggered by an aridity episode that, together with a clear increase on the anthropic signal, that sets a change on previous soil/vegetation system resilience.

Geohydrodynamics and sedimentation in the Kosi river basin (Himalaya)

Mahato R. K., Jitendra S.

Department of Geography, Ranchi University, Ranchi, Jharkhand, India (mahtolu@gmail.com)

The Kosi River runs off through Nepal, China and India. In the upper part of the course this river passes some glacial effect from just east direction of Mt. Everest, where the average height is around 6000 m a.s.l. All hydrological property acts as glacial impact at concerned coordinate. Owing to the great amount of soil erosion and landslides in its upper catchment area, it makes possible to carry further; therefore, the Kosi has a sediment yield of about 19 m^3/ha/year, one of the highest in the world. The Arun, with its origins in Tibet, brings the greatest amount of coarse silt in proportion to its total sediment load. The river is able to transport its heavy sediment load down the steep gradients and narrow gorges in the mountains and foot hills, but on the plains beyond Chatra where slopes are flatter, the sediment load is deposited in an immense alluvial fan that has grown to an about 15000 km^2 . It enters in Bihar (India) near Birpur and deposits the carrying sediments therefore it creates world's extensive alluvial tract. Over the last 250 year, the Kosi has shifted its course over 120 kms from east to west and the unstable nature of the river is attributed to the heavy silt which it carries during the monsoon season; previous year river again reform their old path. This fan extends some 180 km from its apex where it leaves the foothills. Instead of a single well-defined channel, the river has numerous interlacing channels that shift laterally over the fan from time to time. Without sufficient channelization, floods spread out vary widely, which has become a general phenomenon in every year. The record flow of 24,200 m3/s is equivalent to water a meter deep and more than 24 km wide flowing down the slight slope of the alluvial fan at 1 m/s. Therefore many landforms form due to this huge sedimentation processes. Amount of carrying sediment from upper course and deposited sediments in lower portion in the basin can be calculated through quantitative modelling.

Role of geological and hydrological factors in the development of spring mires in the Parsęta River catchment (northern Poland)

Mazurek M.[1], **Dobrowolski R.**[2], **Osadowski Z.**[3]

[1]*Institute of Geoecology and Geoinformation, Adam Mickiewicz University, Dziegielowa 27, PL-61-680 Poznan, Poland (gmazurek@amu.edu.pl)*
[2]*Institute of Earth Sciences, Maria Curie-Sklodowska University, Krasnicka 2 CD, PL-20-718 Lublin, Poland (rdobro@poczta.umcs.lublin.pl)*
[3]*Department of Botany and Genetics, Pomeranian Academy, Arciszewskiego 22B, PL-76-200 Slupsk, Poland (osadowsk@sl.onet.pl)*

Spring mires belong to a rare group of geoecosystems that are supplied with groundwater (soligenous fens) and are characterised by a specific type of lithological development, i.e. peats alternating with calcerous tufas. Whereas, in the context of the great usefulness of tufa and peat series from such objects for palaeoclimatic and palaeohydrological reconstructions, which have been emphasized in the recent years, definition of the geological and hydrological conditions of their functioning seems to be the key to further palaeoenvironmental interpretations. Spring mires classified among the low soligenic mires cover small areas; their total presence in Poland is assessed at less than 1% of the whole mire area. The aim of the research is characteristic of the geological and hydrological conditions for the presence of spring mires in the Parsęta River basin (Northern Poland). From 53 spring mires two objects were chosen for detailed study. Within the two sites there were analysed: supply and drainage conditions as well as lithology of biogenic and mineral deposits. Cores of undisturbed structure were taken for chronostratigraphic and palaeogeographic interpretations. Sedimentological and geochemical analyses and AMS radiocarbon dating were carried out for theses cores. The obtained results provide a basis for studies on the evolution of this type of mires in the Holocene. In the Parsęta River basin spring mires are concentrated in the contact zones of geomorphological units of different geological structure and in the areas of considerable hypsometric gradients. Such areas are: (1) morainic plateau scarps, (2) fluvioglacial outflow valleys on outwash plains, (3) valleys of subglacial origin, and (4) slopes of melt-out depressions on morainic plateaux. The increased hydraulic gradient on the slopes of postglacial and fluvial forms creates favourable conditions for groundwater drainage in the form of ascending springs and seepages. The formation of spring mires and their size are also connected with the manner in which they are supplied (descending or ascending outflows) and the groundwater resources of drained local and transitory aquifer systems. Waters with free water table, supplying the layer springs around which the hanging spring mires were formed are drained on the slopes of the valleys. In slope-foot locations with good conditions for drainage of inter-morainic pressure waters supplying efficient ascending springs, cupola spring mires were formed. On the morainic plateaux, which are poor in groundwater outflows, no spring mires are found as a result. The deposits building the beds of the two analysed spring mires demonstrate great internal lithofacial variability with a simultaneous similarity of sediment succession in the individual objects. They consist of discontinuous layers of highly mineralised peat and thick layers and inserts of calcareous tufa with interbedding of various lowmoor peats. The thickness of spring series in the studied mires ranges from 1 m to 8 m. The evidence of layer succession documented within the studied spring mires shows great variability (time and spatial) of sedimentation and deposition processes, being a consequence of changes of supply conditions (spring activity, physico-chemical features of groundwaters) and development of natural vegetation. The main palaeogeographical conclusions resulting from the research carried out so far are as follows:1) The peat land started to develop at the turn of the Boreal and Atlantic periods; from the beginning it was a soligenic mire, supplied by confined groundwaters. 2) Maximum deposition of calcareous tufa is correlated with the Atlantic climatic optimum. The occurrence of thick calcareous tufa layers proves the intensive supply of these mires by waters rich in calcium carbonate. 3) Considerable efficiency of the springs supplying the mires was probably maintained until the Atlantic period decline. 4) Distinct deterioration of thermal and humid conditions at the beginning of the Subboreal period significantly limited activity of ascension springs, decreased organic matter accumulation rate and radically diminished carbonate deposition.

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Meter-scale geomorphology of Mars

McEwen A. S., the HiRISE Team

LPL, University of Arizona, Tucson, AZ 85711 USA (mcewen@lpl.arizona.edu)

The High Resolution Imaging Science Experiment (HiRISE) on Mars Reconnaissance Orbiter (MRO) has been imaging Mars at scales near 30 cm/pixel since 2006. Over 17,000 images have been acquired with over 14,000 Gigapixels of data, covering up to 1.16% of the martian surface (if it was all unique coverage). More than 1,900 stereo pairs have been acquired, with meter-scale Digital Terrain Models (DTMs) derived for ~100 scenes. There are also sequences of images for detecting changes over hundreds of locations. The images, DTMs, and stereo anaglyphs are available at http://hirise.lpl.arizona.edu/. The geomorphology of Mars is diverse, including landforms produced by volcanic, tectonic, fluvial, eolian, impact, mass wasting, glacial, periglacial, and seasonal processes. Many of these landforms appear quite similar to comparable landforms on Earth, but are generally much better preserved as Mars lacks the ubiquitous fluvial erosion of Earth. In particular, periglacial landforms resulting from slow processes are very well preserved on Mars. Landforms on Mars that might have been produced by water are of particular interest in the search for extraterrestrial life, but the geomorphic interpretations are often controversial. Mars has some processes with no counterpart on Earth, driven by the seasonal deposition of CO_2 frost and/or snow. Gullies and ravines on steep slopes, generally believed to be due to very recent flow of water, have been observed to form in recent years (from before-and-after images). When the seasonal timing of gully formation is well constrained, it has occurred only in association with the late winter/early spring CO_2 frost, when temperatures are far too low for water. The south-polar region contains some truly alien landscapes including “spiders” and “Swiss cheese terrain”. Some sand dunes at high latitudes are especially active, with gullies forming and getting erased (presumably by saltation) on a yearly timescale. Small impact craters (1-30 m diameter) form at a much higher rate on Mars than on Earth, and provide probes of the subsurface, including exposures of clean ice down to the middle latitudes. HiRISE has imaged 164 new impact sites, often with crater clusters from atmospheric breakup. Some of the most spectacular martian landforms are very old deposits where the bedrock is well-exposed from eolian erosion. These include layered terrains with a great diversity of morphologies and mineral compositions. Some of these sites are very well imaged as they have been candidate landing sites for the Mars Science Laboratory rover, to be launched in October 2011. These well-exposed bedrock terrains reveal tectonic, fluvial, eolian, and impact structures in exquisite detail.

Large-scale gravitational spreading in southeast Ethiopia

Mège D.[1], Le Deit L.[2], Rango T.[3], Jourdan F.[4], Tesfaye K.[5], Lopez-Gonzalez T.[6], Purcell P.[7]

[1]Laboratoire de Planétologie et Géodynamique, UMR CNRS 6112, Université de Nantes, France (daniel.mege@univ-nantes.fr); [2]Institut für Planetenforschung, DLR, Berlin, Germany (Laetitia.LeDeit@dlr.de); [3]Nicholas School of the Environment and Earth Sciences, Duke University, Durham (NC), U.S.A (tewodros.godebo@duke.edu); [4]Western Australia Argon Isotope Facility, Curtin University of Technology, Perth (WA), Australia (F.Jourdan@exchange.curtin.edu.au); [5]Regional Centre for Mapping of Resources for Development, Nairobi, Kenya(korme@rcmrd.org);[6]Laboratoire de dynamique terrestre et planétaire, UMR CNRS 5562, CNRS, Université de Toulouse III, France; [7]P & R Geological Consultants, Scarborough (WA), Australia (peterpurcell@tpgi.com.au)

The geomorphology of the Ogaden Plateau, Southeast Ethiopia, is dominated by volcanic and gravitational spreading landforms. Volcanic landforms are discussed in more detail in another presentation (Purcell *et al.,* this volume). Gravitational spreading, which had not been studied previously, is observed in western Ogaden, and generated some of the most dramatic mass wasting landscapes observed on Earth. It affects a series of mesas in various states of preservation covering a surface area of 15,000 km2 between the Gestro (West) and Shebele (East) rivers. Spreading results from flow of the lower stratigraphic unit of the mesas, the Neocomian evaporitic Gorrahei Formation, and affects the overlying, initially horizontal Mustahil carbonates (upper Aptian-Albian) and Jessoma sandstones (Palaeocene). The Jessoma sandstones cover a surface area of 5,000 km2 mistakenly mapped as Cenozoic volcanics on the second edition of the Geological Map of Ethiopia. The horst-and-graben geometry follows the drainage network, suggesting that gravitational tectonics was triggered by Ogaden Plateau uplift and river incision. The geometry of the drainage network may have been partly controled by basement structures; at present geophysical data cannot provide clear constraints in this respect. Topographic spreading is expecting to have been triggered while river incision attained the Gorrahei Formation. Two mesas have been studied, the Jabis and Kebenawa ridges. Due to the difficulty of field access, the Jabis Ridge was studied using remote sensing data only. It consists of a narrow triangle-shaped Jessoma-capped mesa surrounded by horsts and grabens spreading in three main directions that follow the orientation of the surrounding rivers. The Kebenawa Ridge has a linear (N110°E) trend resulting from erosion along two parallel tributaries of the Shebele river. It was visited in the field in 2006. Two types of deformations have been identified. (1) The Gorrahei Formation displays evidence of halokinesis, probably a combination of diapirism and evaporite karstification and dissolution. Halokinesis was associated with brecciation of the overlying Mustahil carbonates. Diapirism requires that the base level was 200-300 m higher than the present level. (2) The halokinetic structures are cut by veins filled in by satin spar whose fibres crystallized perpendicular to the ridge trend, indicating that ridge spreading occurred after halokinesis in response to incision by the two Shebele tributaries. Ridge spreading also generated Gorrahei Formation flexuring, and formation of a summit graben within the Jessoma sandstones similar to the crestal grabens typically observed in ridge sackung. The age of uplift and incision in western Ogaden is not well constrained. A basalt pebble from an uplifted conglomeratic terrace identified at West Imi, 50 km east of the Kebenawa ridge, could be ascribed a reliable 40Ar/39Ar age of 14.38±0.13 Ma (MSWD 1.04, probability of fit 0.38). This suggests that a major period of uplift and erosion probably occurred after 14 Ma upstream; incision of this conglomerate might correspond to the period of major topographic incision and gravitational spreading of the western Ogaden topography. Gravitational spreading in western Ogaden is very similar to spreading of the grabens in the Needles District, Canyonlands National Park, Utah, where the carbonates and sandstones of the Honaker Trail Formation and the Cutler Group have been spreading over the evaporitic Paradox Formation in response to Colorado Plateau uplift and incision by the Colorado River. Two main differences exist, however; first, in contrast to the Ogaden, spreading in the Canyonlands has occurred in response to topographic debuttressing in a single direction, controlled by incision along the Colorado river valley. Secondly, only the top of the Paradox Formation has been incised, in contrast to the Ogaden where the whole Gorrahei Formation has been incised. This difference should have influenced the mechanics of spreading in ways that need further investigations.

Gravitational spreading of high wallslopes on Mars: evidence of past tropical glaciations on Mars

Mège D.[1], **Le Deit L.**[2], **Lucas A.**[3], **Bourgeois O.**[1]

[1]*Laboratoire de planétologie et géodynamique, UMR CNRS 6112, Université de Nantes, France (daniel.mege@univ-nantes.fr, olivier.bourgeois@univ-nantes.fr)*
[2]*Institut für Planetenforschung, DLR, Berlin, Germany (Laetitia.LeDeit@dlr.de)*
[3]*Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, U.S.A (alucas@caltech.edu)*

The equatorial region of Mars exhibits a 2000 km-long, 660 km-wide network of parallel troughs (chasmata) of depth ranging between 2 and 10 km. This network, named Valles Marineris, cuts across the crust of the Tharsis volcanic plateau. Most chasmata initiated as huge grabens, in which horsts are occasionally observed and form topographic ridges. These ridges display abundant evidence of sackung (deep-seated gravitational spreading) features. Sackung is a mechanism of topographic ridge destabilization by normal faulting that produces (1) ridge-top splitting at ridge summit, resulting in diagnostic narrow crestal grabens, (2) uphill-facing normal fault scarps on ridge flanks, and (3) occasionally, lower slope bulging, folding, or valley overthrusting. On Earth, sackung has been almost exclusively observed in mountain ranges that were glaciated during the Quaternary, and have been nearly systematically attributed to paraglacial topographic readjustment. Of 44 articles published in peer-reviewed papers on distinct sackung cases on Earth in which the sackung triggering mechanism has been explicitly discussed by the authors, 39 conclude that sackung is a paraglacial process. Ridge debuttressing by the removal of valley glaciers on both ridge sides is a key process for sackung to initiate, and may be in some cases assisted by postglacial unloading and rebound. Two other articles suggest that it is a paraglacial process assisted by regional neotectonic activity, two others ascribe sackung scarps to collateral events of intense seismic shaking on a nearby fault with no discussion about the possible influence of past glaciations, and one sackung case has a unidentified origin despite many investigations. In the paraglacial environment, the mechanisms that link ridge debuttressing and sackung are not fully understood yet; nevertheless, rock decohesion by alteration and formation of clay minerals accumulating at the bottom of the crestal graben scarps, and selectively weaken lithological sequences probably play a major role in ridge slope destabilization. Saturated or nearly-saturated water conditions in the ridge rock mass probably contribute to ridge weakening through stress corrosion and subcritical crack growth. In some circumstances, such as during melting/freezing cycles, hydraulic fracturing might also be involved. We argue that sackung in Valles Marineris is most likely due to deglaciation of the horst-surrounding grabens because of the excellent statistical correlation between sackung occurrence and deglaciation on Earth. Many Valles Marineris chasmata were once extensively covered by valley glaciers. Supporting this interpretation is the possible existence of glacial trimlines at the bottom of the slope of many chasmata. In an earlier work the associated scarps were first interpreted as normal fault scarps; however, evidence of along-strike fault offset variations, and scarp end tapering off, which would confirm this interpretation, is usually lacking. If the trimline interpretation is correct, its elevation above chasma floor gives an idea of valley glacier thickness, usually found to be between 0.5 and 2 km. Many deposits observed in the chasmata below the spreading ridges display a morphology consistent with frontal or supraglacial, ice-cored moraines. Modelling of CRISM orbital hyperspectral data below sackung sites has revealed sulphates and hydrated silica on chasma floor. This association has been convincingly interpreted as the product of silicate material weathering in massive ice deposits. Paleoclimatic models can predict glaciations in tropical areas of Mars, including Valles Marineris; however they are based on the presently observed astronomical cycles and apply to the last few million years only. The glaciers inferred from this study are much older, between 3.5 and 1.4 Ga according to the (loose) Martian stratigraphic scale. Landsliding occasionally follows sackung on Earth, a genetic link that has been rarely described and is probably underestimated. Using granular physics we show that information on landslide failure plane dip angle can be inferred from the shape of the debris aprons; applying this result to Valles Marineris it is found that several major landslides, having a scar width > 10 km, initiated from uphill-facing sackung normal fault scarps.

Using LiDAR to detect landslide remnants under forest: a study from southwest Poland

Migoń P., Kasprzak M.

Department of Geography and Regional Development, University of Wrocław, pl. Uniwersytecki 1, 50-137 Wrocław, Poland (piotr.migon@uni.wroc.pl)

The study concerns a multi-storey plateau of Góry Stołowe in the Middle Sudetes Mts, SW Poland. Overall stepped morphology of the area, with a few isolated mesas, is controlled by structure and lithology. Level surfaces are underlain by nearly flat-lying calcareous sandstones, mudstones and marls, whereas prominent escarpments up to 300 m high are capped by thick-bedded, massive quartz or arkosic sandstone series. These different sedimentary units are all of Late Cretaceous age and were deposited in a shallow epicontinental sea. However, the base of the northern escarpment is developed in older Permian sediments. It has long been envisaged that sandstone-capped escarpments are subject to retreat, but the exact means of slope backwearing have been assumed rather than definitely proved. In fact, close examination of the lower sections of the escarpments has been hampered by dense forest cover and unavailability of sufficiently accurate topographic maps. Recent acquisition of high-resolution (0.6 m) LiDAR image for the Góry Stołowe National Park opens new opportunities for geomorphological studies of forested escarpments and allows for identification of subtle morphological patterns which otherwise may have been left unrecognized. A few such patterns are best attributed to landslides which affected the escarpments rather than are compatible with steady shedding of joint-bound blocks off the caprock face. However, the generic term 'landslide' is used here to cover different types of mass movement which have left different morphological records. LiDAR-derived DEMs, particularly slope gradient maps, reveal that escarpment morphology cannot be adequately described using a classic free face – debris slope – wash slope model. In many localities, topography of the lower sector is either wavy or shows the occurrence of alternating benches and steeper segments (bulges). The latter are slightly arcuate in ground plan, parallel to the extension of the escarpment, and may be associated with the presence of huge sandstone blocks (up to 5-6 m long) derived from the free face. They are interpreted as predominantly translational landslides developed in weak sub-caprock units, particularly in Permian sediments, whereas sandstone boulders were passively carried on top of the slides to as far as 800 m from the free face. Lobate footslope morphology is widely present beneath spurs within the escarpment but disappears in amphitheatres drained by streams. Along other escarpments, cut entirely across Cretaceous strata, bulges are less distinct and located at closer distance from the free face. Another morphological feature evident on LiDAR-derived images is the occurrence of large boulders dispersed over middle and lower slopes of escarpments, which do not show the presence of benches and bulges. Subsequent ground check showed that many these boulders are nearly 10 m long, whereas the attitude of bedding surfaces is often close to vertical. The distance from the free face is locally in excess of 400 m. They are probably remnants of catastrophic rock falls, involving simultaneous movement of large portions of caprock. The presence of deep clefts near the margin of the highest sandstone mesa, with outward tilted rock faces, indicates that toppling is under way and this may have occasionally led to massive rock slope collapses. Sub-metrical DEM also helped to locate large-scale sagging which affects the highest sandstone mesa of Szczeliniec Wielki. The entire eastern part of the mesa (1/6 of the total top surface) is displaced downslope by 15-20 m, separated from the rest by a straight scarp coincident with a major jointing set. Ground check confirmed chaotic arrangement of sandstone masses, frequent tilting and collapses. A few other localities of probable sagging, albeit not on such a grand scale, have been identified. Large-scale mass movements within the sandstone escarpments have not been recorded in historical times, in the past 200-300 years. This is compatible with morphological evidence. Landforms recognized with the aid of LiDAR images lack diagnostic features typical for fresh landslides and cannot be traced towards zones of depletion. It is therefore suggested that considerable time must have elapsed since landslide activity. Although we are unable to say anything precisely about ages of mass movement events, it is clear that both sub-caprock landslides and singular catastrophic rock falls have played a major role in the long-term evolution of sandstone escarpments in Góry Stołowe.

Geomorphology of nephelinite syenite stocks around Axum, northern Ethiopia: adding Earth Science value to the Axum World Heritage site

Migoń P.[1], **Billi P.**[2], **Ciampalini R.**[3], **Ferrari G.**[4]

[1]*Department of Geography and Regional Development, University of Wrocław, pl. Uniwersytecki 1, PL-50-137 Wrocław, Poland (piotr.migon@uni.wroc.pl)*
[2]*Department of Earth Sciences, University of Ferrara, Via Saragat 1, I-44100 Ferrara, Italy (bli@unife.it)*
[3]*UMR LISAH - INRA, IRD, SupAgro Campus AGRO, Bat. 24 - 2, Place Viala, F-34060 Montpellier Cedex 1, France (rossano.ciampalini@supagro.inra.fr)*
[4]*Dipartimento di Scienze delle Produzioni Vegetali, del Suolo e dell'Ambiente Agroforestale, University of Florence, Piazzale delle Cascine, 18, I-50144 Firenze, Italy (marta.giovanni2000@alice.it)*

World Heritage programme was launched in 1970s with the aim to ensure maximum recognition and protection of objects, sites and areas which are considered of outstanding universal value for the entire humanity. Three categories of World Heritage properties are distinguished: cultural, natural, and mixed, the latter combining superlative natural features with outstanding cultural legacy. Natural sites can be nominated on the basis of their scenery, geological heritage, ecology, or biodiversity. At the moment (as of 2010), the list contains 704 cultural sites, 180 natural sites and 27 mixed sites. However, among cultural World Heritage properties are many which are associated with spectacular landforms and geology, even if these do not enjoy an explicit recognition. In many examples, Earth heritage not merely provides a setting in which a cultural site exists, but it crucially underpins the material and immaterial legacy of the past. From the point of view of geoconservation and geotourism, a parallel emphasis on Earth science values at suitable World Heritage sites broadens the scope of visitors' experience and may help to diversify tourist flows reducing vulnerability. Therefore, it is desirable to explore the Earth science context of existing World Heritage cultural properties. Axum is one of 8 World Heritage sites in Ethiopia, inscribed in 1980 in recognition of the significance of the remains of an ancient Axumite civilization from the early modern era. The property includes monolithic stelae, obelisks, inscribed stones and various archaeological excavations. Geomorphologically, Axum is located on a high plateau of Tigray in northern Ethiopia, at an elevation of c. 2250 m a.s.l. The plateau in general is underlain by flat-lying basalt flows of mid-Cenozoic age and a thick succession of Mesozoic sedimentary rocks, including sandstones, but the landscape around Axum and further east toward Adwa is dominated by exposed subvolcanic plugs of late Cenozoic age. In the immediate vicinity of Axum archaeological site there are two distinct isolated hills of 150 m high, Byeta Gyiorgis and Gobo Dura, built of nephelinite syenite plugs. Both are excellent examples of rock-controlled landforms, exposed through the long-term etching of lithologically diversified bedrock. They are flat-topped and their summit flats terminate with steep rocky escarpments, sculpted into an array of spurs, pillars, angular tors (castle kopjes) and boulder-mantled slopes. Interestingly, their perimeters do not coincide with lithological boundaries which are located further down, at the plateau level. These less elevated parts of the plugs appear as boulder-covered benches; however, many boulders are in situ and due to differential weathering rather than they have moved down from the backing slopes. Rocking stones can be found within the boulder mantle. The clear bipartite morphology of the plugs can be explained in terms of either scarp retreat after excavation or differential etching within the intrusions, with their outer parts being more susceptible to weathering and erosion. The latter hypothesis receives additional support from the occurrence of minor boulder-free basins within the benches, which indicate structural variability within the syenite plugs themselves. There are evident links between geomorphology and cultural heritage in the Axum area, both geographical and causal. The ancient site, including the famous stelae park, occupies the footslopes of Byeta Gyiorgis and underground tombs have been excavated within the nephelinite syenite. Stelae themselves, however, were carved out in ancient quarries at the foot of Gobo Dura hill, on a boulder-mantled bench. These are less visited sites but allow seeing both unfinished obelisks and stelae abandoned during transport to Axum. There are also many examples of rock carving and dressed stones spread across the area, including the famous image of a lioness chiselled out from a huge syenite boulder at Gobo Dura. Sparse vegetation around Axum and relatively good access to particular sites are helpful in appreciation of geomorphology and geology of the area. Consequently, little work is required to add them to visitors' itineraries. Given the occurrence of a truly spectacular assemblage of rhyolite and phonolite hills further east and clear rock–landform–humans relationships in northern Tigray in general, the wider surroundings of Axum may be considered a candidate for a geopark, thus adding to the potential of the area for development.

Applications of the topographic thresholds slope and runon area in the study of hillslope incisions along the Albertine Rift in Kivu (DR of the Congo), Rwanda and Burundi

Moeyersons J., Vandecasteele I., Trefois P.

Royal Museum for Central Africa, 3080 Tervuren, Belgium (jan.moeyersons@africamuseum.be)

Geomorphological work in Rwanda has led to the establishment of a local envelope of slope – runon area combinations for hillslope incisions as a result of gullying or landsliding. This security envelope is given by the equation:

$$S_{cr} = \sim 0.6A^{-(\sim 0.6)}$$

where S_{cr} = critical slope gradient (tangent of slope) at the gully head or landslide scar, and A= the area (ha) drained towards the incision head. This equation has been tested in rural areas in Kivu, Rwanda and Burundi. In the case of gullying, the equation indicates that in most cases human interventions in the spatial organization of runoff are at the base of gully development. Gully erosion in the whole region should therefore be considered as an 'unnatural' phenomenon. The equation is also practical because it allows definition of the maximum surface which can be drained along one unprotected drainage line of known slope. For landslides, work at Uvira, Bukavu and Butembo has shown that a number of cases fall below the security envelope. Analysis of aerial stereo pairs and high precision numerical models show that these landslides in Bukavu and Uvira can be linked to active tectonic movements. In these cases the topographic security envelope facilitates distinction between seismically triggered mass movements and landslides driven by high hydrostatic pressures. In the case of Butembo, the application of the envelope shows that a number of landslides have been triggered by the fact that road patterns artificially increase the runon area.

Investigations of the changes (degradation) of karst landscapes and epikarst due to human impact in two Hungarian karst areas

Móga J.[1], **Szabó M.**[1], **Borsodi A.K.**[2], **Kiss K.**[1], **Kéri A.**[1], **Darabos G.**[1], **Mari L.**[1], **Knáb M.**[2]

[1]*Eötvös Loránd University Geography and Earth Science Institute (jmoga@freemail.hu)*
[2]*Eötvös Loránd University Biology Institute*

All regions are endangered by anthropogeneous effects, but the treat of karst is outstanding. Karst areas are especially sensitive due to the system's 3D impact surface. Men always influenced the development of karst in a larger or lesser extend: they utilized it in many ways, which caused changes in the landscape. The growing activity of local population and agriculture affected the karstic ecosystem: changes occured in the woodland and it degradated the rock grassland too. The quality of karst waters slowly declined due to the contamination at swallow holes, soiling of infiltrating waters and the contamination of karst springs. The mining left behind pits and quarries on the surface, the karst water level sank down due to growing water usage. The intensive landuse degradated the soil, changing its consistency through growing amount of acidity and the burden of heavy metals and the erosion rate increased. Karst systems can be summed up of different aboveground and underground processes. The analysis of karst ecological system and its subsystems is a task of priority on the karst area in Hungary as well - because of the preservation of natural values, sustainable farming, the protection of undersurface waterbasis and the sustainable demonstration at National Parks. The damages and pollution of karsts take place through the karst's epikarstic systems which are in connection with the surface. This gives a special significance to the cognition of natural processes taking place in epikarstic systems and the analysis of changes due to human impacts. Our researcher team was made up to analyze the complex processes and system connections in karst ecological system. We are planning to investigate interdisciplinarily the large near-surface karst segment (epikarst). These researches will cover the elements of the abiotic system (soil and karstic cover-deposit, water, interaction between soil gas and rock). Our planned researches will include the study of surface's and epikarst's biogene factors (vegetation on surface, changes of soil's microbe communities) impacts on processes of karst corrosion. To emphasize the interdisciplinary character of our planned study and to pronounce the system's connections and coherence even on the level of study, our research plan was divided according to specialties to make the tasks better understood. In our study we provide a picture on the karstological research conducted at the Tapolcai karst (Hungary), gathering the traces of environmental changes due to hundreds of years of land usage on one side, and the effect of anthropogenic processes on the alterations in the epikarst system, in the hidro-, bio-, and pedosphere on the other. In the scope of our research on the Tapolcai karst our aim was to map in a broad sense all the anthropogenic processes affecting the study area. The qualification of surface waters happened with the help of biological water labeling, as well as by water sampling and labor survey. The sample collection was accomplished by soil drilling in karst soils (cover deposits), and through the collection of large blocks of soil (soil-monoliths) we conducted rain simulation experiments as well. We compared the physical-chemical composition of the soil dissolution infiltrating through the monoliths (grain size**,** humus and carbonate content, pH etc.) as well as the microbiological parameters. We studied the karstic landscape changes through fieldwork and GIS methods following the changes of coverage in different time layers. This presentation gives an account on the preliminary results of the study started in 2009 by our researcher team (OTKA Grant: K 79135) of the changes of biogene and abiogene factors of the epikarst system on two Hungarian karst regions.

The interplay of mantle dynamics, tectonics, and surface processes: the Romanian Carpathians topography

Molin P.[1], **Sperini S.**[1], **Nocentini M.**[1], **Fubelli G.**[1], **Scotti V.N.**[1], **Dramis F.**[1], **Grecu F.**[2]

[1]*Roma Tre University, Department of Geological Sciences, Rome, Italy*
[2]*University of Bucharest, Faculty of Geography, Bucharest, Romania*

Tectonic processes and dynamic mantle flow impart a unique imprint on topography and geomorphic responses over time scales of 10^4 to 10^6 yr. So first-order topographic features in a tectonically active landscape represent ways to quantitatively characterize the interaction between crustal tectonics, mantle dynamics, and geomorphology, providing a basis for modeling landscape evolution. We analyzed the topographic features of the Romanian Carpathians, a mountain range characterized by two straight segments connected by a narrow curvature zone. Since late Cretaceous, the deformation history of Carpathians includes three phases that progressively affected the southern segment, the eastern one, and finally the curvature zone. This is mirrored in the fission tracks data that record, not only an older exhumation in the southern Carpathians, but also a progressively younger one from north to south in the eastern portion of the chain. We examined the tectonic geomorphology of the Romanian Carpathians focusing on regional and local topographic setting, drainage pattern and stream long profiles. Our main data base is composed of DEM-based topographic analysis, supplemented with field investigations in the Slanic River basin, located in the Carpathian curvature. The longitudinal profiles of streams draining the southern Carpathians are more concave and characterized by knickpoints generated by changes in rock-type. Their profiles, more close to the equilibrium shape, fit well with the older emersion of the chain. The longitudinal profiles of the streams draining the eastern Carpathians and the curvature are less concave, presenting a knickpoint at 500-600 m a.s.l. that records a regional regressive erosion wave produced by a regional change in base level. Locally upstream, a second knickpoint, in some profiles, indicates fluvial piracy phenomena at least in part driven by back-arc extension. Filtering the topography at different wavelengths, we observed a relative depression in correspondence with the Carpathian curvature, where mantle seismicity data indicate a narrow but still active Wadati-Benioff zone. On the contrary, in the Transylvanian extensional basin, the filtered topography presents a high. In the same location, tomography data show a low velocity area, interpreted as an upwelling of hot asthenospheric materials. On this basis, we hypothesize local mantle convection generating a positive dynamic topography in the Transylvanian basin and a negative one in the Carpathians Bend. In the Slanic River basin, the foredeep deposits (Middle Miocene-Upper Pliocene) are folded and tilted, suggesting compression still active in Lower Pleistocene. This tilting, that progressively migrated to the south, generated an unconformity on which Lower-Middle Pleistocene alluvial fan and glacis deposits lay. These sediments record a strong delivery of material from the chain and are correlated with the first order fluvial terrace. During Late Pleistocene and Holocene, other three terrace orders developed. The projection of their elevation on the Slanic River longitudinal profile shows a downstream diverging pattern, that suggests an increase of uplift rate towards the mountain front. A ^{14}C dating of a bone found in a forth order terrace, close to the mountain front, allowed to calculate a Holocene incision rate of 1.4 mm/yr. This value is exactly the same of the uplift rate obtained by the GPS data on vertical movement in the very same area of the mountain front, where the regional buried structure, called "Peri-Carpathians Thrust", is located. In conclusion, the Carpathians topography results from a diachronous and differential uplift superimposed on tectonics, extensional in the back-arc and compressive at the mountain front. The differential uplift of the Romanian Carpathians influenced the chain topography, the shape of stream long profiles, and the formation and pattern of strath terraces. Crustal tectonics dominated the hydrographic net organization inducing river captures in the axial sector of the chain. In correspondence with the Carpathians Bend and the Transylvanian Basin, mantle flow driven by the subducting slab produced respectively a negative and positive dynamic topography.

Morphodynamic mapping of landslide affected slopes: the case of the Groapa Vantului (Romania)

Mulas M.[1], **Fubelli G.**[1], **Sandric I.**[2], **Balteanu D.**[3], **Micu M.**[3], **Ignat P.** [2, 4]

[1] *Department of Geological Sciences - Roma Tre University (fubelli@uniroma3.it)*
[2] *University of Bucharest, Faculty of Geography*
[3] *Institute of Geography, Romanian Academy*
[4] *National Research and Development Institute for Soil Science, Agrochemistry and Environmental Protection–RISSA Bucharest*

Present-day technology allows combining field work activities with GIS supported analysis of multitemporal air-photos, satellite images and Digital Terrain Models, in order to create morphodynamic maps. This approach may be very useful in areas affected by landslides, because of the heavy changes induced to the landscape in a relatively short time. The case study area is located in the Buzau River valley (Eastern Carpathians Bend area, Romania), 10 km upstream the town of Nehoiu (12,000 inhabitants), at the confluence with the Siriu River. Here a huge landslide (3,000,000 m3 in volume) deeply involves the right slope of an artificial lake, dammed in 1990 for a complex purpose (flood control, irrigation support, water supply and energy production). The outcropping bedrock consists a complex sequence of flysch sediments of Eocene-Oligocene age (schystose sandstone flysch formation) that have been classified according to their mechanical characteristic into three arenaceous, arenaceous-pelitic, and pelitic-arenaceous lithotypes. The investigated unstable slope is characterized by three different styles of movement: rotational slides of different extent (up to 700,000 m^3 in volume) with detachment scarps up to 20 m high in the upper sectors of the slope; an earth flow in its central part with its accumulation heaps affected by small rotational movements; and high angle translational slides on the left side. Field survey and air-photo interpretation allowed to understand the predisposing factors of the different landslide movements. The main rotational slide is related to the presence of the pelitic-arenaceous lithotype, heavily deformed by a back-thrust in a pop-up structural context. The left side translational slides are induced by the local downsloping strata attitude. The earth flow involves the landslide accumulation material. Morphometric analysis has been carried out from three multitemporal DTMs extracted from a 1:5,000 topographic map surveyed in 1978; a 1:25,000 air photo couple taken in 2005; a recent satellite images. The landslide evolution during the last thirty years, as reconstructed by GIS analysis, shows a constant movement interrupted by the paroxystic event of May 2006. This started with shallow rotational movement in the lower part of the slope and a subsequent rapid retrogression upward involving deeper and deeper portion of the slope. The main triggering factor was the lake level fluctuation while the role played by rainfall seems to be not relevant. In fact, the meteorological record shows that the precipitation during the previous four months was quite small (70 mm total with only 32 mm in April) with full absence of snow. On the other hand, the lake level underwent a strong lowering in February followed by a sharp rise in March (due to the closing of the dam outlet) and a new lowering in April (just before the landslide activation).

Landscape recovery and resilience in a badly degraded region, Tigray (Ethiopia): 1974 - 2006

Munro R.N.[1], Mitiku Maile[2], Nyssen J.[3], Virgo K.J.[4], Wilson R.T.[5], Poesen J.[6], Deckers J.[6], Frankl A.[3],Lewis J.G.[7]

[1]*Old Abbey Associates, Tarbet Court, Dirleton, East Lothian, Scotland, EH39 5DX, UK (neil.munro@dial.pipex.com)*
[2]*Department of Land Resource Management and Environmental Protection, Mekelle University, Mekelle, Ethiopia*
[3]*Department of Geography, Ghent University, B-9000 Ghent, Belgium*
[4]*Village Ways, Pettets Farm, Great Bradley, Newmarket, CB8 9LU, UK*
[5]*Bartridge House, Umberleigh, North Devon, EX37 GA5, UK*
[6]*Department of Earth and Environmental Sciences, K.U.Leuven, B-3001 Leuven, Belgium*
[7]*Korongo Ltd., Dar es Salaam, Tanzania*

The 1972-1973 rains in northern Ethiopia were well below average and an ensuing drought caused crop failure and livelihood loss amongst the farming and nomadic populations. Experienced conservationists had already warned, even before this drought, that lack of a national landuse plan and of indigenous traditions or programmes of soil and water conservation (SWC), together with uncontrolled and unregulated cultivation on any slope where there was soil, were resulting in unsustainably high soil erosion, and excessive degradation of the land cover. This was thought to be spiralling downwards to a catastrophe, which would have an adverse impact on the rural economies that provided much of the food for the country. The effect of that drought exacerbated a desperate situation. The upland plateau region of Tigray (or Tigre, Tigrai) from 2000 to 4000 m a.s.l. was particularly badly hit as rainfed farming communities had no stored reserves. The UK response to this disaster in 1974 was a long-term technical assistance (TA) package - the *Tigrai Rural Development Study (TRDS)* that made in-depth baseline studies on soil conditions, geomorphology, landuse planning, livestock, vegetation and range ecology, surface and groundwater resources, demography, the rural economy, and institutions. Demonstrations in SWC and exclosing land were key interventions. Civil war forced cessation of the TA work in 1976 but the Tigray people began to initiate change and since then have made remarkable institutional reforms, applied SWC measures over large parts of upland Tigray and transformed a degraded landscape into a productive one where scars of the past are being healed. The TRDS team had taken many landscape photographs for monitoring purposes in this scenically stunning area. Repeat photography analysis at these sites in connection with advanced geomorphological research all over Tigray was able to provide a semi-quantitative assessment of change in the region. The Universal Soil Loss Equation (USLE) and particularly changes in C (cover) and P (management) factors was applied to assess change. The study indicates that there has been a positive change to the landscape due to improved vegetation cover and introduction of physical SWC structures. The USLE application indicates that over a large area the current average soil loss would be around 68% of its 1975 rate. Whilst central gullying had increased dramatically in several areas, and some remnant forests were being degraded illegally, the repeat photography exercise demonstrated that there is a strong natural resilience in soils and vegetation allowing recovery from what appeared to be a quite hopeless and terminal situation and that SWC interventions are, as long claimed, highly appropriate.

Aeolian geomorphological, soil and ecological applications for sand dune stabilisation in Arabia and northeast Africa – 1970s to present

Munro R.N.[1], **Abuzeid H.M.**[2], **Abdel Mahmoud M.**[3], **el Hassan B.**[4], **el Siddig E.**[5]

[1]*Old Abbey Associates, Tarbet Court, Dirleton, East Lothian, Scotland, EH39 5DX, UK. (neil.munro@dial.pipex.com)*
[2]*Dept. of Arid Zones and Desert Agriculture, Faculty of Agriculture, Islamic University of Omdurman, Sudan*
[3]*UNDP, Kassala, Sudan*
[4]*Independent Forestry Consultant, Khartoum, Sudan*
[5]*Dept. of Forestry, University of Khartoum, Shambat, Khartoum, Sudan*

The relentless movement of sand sheets and dunes onto farmlands and settlements has long posed an enormous problem and challenge for communities, rulers and governments in many parts of Africa and Arabia. Where human interventions – such as cultivation, settlements or more recently petroleum installations – are established in the hot desert aeolian environment, the front-line techniques used to control sand movement and limit its impacts have been variable in their nature, success and sustainability. Although sand stabilisation and shelterbelt programmes received widespread attention and funding in the past throughout this region, the initiative today can be left to the actual developer or contractor. He may have no experience in this field, and less desire to spend large sums to reduce the impact of drifting sands, even where simple observations might show that it is sensible. But it is not a new issue for concern, as excavations of Christian churches along the main Nile in Mediaeval Nubia (Northern Sudan) revealed that drifting sands overwhelmed them several times by; in adjacent areas early Holocene Nile palaeochannels and associated Neolithic settlements were buried by drifting sands. Whilst burial is a blessing for the preservation and concealment of archaeological sites, there is also surely a very strong message here from history and prehistory respectively, that the same disaster could well happen in modern times, if nothing is done to reduce the influx of aeolian sands into a scheme. Based on geomorphological and biological applications on recent sand stabilisation programmes in Sudan and Yemen, the key issues when planning sand stabilisation programmes are considered to include: base line studies on aeolian geomorphology including winds and sand drift rates (from Sudan we report on utilisation of sand drift rate measurements by HMA being applied to current irrigation planning); preparation of sand drift hazard maps; monitoring programmes for wind speeds and impact of programmes on sand movement using automatic data loggers; assessments whether irrigation from surface or groundwater; using indigenous vegetation ecology for vegetative belts to ensure success, and less reliance on exotics; and most importantly, community participation. Good management too will ensure that satisfactory progress is made, and the fact should be stressed to all that programmes need to be nurtured and managed for as long as the project or infrastructure lasts, that is really forever – a difficult concept sometimes from the funding agencies down to the community level. This poster reports also, with examples from Gaza, Jordan, Saudi Arabia, Yemen, Sudan and Somalia, how natural sand stabilisation events during the Pleistocene and Holocene may be able to offer guidance for modern attempts to halt sand movement.

Vulnerability mapping for sustainable hazard mitigation in the city of Bukavu, South Kivu, DRCongo

Ndyanabo S.[1], Vandecasteele I.[2], Moeyersons J.[2], Trefois P.[2], Ozer A.[3], Ozer P.[3], Dunia K.[1], Cishugi B.[1]

[1]Official University of Bukavu, B.P. 570 Bukavu, DRCongo (Stephan_ndy@yahoo.fr)
[2]Royal Museum for Central Africa, Geomorphology and Remote Sensing Department, Leuvensesteenweg 13, 3080 Tervuren, Belgium
[3]University of Liege, Department of Geography, Allée du 6 août, 2 - B11, 4000 Liège (Sart-Tilman), Belgium

This study presents the natural as well as human factors which are responsible for the environmental degradation and the increasing vulnerability of the population of Bukavu to natural hazards. The city of Bukavu is located within the Albertine rift, a region which is prone to seismic activity. Moreover, the accentuated topography, the lithology and climate regime contribute considerably to the occurrence of both geomorphologic and hydroclimatic hazards. Over the last few decades the city has evolved at an exponential pace, without appropriate urban planning. Between 1970 and 2008 the population increased more than four times within a constant area of about 60 km^2. The related change in land use has drastically amplified both the frequency and impact of natural hazards in the city. The zones at high risk of mass movements and flooding have been identified and mapped using remote sensing and Geographical Information System (GIS). The changes in land use and population density were also studied, and we propose several approaches to raise the resilience of the population in order to reduce the impact of natural hazards on the city.

Characterizing natural terrain landslide distribution at catchment scale, west Lantau, Hong Kong

Kit-Ying Ng, Millis S.W., Wallace M.I.

Ove Arup & Partners (Hong Kong) Limited (angel.ng@arup.com)

Geomorphological maps and models have been increasingly adopted as a tool in natural terrain landslide studies in Hong Kong, with an emphasis on the identification of slope breaks and landform assemblages. However, limited quantitative geomorphological analyses have been done on the relationships between natural terrain morphometry and landslide distribution at catchment scale. Such analyses require a different mapping approach of terrain classification using drainage basin as the basic geomorphic unit. This paper presents details of the quantitative mapping approach applied to the western part of Lantau Island, Hong Kong (22°15' N, 113°53' E), which is currently undergoing landslide hazard and risk assessments. The study area is about 31 km2 comprising fluvially dissected, deeply weathered and colluvial hillslopes. Over 7,000 shallow debris slides and debris flows of 1-3 m depth were recorded from aerial photographs available from 1924 to 2009. The geomorphological map was compiled through aerial photo interpretation and field reconnaissance. Landslide locations, catchment boundaries and drainage lines were mapped with reference to the Strahler's ordering system. Morphometric parameters of each ordered catchment relevant for landslide assessment, including drainage area, drainage density, drainage gradient and hypsometric integral were measured based on 1:1,000 scale topographic survey maps and correlated with landslide frequency/density. This mapping approach allows quantification and assessment of landslide process in a geomorphological context with regard to the relative catchment position. The results further demonstrate a systematic distribution of landslides with reference to drainage order and the associated basin morphometry. The process-form analyses, performed in a Geographic Information System (GIS), could serve as a measurable tool to supplement regional qualitative landslide assessment.

Are changes in north Ethiopian mountain landscapes over the last 140 years caused by changing climate, or by human-induced degradation and rehabilitation?

Nyssen J.[1], Frankl A.[1], Mitiku Haile[2], Hurni H.[3], Descheemaeker K.[4], Ritler A.[3], Crummey D.[5], Nievergelt B.[6], Moeyersons J.[7], Munro R.N[8], Portner B.[3], Deckers J.[9], Billi P.[1,10], Poesen J.[9]

[1]*Ghent University, Department of Geography, Gent, Belgium (jan.nyssen@ugent.be)*
[2]*Department of Land Resources Management and Environmental Protection, Mekelle University, Ethiopia*
[3]*Institute of Geography, Department of Integrative Geography, University of Bern, Switzerland*
[4]*International Water Management Institute/International Livestock Research Institute, Addis Ababa, Ethiopia*
[5]*Department of History, University of Illinois, United States of America*
[6]*Institute of Zoology, Zürich University, Switzerland*
[7]*Royal Museum of Central Africa, Tervuren, Belgium*
[8]*Old Abbey Associates, Dirleton, Scotland, U.K*
[9]*Department of Earth and Environmental Sciences, KULeuven, Belgium*
[10]*Earth Sciences Institute, University Ferrara, Italy*

Studies on recent environmental change in tropical areas are generally conducted over limited time scales. This study makes a multi-temporal and multi-locational assessment over a period of 140 years, in one of the world's most degraded areas: the Highlands of Northern Ethiopia. 300 landscapes, recorded on historical photographs, taken from 1868 onwards, were rephotographed in 2006-9 and environmental changes apparent on the paired photographs were analysed through expert rating. General tendencies in landscape changes include an improved vegetation cover, in spite of a general, poorly scientifically supported belief of an opposite trend, as well as better soil and water conservation nowadays as compared to any period of the last 140 years, with a second optimum in the early 20th century. In the Simen Mountains (above 3500 m a.s.l.), upslope shifts of the upper tree line (*Erica arborea*) and of the upper cultivation limits of barley and potatoes are observed both inside and outside the National Park. These upslope shifts are observed since the 1970s and are probably related to global warming. In other mountain ranges, grazing pressure is greater and no change to the tree line could be observed though an upslope shift of crop species (wheat) was noted. At lower elevations, increased vegetation cover is the result of farmer initiatives as of the 1930s and intense rehabilitation activities since the 1980s. The implementation of physical soil and water conservation (stone and soil bunds, check dams) follows the same trend. Regional variations occurring in these trends are observed and discussed. The findings are substantiated by field investigations. The positive changes that result from these conservation activities in the Northern Ethiopian Highlands are an issue of global concern as they show that (1) in this study area direct human impact on the environment has so far been more important than potential effects of climate change and (2) severe land degradation should not always be irreversible.

Analysis of suspended sediment variation in a subtropical watershed, southern Brazil

Oliveira F. A.

Department of Geography, Federal University of Parana, Curitiba, Brazil (foliveira@ufpr.br)

Few studies regarding suspended sediment dynamics are focused in Brazilian subtropical environments. Suspended sediment may correspond up to 99% of the total solid load transported by a river in major pluviometric events and from 70% to 90% of the usual transported sediment load. The study aimed to analyze the variation of suspended sediment yield at different points of the Cubatão River and its main tributary, the Quiriri River, located in Santa Catarina State, southern Brazil. The 490 km^2 watershed is composed mainly by three different environments: the coastal plain, the scarps of the Serra do Mar mountain range and the Atlantic Plateau. Structural and morphological features have strong influence on river dynamics, in the rain distribution pattern and in the vegetation distribution, which ranges from mangrove forests, at the estuary of the river, to *Araucaria* (Brazilian pine) forests and bush fields in the higher altitudes. Discharge and suspended sediment concentration were monitored monthly over a period of 30 months at three different points along the Cubatão River, located in the plateau (point 1), at base of the escarpments (point 2) and in the coastal plain (point 3), as well as at one point in its main tributary located just before their confluence (point 4). Results indicate clear distinct hydrological and hydro-sedimentological patterns within the watershed, with substantially different suspended sediment yield patterns. Suspended sediment concentration decreases slightly as discharge increases at point 1, while concentration decreases substantially as discharge increases at points 2 and 4. At point 3 suspended sediment concentration increases proportionally to discharge increase. On the other hand, general suspended sediment yield per unit area decreases from the plateau to the coastal plain. Differences in suspended sediment concentrations at the monitoring points can be related not only to relief structure and pluviometric distribution, but also to land use characteristics.

Variety in rift valleys and in passive margins

Ollier C. D.

School of Earth and Environment, The University of Western Australia, Crawley, WA 6009 (cliffol@cyllene.uwa.edu.au)

It is generally accepted that passive continental margins start as rift valleys and many differences in passive margin geomorphology are inherited from the original rift valley form. Here I compare features of rift valleys with those of passive margins around the world. Many rift valleys are on the crests of swells, and a broad uplift is a precursor of faulting. The Rhine Graben is a familiar example. The Rift Valley region, in central Africa was already high when the rifting occurred. People often ask 'what caused the uplift of the highlands', but perhaps they were high from birth. The Albert Rift valley has about 1700 m of sediment, so the basement is well below sea level, as it is in many other rift valleys. Lake Baikal is 1,650 m deep, but is underlain by 7 km of sediment. So sedimentation can start very early in the evolution of a new passive margin. Yet most passive margins have dominantly marine sediments, not lacustrine or terrestrial sediments. A rise to the rift edge is the generally preferred model, and there are some real-world examples such as the borders of the Red Sea. Elsewhere there is a rise to a broad swell many kilometres away from the actual fault. The classic is the swell SE of the Lake Albert Rift in Uganda. This is clearly marked by great changes in geomorphology, including drainage reversal and a totally different style of valley on opposite sides of the uplift axis. The swell is known as 'Randschwellen' in German and 'bourrelet marginaux' (marginal cushion) in French and workers from these countries were often more impressed by the swell than by great escarpments. Great escarpments are a feature of many passive margins, and are erosion features, very irregular in plan, caused by scarp retreat and many kilometres inland of any original fault scarp. Symmetry varies along the length of Rift Valleys. The central Lake Albert Rift is basically symmetrical, although the Congo side is higher than the Uganda side. In the north a downwarp in West Nile Province meets a simple fault on the eastern side of the Nile to form a half-graben. Lake Baikal is similar but much larger. The centre of Lake Albert Rift is a simple graben. Associated with the massive downfaulting of the rift valleys are great uplifts. Ruwenzori, bordering the southern Albert Rift, is the highest non-volcanic mountain in Africa (5110 m). To the north it is a true horst, but one fault dies out and to the south the African Surface was simply upwarped. Much has now been eroded by glaciation. Similarly in China the Turfan Depression (the second lowest point on Earth) is adjacent to the fault-bounded Flaming Mountains. An old surface (palaeoplain) existed before rift valleys were initiated, and may be still present, as at the Lake Albert Rift. On passive margins some assume the present ground surface on the plateaus is roughly the same as the initial surface; others believe there has been substantial erosion and surface lowering. Multiple planation surfaces have often been postulated. The palaeoplain is older than the start of rifting, and older than the youngest sediments deposited on it. Thick sediments may accumulate in the rift stage, and offshore sediments accumulate after seafloor spreading sets in. Offshore of the Appalachians, for instance, the sediments are Cretaceous. The planation surface may be equated with the break-up unconformity that underlies marine sediments in the offshore region. In southern Africa the downwarp model has long been accepted. The Natal Monocline is well documented on geomorphic and geological data. Elsewhere the simple connection has been made between the African Surface inland and the sub-Cretaceous break-up unconformity offshore. In the Serra Geral in Brazil a downwarp is indicated by the base of the volcanic rocks which is warped down to sea level. Some major rivers were in existence before the formation of the marginal swell and rift valleys. River reversal by the rift valley swell in Uganda is similar to that in eastern Australia. Volcanic activity is associated with rifting. It may have a long history as in the Gregory Rift Valley, though Quaternary movements created the present landscape. The Deccan Traps of NW India occupy the entire landscape and the opening of the Indian Ocean seems to have occurred after volcanicity ceased. Similarly the passive margin of southern Brazil can be matched with Namibia: in both there is ignimbrite over basalt and volcanicity finished before the southern Atlantic opened. All over the world there has been a phase of rapid uplift that caused vertical elevation of mountains. This is evident in most rift valleys, but some passive margins are older, and some indicate two phases of uplift. At the greatest scale there is no rock control. Marginal plateaus and great escarpments can occur on igneous, metamorphic or sedimentary rocks (folded or horizontal). The Great Escarpment of the Western Ghats of India is continuous from the metamorphic and igneous rocks in the south to the all-basalt Deccan Plateau in the north, with no change in form and similar distance to the sea. At smaller scales rock control can be important, as in Ethiopia.

Stages of post-glacial evolution of the Odra River mouth area, Poland-Germany

Osadczuk K., Borówka R.K., Osadczuk A., Witkowski A. & Duda T.

Institute of Marine Sciences, Faculty of Geosciences, University of Szczecin, Poland

Multidisciplinary research (sedimentological, geochemical, diatomological, palynological and malacological analyses of sediment cores, supported by seismo-acoustic surveys) allowed environmental reconstruction of the postglacial evolution of the area of the Odra River mouth. The study revealed that during the Late Glacial and Holocene, this area developed in several stages: glaciofluvial, fluvial, swampy-limnic, marine and lagoonal. First of them is connected with deglaciation of this area, ca. 16 ka BP. Late Glacial the whole study area constituted a low alluvial plain. The pre-Odra flowed westward along the Toruń-Eberswalde ice-marginal valley, and farther away, together with the Elbe and Rhine rivers, discharged into the Atlantic. When the icesheet retreated (ca.14.5 ka BP) to the area of the present-day Szczecin Lagoon, the pre-Odra changed its course and turned to the north-east. The pre-Odra discharged into the Baltic most probably near the eastern part of Rügen Island. Initially, the Odra was most likely a braided river, with its waters flowing along numerous channels. In the early Holocene it changed to a meandering river. During the middle Holocene, the Odra became an anastomosing river flowing among swamps and bogs – similar to today's Lower Odra south of Szczecin. This stage is documented by three erosion/deposition terraces buried under recent Holocene sediments. During the late Atlantic period, while the Littorina transgression was in progress, ca. 6.1 ka (^{14}C) years BP, the Odra River valley was flooded by sea water. The valley transformed into marine embayment extending southward up to today's Szczecin town and the Odra River mouth became an estuary. The next stage began ca. 3.1-3.4 ka BP. Intensified abrasion processes on the high moraine shores of the Uznam and Wolin Islands caused rapid growth of two spits, progressively closing of an embayment and turning it into lagoon that today is called Szczecin Lagoon. Simultaneously to the isolation of this area from marine influences, the Świna back-delta began to develop behind the barrier system. The lagoonal stage of Odra River mouth still persists. However, the last geological stage of the Odra mouth development is under strong anthropogenic influences which began in Early Middle Ages, together with extension of colonization and shipping trade. The biggest transformations of the Odra River mouth landscape were initiated in 18th century. The development of modern shipping trade and harbors caused changes in hydrological system and natural landscape of that region.

A New hypothesis in stream ordering methodology

Pandey P. K., Das S. S.

Department of Earth & Planetary Sciences, Nehru Science centre, University of Allahabad, Allahabad, India (ppgeom@gmail.com; siddharthasankardas.alld@gmail.com)

Several stream ordering methods have been proposed in order to describe some aspects of the geometry of river networks; namely, Horton's, Strahler's, Milton-Ollier's, and Scheidegger's ordering methods. The aim of the present paper is to present more scientific and logical stream ordering methods and to modify Strahler's stream ordering method. Some of these methods are very easy to adopt and simple for basin study but they don't keep concern for physical and chemical properties of streams which may change after a confluence. Particularly Strahler's method can be objected in this respect. It is clear that the concept of order, in Horton's sense, applies to complete streams and not to stream segments or links, as the order of any channel remains unchanged from the source down to the point where such a channel "dies" by joining a higher-order river, or by reaching the mouth of a network. In Horton's method (1945), additional difficulties arise, since it is not always clear which fingertip channels are to be considers true first order streams, and which ones are simply upstream extensions of higher-order Rivers. Strahler (1957) proposed a slightly modified method of stream ordering. In this method, the difficulty of the choice of true first–order stream is avoided by regarding all fingertip tributaries as segment of order 1. When two channels of order P, Q join, the resulting channel downstream is assigned the order according to the rule:

$$P \S Q = P \text{ if } P > Q$$

i.e., 2§ 1= 2 where 2 & 1 are stream orders;

$$P \S Q = P+1 \text{ if } P = Q$$

i.e., 4 §4 = 4+1 = 5 where 4 & 5 are stream orders.

According to the above law, we are facing the following problems in Strahler's method: (i) 2+2 = 3 and 3+2 =3 where 2 & 3 are stream orders. But in real world we get that streams having two different orders like 2&3 are different in respect of their physical and chemical properties. These two different rivers may originate from two different regions and so their sediment load and velocity may be different. When 2nd order stream joins to 3rd order stream its resultant segment should not be of 3rd order. With the help of Rank-Order statistical methods this problem can be reduced; (ii) Strahler has not told why the source or parent stream will get 1st order. In his ordering, the Ganges, the Congo and the Nile, etc. will be ranked as different orders which is not logical, because all these rivers are prominent rivers of their region so all should get 1st order (Pandey, 2010). In the end of their journey these rivers embrace ultimate base level. It means base level of river should be a determining factor for stream ordering. Keeping the above problems in view, a new stream ordering method is proposed.

Drainage pattern and linear morphometry of Barakar -Usri confluence region, Giridih, Jharkhand (India) using G.I.S. technique

Pandey P. K., Das S. S.

Department of Earth & Planetary Sciences, Nehru Science centre, University of Allahabad, Allahabad, India (ppgeom@gmail.com; siddharthasankardas.alld@gmail.com)

The digital morphometric technique has been used to study the drainage pattern of Barakar and Usri rivers around the confluence region and determine the stage of geographical cycle of erosion. The study area is part of Koderma Plateau (a part of Chhota Nagpur Plateau), Jharkhand state, India, and lies between latitude 24°00'N to 24°15'N and longitude 86°15' E to 86°30'E. The geology of the area is characterized by Permo-Carboniferous sediments belonging to the Gondwana Group surrounded by Precambrian Rocks. The Gondwana sediment consists of Talchir group, the Karahrabari and Barakar members (Das & Tripathi, 2009). The region is mainly drained by two rivers, the Barakar and Usri. Barakar River, a tributary of Damodar River is the major river draining through this area. The Usri River, a tributary to Barakar River makes confluence near Guladih, Giridih District, and Jharkhand. The topographic sheet No.72 L/8, Survey of India on 1:50,000 Scale is utilized and ARC GIS 9.2 software is used for the analyses of above objectives. Strahler`s method is applied for stream ordering. Dendritic drainage pattern is observed after digitization of drainages. The region consists of drainage level of 6th order. The low bifurcation ratio of the study region indicates that the rivers are flowing in hilly tract and tending to rolling surfaces. Landforms like Usri waterfall advocates that basin is in youth stage.

Active tectonic and seismicity in permafrost environment: the Terekhol basin, southern Siberia

Panin A., Selezneva E.

Faculty of Geography, Moscow State Lomonosov University (andrey-panin@rambler.ru; seevgenia@gmail.com)

Terekhol Basin is a 300-400-m deep pull-apart depression at the south-west edge of the Baikal rift zone. Start of its formation is estimated at the Miocene/Pliocene transition (5-6 million years ago). In the North-West the basin is bordered by the active Agardagsky fault. The 20×40 km elliptical in shape bottom of the depression is modified by alluvial accumulation. In the beginning of the Holocene, a shallow Terekhol Lake was formed in the south-west corner of the basin due to alluvial damming. Now the lake is 30 km^2 in area and 0.5-0.6 m deep (1.2 m at maximum). Permafrost in the bottom of the basin is >100 m thick. No permafrost (talik) exist under the lake, but lake islands are frozen to 15-20 m depth. No drilling or clear geophysical data exist for the basin. Therefore geomorphic methods make the only means to inquire into tectonic development of the basin over different spatial and time scales: (1) topography of the whole basin - $n\times(10^4\text{-}10^5)$ years, (2) the Terekhol Lake shoreline - $n\times10^3$ years, (3) local seismic deformations - $n\times10^3$ years. Basin topography was studied using DEM derived from 1:25 000 topographic maps. The basin is divided into two topographically different parts - high SE area (up to 1350-1370 m abs) and low NW area (1300-1310 m abs) linked by gentle slope. To explain this topographic irregularity 4 hypotheses were suggested: (1) uneven subsidence of two tectonic blocks; (2) subsidence of one and tilting of the other of two tectonic blocks, (3) monoblock tectonic tilting; (4) irregular alluvial sedimentation over horizontal tectonic monoblock. We assume that sedimentation rate in different parts of the basin are proportional to feeding catchment area. We divided the basin by a regular grid (approx.7×9 km) into 10 polygons taking into respect the hypothetical tectonic blocks. For each hypothesis we generated probable position of bedrock and obtained average thickness of sediments over each polygon. The main performance criterion to choose between the hypotheses was correlation between catchment area linked to each polygon, and sediment thickness. *Spearman* rank correlation coefficients are as follows: 1st hypothesis – 0.64-1.50/not significant; 2nd – 1.15-1.45/not significant; 3rd – 0.88/not significant; 4th - 0.72/ significant. Therefore the 4th hypothesis was confirmed as the most probable mechanism of the basin development. To study the Holocene tectonic movements we used the Terekhol Lake terrace levels as geomorphic markers. In the field, 40 high-precision GPS cross-sections were made along the perimeter of the lake. The profiles were statistically filtered to eliminate topographic irregularities accounted for permafrost action. GIS modeling over filtered terrace heights revealed a distinct SE - NW upward trend in position of the highest (2-3.5 m) terrace dated at 6-8 ka BP. The overall deformation was estimated at 1.2 m, which gives the rate of tectonic rise of 0.2 mm/year over the second half of the Holocene. Given the general subsidizing of the basin, this rising tendency is regarded as a temporary inversion due to the rise of bordering block at the Agardagsky fault, which the adjacent part of the basin was involved to. This temporary rise should probably be compensated in future. A number of severe palaeo-earthquakes in the last millennium were detected during geoarchaeological studies of the Por-Bazhyn Fortress, an archaeological monument dated to the 9th century AD. The monument is located on a small 6-ha island in the Terekhol Lake. There is permafrost in the island some 15-20 m thick, which should have influenced styles of ground deformations. Seismic impacts were found to deform the island greatly with irregular sinks up to 5-6 m in amplitude. Spatial modeling of seismic deformations of the island topography was made in GIS environment based on deformations of the fortress walls and topography of buried pre-construction soil studied in the field.

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Geomorphological observations in the Mani Peninsula, (south Peloponnesus, Greece) and their seismotectonic implications

Papanastassiou D.[1], **Gaki-Papanastassiou K.**[2], **Karymbalis E.**[3]

[1]*Institute of Geodynamics, National Observatory of Athens, 11810 Athens, Greece (d.papan@gein.noa.gr)*
[2]*Department of Geology and Geoenvironment, National University of Athens, Athens, Greece (gaki@geol.uoa.gr)*
[3]*Department of Geography, Harokopio University, Athens, Greece (karymbalis@hua.gr)*

Mani peninsula, the middle one in South Peloponnesus, is the southern end of the Taygetos mountain range (2409 m a.s.l.) that dominates the area, having a length of 40 km and a N-S direction. It is situated about 50 km east of the NW-SE trending subduction zone between the African and the Aegean (Eurasia) plates. The area is characterized by intense seismicity, as several strong earthquakes have affected it in the last centuries. The western side of the peninsula is characterized by the existence of a continuous uplifted palaeo-coast surface tilted towards the southeast, carved on limestones, with a maximum elevation of 350 m a.s.l. Uplifted Pliocene marine sediments are found at several sites of the area, filling some palaeo-valleys. Below this palaeosurface, several other palaeo-coastlines and smaller surfaces are also observed. These observations indicate that the higher surface should be of pre-Pliocene age and that the uplift should be post-Pliocene. They also imply that the uplift should be induced by a N-S trending, westward dipping normal fault, located offshore west of the peninsula towards the subduction zone. On the contrary, along the western coastal zone of the peninsula, beaches covered by Last Glacial scree deposits and corresponding to the last interglacial period (5e OIS), are not significantly uplifted, being located just above sea level. These features imply that either the offshore fault has been inactive during the last 100.000 years or that it is connected with the subduction zone with a downward movement affecting the whole area. The above observations are discussed along with the seismicity and geophysical data of the area in order to understand the geodynamic processes that occur in the region and their seismotectonic implications. Moreover, an attempt is made to assess the seismic hazard in this region and to clarify whether there is a high potential for a large earthquake in the near future.

Ridge and trough terrains on outer planet satellites

Pappalardo R. T.

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

Major satellites of all four outer planets display ridges and troughs, occurring individually and in subparallel sets of "ridge and trough terrain." Ganymede's bright "grooved terrain" is the archetype example, where the icy surface is deformed at multiple scales and locally highly strained. Its characteristics are consistent with domino-style normal faulting and extensional necking of an ice-rich lithosphere above a ductile icy asthenosphere. Probably the best terrestrial analogues to the faulted icy lithosphere of Ganymede are the Basin and Range of the western United States and the pervasively faulted lithosphere of the Afar rift zone of Ethiopia. Other ridge and trough terrains and related landforms also occur on Io, Europa, Callisto, Enceladus, Tethys, Dione, Rhea, Miranda, Ariel, and Triton. A variety of geological processes can produce individual ridge or trough landforms or sets of ridge and trough terrain. In tectonic models, they can be produced by extension (as tilt-block or horst-and-graben normal fault blocks), contraction (as thrust blocks and/or folds), or strike-slip (especially as related to fault duplexing). In magmatic models, ridges might form by extrusion (as linear eruptions) or intrusion (as linear laccolith-like bodies) of volcanic or diapiric source materials. Imaging data from the Voyager, Galileo, and Cassini spacecraft reveal a wide variety of specific ridge and trough morphologies on the outer planet satellites. Extensional tectonism is inferred as the principal cause of many ridge and trough terrains, and has at least partially tectonically resurfaced older terrains by erasing preexisting features and/or brightened surfaces by revealing brighter material beneath a darker surface layer (on Ganymede, Europa, Enceladus, Tethys, Dione, and Rhea). There is also strong evidence that contraction (on Io, Europa, and Enceladus) and strike-slip faulting (on Ganymede and Europa) have shaped some ridge and trough terrains. Active strike-slip tectonism is inferred on Enceladus today, driven by tidal forcing as the satellite orbits Saturn. Intrusive and extrusive models are viable for some individual ridge and ridge sets on Europa, Miranda, Ariel, and Triton. While important commonalities of morphologies and process exist, multiple processes are inferred to have formed ridges and troughs on the outer planet satellites, implying rich geological histories. Comparison to terrestrial analogues is extremely valuable to deciphering the nature of ridge and trough terrains on the outer planet satellites.

Integrated landform mapping: methodology and application for digital soil mapping in Somalia

Paron P.[1], **Vargas Rojas R.**[2], **Omuto C.T.**[3]

[1]*Freelance Consultant, PoBox 8 – 00606 Nairobi, Kenya (paoloparon@gmail.com)*
[2]*CISTEL– San Simon University, Cochabamba, Bolivia (sbcs_cbba@yahoo.com)*
[3]Department *of Environmental &* Biosystems Engineering, University of Nairobi, Kenya (*thineomuto@yahoo.com*)

A new baseline for land development in Somalia was one of the goals of FAO SWALIM Project. Two study areas were chosen according to population density distribution and to the presence of agriculture land use: one in the northwest and one in the southern part of the country. This presentation focuses on the methodology used and on the application of its outputs for digital soil mapping. An integrated landform mapping approach - combining GIS, Remote Sensing and a very limited field survey- was set up and tested. It led to the creation of a new semi-detailed baseline (scales from 1:100.000 to 1:50.000) of landform that has been used as a predictor for digital soil mapping and also for land suitability assessment. The landform mapping was conducted exploiting most of the characteristics of the GIS environment (overlaying, transparency, spatial analysis, database management, etc), integrating different data layers: topographic maps, geological maps, DEMs and their supervised digital automatic elaboration, and multi-resolution, multispectral and multitemporal satellite imagery. A hierarchical landform legend (Landscapes, Landforms, Reliefs) was set up adapting the GeoPedologic approach to the specific use and morphogenetic environments, and considering also other land mapping systems like the FAO-SOTER approach among others. A semi-automated landform legend system was developed under GIS environment, exploiting the ESRI Geodatabase domains characteristics, in order to aid the image interpreters in performing their work. The two areas differing greatly in terms of climate, geology, morphology, vegetation, land cover and land use, proved to be good test sites for this approach. From a morphological point of view the northern area (western part of the former Somaliland) is characterized by a quite elevated and dissected topography, with elevation ranging from sea level to 1850 m a.s.l. The following main landscapes have been identified: coastal area, piedmonts, peneplains, hillands, mountainous areas, plateaus, and valleys. Three main climatic zones (pertaining to the arid and semi-arid climates) follow the landscape subdivision. The southern area, corresponding to the lower part of the Jubba and Shabelle river basins, is characterized by a topography with elevation from sea level to 750 m a.s.l. The main Landscapes found here are alluvial plains, domed hill-land, piedmont and valleys. This area is characterized by a higher value of rainfall than the northern one, still falling into the semi-arid climate. As a result two new landform maps and a semi-automated hierarchical landform legend under GIS environment were prepared. An enhancement of the GeoPedologic approach is also suggested. The landform maps were adopted as one of the fundamental layers for the Digital Soil Mapping, the the land suitability assessment and for the soil erosion modeling activities in the project. Further application of this methodology in different geological and morphoclimatic context (Kenya) and with different datasets is already ongoing by the authors.

Analysis of environmental change in Somalia using historical aerial photography archives

Paron P.[1], **Munro R. N.**[2]

[1]*Freelance Consultant, P.O. Box 8 Nairobi, Kenya (paoloparon@gmail.com)*
[2]*Old Abbey Associates, Tarbet Court, Dirleton, Scotland, EH39 5DX, UK*

Environmental change in Somalia and in the whole Horn of Africa has had a large impact on livelihoods especially on the pastoralist communities who rely so much on the availability of pastures in the rangelands. The Somalia part of the Horn of Africa is a vast tract of land where in the last twenty years civil strife has made most of it inaccessible for extensive field survey. Furthermore, it appears that global climate change has had a significant impact on this region: the older photography will help resolve the questions being asked for this region. A necessary tool for the analysis of environmental change is remote sensing. The recent satellite images offer a good aid in this field as they have very high resolution. The availability of decades old aerial photography taken during between the 1940s and 1970s over the same area, offers the possibility to extend the creation of baselines backwards in time beyond the advent of systematic satellite coverage in 1972. At present, we own a very large (over 500 items) photo-archive of aerial photographic mosaics, and individual photographs, dating mostly from the 1960s, and covering almost all of Somalia. This needs to be scanned, converted in most cases from negative to positive images and then geo-referenced. The project would then make analysis of change between this dataset and the present period. This poster presents the availability of such an immense archive and proposes a project to transform this hardcopy material into a modern digital and geo-referenced one, that can then be used freely and for non-profit research. The proposed project will be a supplement to a larger one that is attempting to bring into use some 1.5 million stereo aerial –photographs that cover the former British colonies and other Commonwealth countries. These photos have also the advantage of often being taken repeatedly over the same territories during the 1940s-1980s and are at scales of 1:30,000 to 1:60,000. We seek partners and funding to save the Somalia mosaic and photograph archive and transform it into a workable dataset, from which we can then make analysis of change.

Review on the possible stream piracy drainages between the Middle Paraiba do Sul and High Tietê: the case of Guararema's elbow – Brazil

Pasa V., de Oliveira D.

Department of Geography, University of São Paulo (USP), Brazil (vaniza@usp.br; debolive@usp.br)

This poster aims to resume some discussions of the 1950s on the stream piracy localized in the municipality of Guararema (Sao Paolo, Brazil) to obtain new knowledge about the old connections and the possible separation of the drainages of the rivers Tietê and Paraíba do Sul. It starts with understanding the process of stream piracy in the medium course of Paraíba, which would be responsible for the appearance of a wind gap between the two drainages in question. The landscape of this region is of great interest because it presents peculiar aspects of relief, and for being one of the few areas in Brazil where there has been such a geomorphological feature. In the region of Mogi das Cruzes, the High Tietê is at 740-745 m a.s.l. while the Paraiba River in Guararema, where there is an elbow, is in the range of 575 m a.s.l., being separated by a small relief of granite mountains in the Saw Itapeti. Both in the High Tiete as in the upper and middle Paraíba do Sul, the smaller branches of the drainage is dendritic, while the rivers of medium size have a parallel pattern, sometimes rectangular. The drainage networks of High Tietê and the Middle Paraíba do Sul are in the Plateau Paulista Atlantic. This region is characterized by highlands and consists mainly of crystalline rocks of Precambrian and Cambro-Ordovician, cut by intrusive basic and alkaline Mesozoic-Tertiary, and also by the covers of the sedimentary basins of São Paulo and Taubaté, the first being of tectonic origin. In the region of Guararema, whose sediments are in São Paulo Formation, it is likely that we preceded the piracy a tributary of the High Tietê by Middle Paraíba do Sul, forming an elbow. Few are known about the old connections and separation of these two drainages and the geological and geomorphological processes involved in the period preceding the formation of the elbow. What we know so far is that the passage of the alluvial fan to fluvial deposits of meandering São Paulo Formation may be related to paleoclimate change to wetter conditions. The stream piracy would be the natural diversion of water from one river basin to another, promoting the expansion of a drainage at the expense of neighboring and absorption can occur when a river captures the waters of a river neighboring another; by headwater erosion, when there are two rivers of different altitudes and lower-level undergoes regressive erosion in the headwaters; planning by side, where erosion occurs lateral and posterior caving drying the valley; for overflow of water courses stodgy which rises to higher levels and can cross the lower valleys and turns to a neighboring valley; and underground, caused by the dissolution rate of rocks and by movement of groundwater. The Paraiba do Sul River drainage has a national reach, stretching for three Brazilian states (São Paulo, Rio de Janeiro and Minas Gerais). But there are few authors who try to study the stream piracy, this fact reflected in the literature found, mainly on the possible capture of the river Paraíba do Sul and Tietê. The few works that are known, were developed in the 50s, and were not resumed until then. The premise that an elbow of stream piracy has occurred in the middle valley of the Paraiba do Sul River may be proved with the interpretation of the sedimentation process occurred in the Tertiary and Pleistocene on old connections and the subsequent separation of the drainages of the Tietê River and Paraíba do Sul likely to have succeeded by headwater erosion, which would have formed a so-called angle of 90 degrees in the course captured by a tributary of the Middle Paraíba do Sul.

Multidisciplinary study of Holocene soils in the archaeological site "Piani della Corona"(SW Calabria, southern Italy): paleoenvironmental reconstruction

Pelle T.[1], Scarciglia F.[1], La Russa M.F.[1], Natali E.[2], Tinè V.[2]

[1]*Dipartimento di Scienze della Terra, Università della Calabria, Via Pietro Bucci - Cubo 15B, I-87036 Arcavacata di Rende - CS, Italy (teresa.pelle@unical.it, scarciglia@unical.it, mlarussa@unical.it)*
[2]*Soprintendenza Speciale al Museo Nazionale Preistorico Etnografico "L. Pigorini", Roma, Italy (elena.natali@libero.it, vincenzo.tine@libero.it)*

This work focuses on the reconstruction of climatic and environmental changes during the Holocene through a multidisciplinary study (geoarchaeological, geomorphological and pedostratigraphic approach) of a succession of volcanic soils (Andosols) in SW Calabria, southern Italy. They were excavated in the archaeological site "Piani della Corona", on a wide terrace at 500 m a.s.l. in the surroundings of Palmi. They can be partly dated on the basis of archaeological settlements and finds (ceramic fragments, plowing traces, typical incineration burials found in biconical vases, etc.). An extensive settlement of late early Bronze Age (4000-3700 cal. years BP) and traces of late Neolithic human colonization (6500-5800 cal. years BP) were exhumed. The studied soils show some different features through the pedostratigraphic succession that can be ascribed to Holocene environmental and possibly climatic changes. The upper stratigraphic succession consists of organic-mineral (A) horizons, brown to dark brown in colour, that appear cyclically ploughed during historical times (archaeologically not well dated as a consequence of their reworking for agricultural practices), in places disturbing with abrupt irregular boundaries the underlying horizons. Yellowish-brown, deep argillic horizons (Bt) are also present, with variable amounts of clay coatings in pores, indicating an important illuviation process. The above soil features, coupled with micromorphological observations performed on thin sections from undisturbed soil samples, and chemical, physical and mineralogical analyses, allowed us the following reconstruction. Micromorphological observations confirmed the presence of clay coatings within pores of Bt horizons, suggesting that they have a relict significance and that the illuvial process is inactive: in fact, they are often fragmented and with smooth-banded to grainy extinction patterns between crossed polars. Frequently, dark brown infillings are found in the Bt horizons. They can be interpreted as cavities left by decomposed roots or bioturbation, filled with organic-rich material. This material was probably eroded from surface organic-mineral horizons (nowadays not completely preserved) developed under particularly suited climatic conditions and vegetation cover. In A horizons, characterized by granular to dominant isotropic matrix, some reddish-yellow, subrounded pedorelicts exhibiting fragments of clay coatings, occur, probably derived from the underlying Bt horizons. Based on the archaeological constraints, the Bt horizons and their associated A horizons (partly eroded and reworked) are partly included within the Holocene climatic optimum. The occurrence of clay coatings suggests (pedo) climatic conditions characterized by high moisture availability and some seasonal contrast, enhanced by a warm and humid climate. These conditions are supported by (i) less developed andic properties, estimated with the ICOMAND index and FT-IR spectroscopy in argillic horizons (indicative of low amounts of short-range order minerals (SROM), such as proto-imogolite, imogolite and/or allophane), (ii) more abundant phyllosilicate clays (mainly halloysite and at a minor extent chlorite, smectite and illite) detected by X-ray diffractometry. In contrast, A horizons show more developed andic properties, due to abundant SROM coupled with minor phyllosilicate components. This feature suggests the occurrence of a regime with prolonged and seasonally poorly-contrasted moisture availability, promoting SROM rather than phyllosilicate clays. The variability of andic properties with depth suggests climatic changes probably occurred at the transition from the Neolithic climatic optimum to the upper Holocene, after a period characterized by severe land degradation during the Bronze age, testified by soil erosion and human impact. This phase was presumably coupled with deforestation and agricultural practices, highlighted by truncation of late prehistoric fertile A horizons, once developed at surface under particularly suited climatic conditions and vegetation cover, but nowadays not completely preserved *in situ*. The eroded material likely represents the organic-rich filling of soil macropores in the argillic horizons and more extensively of ploughing furrows and artificial excavations. The chronological constraints supplied by the archaeological stratigraphy are in agreement with the volcanic glass content (pumices) identified with SEM-EDS analysis in all soil horizons. Their dominant rhyolitic composition is quite similar to that analyzed in the nearby, analogous, widespread Andosols of Monte Poro upland and Gioia Tauro plain, which can be related to late Pleistocene to Holocene volcanic eruption/s from the Eolian Islands. Therefore major soil development at the study site probably occurred during most of the Holocene and possibly during part of the late Pleistocene.

Control of geomorphic patterns on development of aeolian processes during the last dry period in a Sahelian region (1970-1999)

Penven M. J., Bouhahad S., Cotonnec A.

Laboratoire COSTEL, UMR 6554 CNRS, Université Rennes 2, UEB, France (marie-josee.penven@uhb.fr)

During the dry period of 1970 - 2000, sahelian rangelands have underwent land degradation by wind erosion and regression of vegetation cover. Many authors have written about this degradation and associated desertification wich implied decrease in fodder resources of cattle and leading to the impoverishment of people. In the south eastern Mauritania, the Hodh depression, is located near the town of Kiffa at the bottom of the Assaba Plateau. It belongs to the dry Sahelian domain with 292 mm of annual rainfalls. This region is covered by a mantle of red sands whose thickness increases from north east to south west. In a parallel direction sand ridge complexes developed with low elevation in the north east (10 m mean between the top ridge and the middle of the inter ridge) and high elevation in the south west (100 m). This organization is in accordance with the theory of Mainguet (1995), the Synoptic Global Wind Action System (GWAS). The wind system is generated in the Sahara desert and is loaded with sands and loams which are dispatched on the Sahelian landranges. This system explains the aeolian geomorphic pattern of sand ridges edified during the last pleistocene period in all regions of Southern Mauritania. Today, after about thirty dry years, the landscape presents a patchwork of mobile sandy areas and of large surfaces of relative high density vegetation. The mobile sandy areas are strictly located on the top of the ridges. They increase towards the south west direction and display active geomorphic aeolian forms. In another study (Cotonnec *et al*., 2010), we have shown that mobile aeolian sands occupied 12% of all the region after 18 years of drought, and more than 15 % at the end of the period in 1999. But this is an average percentage, and the percentage calculated in the south west of the region points out a cover of 30 – 35 % mobile sands in 1999. These voluminous sandy accumulations with active transverse aeolian forms show a positive sediment budget. For Mainguet, in a study on the neighbours of Nouakchott (capital of Mauritania, on the atlantic coastline), wind system of the GWAS explain transformations of sahelian landscapes from fixed sand ridges into active sandy areas. It was our first interpretation, but our field observations in a part of the area show a more complex configuration and more particularly a singular relationship between the presence of sand accumulations and the presence of high density gullies, inherited from the previous wet decades. Our aim is to assess the impact of inherited gully patterns in the development of aeolian geomorphic processes during a dry period and so to validate this relationship. Our method is a spatial and diachronic approach over the period 1956 - 1999, the first date corresponding to the previous wet period (before the beginning of the 70's) and second to the end of the dry period in the Hodh region. We used aerial photographs (1956) and Landsat ETM (1999). We have chosen a representative area which covers a sequence from low to great sand ridges and we have mapped it by stereoscopy. On the same area, mobile sand accumulations were discriminated on Landsat ETM by making a CPA on all the bands of the data, except the band 6. We chose the Neo-band 1 which allows separating the vegetation cover and the bare sands. The 1956 geomorphological map and the bare sand map of 1999 were corrected in geodesic system WGS 84, UTM N 29 and then superposed. The aerial photographs of 1956 authorize an inventory of the features of the landscape before the dry period. This area was characterized by a steppique cover (herbaceous cover and scattered woody vegetation) which stabilized soils and landforms. However this steppique cover promotes hydrological processes of erosion and helps to generate high density deep gullies on the slopes of the sand ridges. The density of incisions is particularly high on the head of the gullies, located in the convexity of the top slope of the sand ridge. Their distribution is controlled by the shape and the elevation of the sand ridges. Gullies are only located west and south west of the area, on the greatest sand ridges. The superposition of the geomorphological map of 1956 and the map of the bare mobile sands in 1999 show a strong relationship between the distribution of the network of gullies and the mobile sand areas. On boundary area between mobile sand accumulations and vegetation cover, our field observations on the heads of the gullies allow to focuss on the aeolian processes of deflation and deposition. The wind blows along rodge. When the wind crosses the head of a gully it has a double effect: first it erodes the sides of the gullies, and second it exports and accumulates the eroded sand on the downwind side of the gully. Progressively mobile sands recover all the top of these eroded sand ridges. The network of gullies is a factor of wind erosion and this shows that inherited geomorphic pattern of a wet period controls the development of aeolian processes during the next dryer period in a dry region. However, we can suppose that the GWAS has an impact on the movement of sands but the discrimination between local and allogenic sands is difficult: particle size analysis performed on the mobile sands and on the local material of dune ridges show that they have the same composition.

Geomatics applications for reliable geomorphological field mapping: examples from the western Alps

Perotti L., Giardino M., Alberto W.

GeoSITlab, GIS and Geomatics Laboratory, Department of Earth Sciences, University of Torino, Via Valperga Caluso, 35, I-10125 Torino, Italy

Geomorphological studies are devoted to collect and interpret information on Earth's surface form, materials, processes and age of formation. Geomorphological maps are synthetic ways of showing the above-mentioned information and are suitable both for theoretical and applied studies. As stated by the Working Group on Applied Geomorphological Mapping (AppGeMa) of the International Association of Geomorphologists, geomorphological maps are, in fact, not only important as end products of scientific researches but also as tools for technical applications by professionals dealing with the landscape and landforms. Classical methods for field data collection on geological and geomorphological features are based on the use of relatively simple tools, such as paper notebooks, coloured pencils, base maps… together with the personal skills of researchers. In the last 15 years, the use of computers and other electronic devices for collection, analysis and distribution of field data had a notable development also in the Earth Sciences and their applications to environmental analysis. This originated effective improvements not only in the field activities, but also in the laboratory ones, in terms of enhancement in both rapidity and precision of data processing, interpretation, and representation. Still, many not-yet-resolved problems concern either the conceptual framework or the practical solutions for field data collection and their transposition into maps. In order to fulfil the above-mentioned requirements, the authors aimed to develop a new application for palm computers to support field data collection and mapping activities on geomorphology. The paper presents and discusses the capabilities of the application including some considerations on essentials in mapping activities, attributes of geological/geomorphological features and characteristics of Geomatics tools and methodologies. Methodologies have been tested in the Western Alps for creating maps and descriptions suitable for both scientific and educational purposes. Some case studies evidenced the importance of supporting terrain surveys and mapping products by 3-D imageries (combination of DEMs and remote sensing images). Some others showed importance of structuring geodatabases and using GIS technologies for better collection, management and presentation of geosites data for geotourism purposes. The analyzed case studies in the Western Alps show how geomorphological maps can enhance assessment, planning and geomorphological landscape management. Standards of mapping procedures and legend systems for different scales have been followed, in order to provide precise and unequivocal information on distribution of landforms, soils and rocks. Thus far, by means of proper geomorphological mapping, a correct identification and interpretation of features created by surface processes can be performed, thus enhancing the modelling of past and present evolutionary stages of landforms. This turns out to be very useful for achieving different objectives: to model geomorphological processes, to draw evolutionary scenarios of natural hazards, to disseminate scientific knowledge.

Palaeosols as proxies for Holocene climate change along the ITCZ (Yemen, Ethiopia)

Pietsch D., Kühn P.

University of Tübingen, Chair of Soil Science and Geomorphology, Institute of Geography, Rümelinstrasse 19-23, 72076 Tübingen, GERMANY (dana.pietsch@uni-tuebingen.de)

Pedostratigraphic and morphological data of soils at the Ar-Rub' Al-Khali desert margin around Ma'rib and in the Highlands of Yemen show a well-preserved and wide-spread Holocene palaeosol. This buried soil can be found in intra-mountainous basins, on plains and pediments and is analysed by AMS ^{14}C-, pedochemical, geochemical data, and micromorphology. It is mainly represented by Ahb and ABb horizons, and is considered as a new proxy of Holocene climate change with alternating low and high precipitation during the Early Holocene and the transition period from the Early to the Middle Holocene. The marker horizon indicates pedogenesis in a moist climate in Southern Arabia between 12 and 6.5 ka BP. Based on geochemical data palaeoprecipiation in this region is calculated as 400 to 600 mm yr^{-1}. Sediments covering the palaeosol show no pedogenic features and are therefore obviously a result of increasing aridity at the latest from 6 ka BP on. In comparison to Yemen, first data of investigations in Tigray, Ethiopia are presented. Both study areas are at the same latitude but with a western-aspect in Ethiopia and an eastern-aspect in the Yemen highlands. Local climate patterns as well as long-term climate fluctuations in both regions can be demonstrated by the stratigraphy and distribution of the palaeosols. We assume, when dated and analysed, the Ethiopian palaeosols will show similarities in the age and in the soil developmental stage – e.g. the intensity of silicate weathering and humus enrichment – to the palaeosols in Yemen and, therefore, substantiate climatic connections between Southern Arabia and East Africa at the end of the early-Holocene period. Finally we propose that the pedogenic status quo is a very important proxy for the interpretation of regional palaeoclimate fluctuations, especially caused by the southward shift of the ITCZ.

Research challenges for soil erosion, soil and water conservation in tropical environments

Poesen J.

Division of Geography, Department of Earth and Environmental Sciences, K.U.Leuven, Heverlee, Belgium

Tropical environments face, like other environments, significant specific environmental changes now and in the near future: i.e. climate change but above all significant land use changes induced by a growing population and urban sprawl. As a consequence, important changes in soil erosion processes and rates at various temporal and spatial scales are to be expected. These need to be better understood in order to adapt human activities and to design and apply appropriate soil and water conservation measures. This presentation focuses on some research gaps related to these geomorphic processes, their rates, controlling factors and possible mitigation measures. Sheet and rill erosion rates in the tropics have been investigated in numerous studies. However, comparatively few studies have looked at gully erosion, piping and river bank erosion as significant sediment sources in tropical landscapes. Likewise, limited attention has been given to rates of anthropogenic soil erosion processes such as tillage erosion, erosion due to crop harvesting, erosion due to land levelling or erosion by cattle trampling. In addition, there is a need to investigate the interactions between these processes as well. Worldwide, there is an increasing interest in land sliding as it affects the livelihood of many people; however, here too land sliding in large parts of the tropics remains an under-researched geomorphic process. Most soil erosion studies have concentrated on agricultural land. Yet other erosion hot spots being major sediment sources such as villages, zones of urban sprawl and (rural) footpaths and roads deserve more research attention. Catchment sediment yield (SY) data for tropical environments are relatively scarce, yet such data are crucial for e.g. the design of reservoirs. In addition, in the drier parts of the tropics, SY is an important desertification indicator and more data are needed to assess spatial and temporal changes in desertification. Many erosion data in the tropics have been collected at the plot or hill slope scale. A major challenge remains the extrapolation of such data to various catchment scales. Recent studies have clearly shown that simple negative relationships between catchment area (A) and area-specific sediment yield (SSY) do not always hold in a range of environments. A major challenge is to develop appropriate methodologies to allow scaling up of erosion rates or sediment yield data collected at particular spatial scales. More efforts should be undertaken to investigate the sediment connectivity in landscapes, the A-SSY relation for various tropical environments and to link this to sediment budgets for various catchment areas. Although a whole range of indigenous soil and water conservation techniques (SWCT) for controlling water erosion in tropical environments exist (see e.g. WOCAT database), still little is known in quantitative terms about their effectiveness in reducing both soil loss and runoff and therefore more research should concentrate on this topic. Vegetation plays a crucial role in erosion control. However, most research has been devoted to the effects of the above-ground biomass characteristics on soil erosion processes, very often neglecting the effects of the below-ground biomass characteristics. Therefore, more research attention should be given to the effects of plant root architecture on erosion process rates and how better insights in this topic might help in conserving soils in a more effective way.

Soil degradation along rainfall gradient on the Meghalaya Plateau (northeastern India)

Prokop P.

Institute of Geography and Spatial Organization, Polish Academy of Sciences, Jana 22, PL-31-018 Krakow, Poland (pawel@zg.pan.krakow.pl)

The Meghalaya Plateau in NE India forms an E-W trending hilly horst block elevated to about 1,900 m a.s.l. Its southern slope strongly modifies southwest monsoon rainfall distribution on a large area. The mean annual rainfall decreases with the distance from the southern edge of the plateau from 11,000 mm in Cherrapunji (1,300 m a.s.l.) to 2,500 mm in Shillong (1,600 m a.s.l.) over a distance of 30 km. Horizontally bedded Cretaceous-Tertiary sandstones near Cherrapunji are parent material for shallow soils which are classified as Humic, Lithic or Typic Dystrudepts. Precambrian metamorphic and igneous rocks built up the central part of the plateau near Shillong. These geological formations have given rise to deep soils which are classified as Umbric and Typic Dystrochrepts. In natural conditions, under forest, the soils of Meghalaya are excessively drained, acidic in nature (pH varies from 3 to 6) with organic matter content up to 9%. The nature of present-day soil degradation is connected with clearing of subtropical broad-leaved forest for agriculture and mineral extraction in historical times. High rates of overland flow produced by heavy rainfalls accelerated slope wash. Varying degrees of erosion have affected large areas of the hilly plateau. Consequently, soil degradation reflects annual rainfall distribution pattern and to some extent it depends on weathered cover of geological formation.

Environmental response to human impact on the Meghalaya Plateau (northeastern India) during the last 2500 yrs BP

Prokop P.[1], **Bhattacharyya A.**[2]

[1]*Institute of Geography and Spatial Organization, Polish Academy of Sciences, Jana 22, 31-018 Krakow, Poland, (pawel@zg.pan.krakow.pl)*
[2]*Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India, (amalava@yahoo.com)*

The Meghalaya Plateau elevated to about 1900 m a.s.l. forms a first barrier to the humid southwest monsoon on its way from the Bay of Bengal to the Himalayas. Orographic effect considerably enhances the rainfall over the southern slope of the plateau which is one of the rainiest inhabited environments on Earth, with more than 11,000 mm of precipitation recorded annually in Cherrapunji. High monsoonal rainfall combined with agricultural development and mineral extraction caused deforestation and intensive erosion over large tracts of land. Subtropical broad-leaved forest which is assumed to have grown on the hilly plateau in the past was replaced by grasses with small, patches of secondary pines above 1000 m a.s.l. As a result, in the landscape of the Meghalaya, coexist elements of the processes characteristic for monsoonal as well as desert or steppe environment. Pollen and grain size analysis supported by radiocarbon dating of the several colluvial, alluvial and lacustrine sediment profiles of this region provided records of climatic conditions and human impact during Late Holocene. Analysis reveals that some places of the upper part of the Meghalaya Plateau were occupied by an open meadow around 2500 year BP, close to subtropical forest where trees like *Quercus, Betula, Carpinus, Myrica, Alnus, Ilex* and *Prunus* were common elements. The meadow was covered mostly by the members of Arecaceae, Polygonaceae, Poaceae and Asteraceae. Ferns were very common close to the site but conifers were absent or distantly located. Presence of a large number of fungal spores throughout the pollen diagram suggests that climate in the area was warm and humid in general. Around 800 year BP the amount of *Pinus* pollen increases in the profiles and a higher input of fine grained mineral material is observed in lacustrine sediments. These can indicate progressing deforestation of some parts of the Meghalaya Plateau. Subsequently, during the last 400-300 years BP both meadow and forest were much degraded due to iron ore extraction and intensification of agriculture. This is evident from the presence of a large amount of charcoal in the coarse grained colluvial deposits. Tree elements, except members of Arecaceae become rare or absent. This data for the first time documents a long and intensive human impact on the environment at higher altitudes of North-East India.

Volcanic geomorphology of southeast Ethiopia

Purcell P.[1], **Mege D.**[2], **Jourdan F.**[3]

[1]*P & R Geological Consultants, Scarborough, Western Australia (peterpurcell@tpgi.com.au)*
[2]*Laboratoire de planétologie et géodynamique, UMR CNRS 6112, Université de Nantes, France (daniel.mege@univ-nantes.fr)*
[3]*Western Australia Argon Isotope Facility, Curtin University of Technology, Perth, Western Australia (F.Jourdan@exchange.curtin.edu.au)*

A new map of the volcanic landscape of the Ogaden region of southeast Ethiopia and adjacent areas of Somalia has been prepared using ETM imagery, supported by local field investigations and supplemented by extensive magnetic data from oil industry surveys. Tertiary volcanic outcrops, now accurately depicted, are shown to be more extensive than previously recognized, while magnetic and drill data show the vast extent of the magmatism. Trap Series basalts are thick (to 1500 m) along the rift and Afar margin, but thin rapidly to the south, where basalts provide capping to the plateaux along the upper Wabe Shebelle canyon. Several spectacular 'meandering' outcrops are undoubtedly exhumed canyon-filling flows. These outcrops, 50-100 km apart and evidencing magma flows over 100 km long, testify to the presence during the Late Tertiary of large river systems across the region. One meander system occurs near and parallel to the present-day Wabe Shebelle, showing the longevity of this drainage system and the larger size of the ancestral river. The well-known volcanic lineament of the Marda Range in north central Ogaden is now thought to have formed by in-filling a fault-controlled river valley, rather than by fissure eruption. Magnetic data from oil exploration surveys show meandering belts of high frequency/high amplitude anomalies that, because of overlaps with basalt outcrops and well intersections, can be reliably interpreted as additional flows. These magnetic data show that isolated basaltic outcrops are part of extensive canyon-fill flows, the bulk of which are now subsurface. In particular, the scattered, poorly mapped outcrops extending from near Dolo on the southern Ethiopia border eastward across central Somalia are shown by associated magnetic anomalies to be part of a massive meandering flow complex over 400 km long and 15-50 km wide. Age dating and well intersections show several volcanic episodes, with the major outpouring occurring across a broad peneplain in the Oligocene. Confluence of the basalt 'meanders' can be used to suggest source areas for the magma. A major dyke swarm extending southeast from the Marda Fault Zone to the Ilgal Hills in the eastern Ogaden has been mapped on ETM imagery and confirmed by magnetics. On the surface, these dyke lineaments are manifest along most of their length as linear depressions varying to 1 km wide and about 15 m deep. The dykes, which also outcrop in isolated hills near the Ethiopia/Somalia border, have been dated at 24-26 Ma and define a zone of crustal extension across the Horn of Africa during the embryonic stages of the Afro-Arabian rifting event. Basalt flows from this dyke system, both sheet and canyon-fill, occur in the subsurface over a vast area, extending into Somalia, as evidenced by intersections in water and oil wells. These basalts are an important control on hydrological resources in the area and a better understanding of their distribution and origin might assist the search for oil and gas in the region.

Recent transformation of alpine debris slopes in the Tatra mts. (Poland)

Rączkowska Z.

Department of Geomorphology and Hydrology of Mountains and Uplands, Institute of Geography and Spatial Organisation, Św. Jana 22, 31-018 Kraków, Poland (raczk@zg.pan.krakow.pl)

The Tatras, reaching up to 2655 m a.s.l., are located at the border between Poland and Slovakia. The highest parts of the Tatras are built predominantly of granite and metamorphic rocks. Their relief is of alpine character. Alpine cliffs and talus slopes below are common features as well as debris mantled slopes with thin weathering cover, built of coarse material. Maximum monthly and daily precipitations as well as high intensity rainfalls of short duration occur in the middle parts of their northern slopes. The most significant role in recent transformation of the Tatras slopes play debris flows, even in the area of cryogenic domain above the timberline (Rączkowska, 2006). They are especially active on slopes and the bottom of glacial cirques where debris flow accumulation buried glacial and periglacial relief. The recent activity of debris flows and debris slopes in the Tatras was examined in summer 2008 and 2009. The method of lichometric dating was applied for studies. The lichen factor for the alpine and subalpine altitudinal belts, established by Kotarba (1988, Jonasson *et al.,* 1991) was used for evaluation age of landforms. Lichens size was measured on debris along the cross profiles of the studied slopes, located in middle part of their altitudinal extend. Landforms of slope microrelief, like debris flow gullies, debris flow levee, avalanche tongue etc., were determined within studied profiles. Diameters of five largest lichens were measured on each microform, and their age was established. Activity of debris flows was examined based on analysis of debris flows tracks on air-photos at 6 time spans during last 60 years. The results of lichenometric studies shows continuous transformation of debris slopes and debris flows activity, during last few hundreds years. Yet there are periods of increased transformation of slopes, what is documented by the highest number of slope fragments of the same age. Such periods are frequent at the end of the Little Ice Age, for example 1909-1913 or 1935-1937. It occurs also afterwards. The latter is confined to periods of increased days with high precipitation. Analysis of precipitation during last 60 years was made based on daily totals. It was found that precipitation triggering debris flows could occur even few times every year. Yet, increase of number of days with precipitation higher then 50 mm was found in the following periods 1947-50, 1963-1966, 1972-1975, 1980-1981, 1989-1991 and 2001 (Niedźwiedź 2003). The results of analysis of air-photos confirm spatial and temporal differentiation of debris flows occurrence and sizes. However, entirely fresh, new gullies are very rare. Debris flows usually use the same gullies or part of it during following rainfall events. But there are distinct differences in number of debris flows in particular time spans. It could be linked with climate changes, but also with human activity, in form of intensive pasture, until seventies in 20 century.

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Some remarks on granitic relief of the Meghalaya Plateau (India)

Rączkowska Z.

Department of Geomorphology and Hydrology of Mountains and Uplands, Institute of Geography and Spatial Organisation, Św. Jana 22, PL-31-018 Kraków, Poland (raczk@zg.pan.krakow.pl)

Granite batholiths, occurring within geological structure of the Meghalaya Plateau (north-eastern India) are marked in the landscape of the area by very specific landform, related to deep weathering, which is characteristic for tropical and subtropical regions. Landform of granite areas was studied in Myliem-Nongkrem region (built with granite) and in Nongstoin region (built with granulite and granite-gneiss). The region is an extreme humid area. Heavy precipitation and man activity are the main factors influence relief development. Generally relief of both studied areas is similar. Dome shape hills, arranged chaotically or in ridges, are characteristic feature of their landform. Depressions between them are occupied by closed drainages or river valleys. Slopes are relatively gentle (10-20°). However differences of relief between discussed areas were observed. In the Nongstoin area depth of weathering of granite is lower then in Myliem. The large undulating top plateau occurs at altitude 1200 m a.s.l. Slopes mostly are mantled by loamy covers with submerged boulder of few meters in size. Relatively not large slope fragments are covered by layer of boulders exposed by erosion from slopes covers. Widespread is debris pavement protected slope surface. Material eroded and removed from slopes filled bottoms of shallow hollows, 1-2 m deep in upper part of valley slopes and 10-15 m in the lower. Layers of buried soils visible in cross-profile of such hollows indicate few phases of slope covers degradations. However their intensity seems be lower than in the Myliem area. Relief of the Myliem area is more typical for granite areas. The detailed study was done in the upper Umiew drainage basin, in Nongkrem region. The broad ridges are elevated here up 1800-1850 m a.s.l. The numerous tors are the characteristic feature. Some of them are huge, up to 100 m in size. Majority of slopes is mantled by sandy-silt (loamy) covers, at least 15-20 m deep, with sunken rocky boulders. Granite in the area is deeply weathered. Large parts of slopes are mantled by covers of big boulders (few to tens meters in diameter) unveiled form weathering covers. Generally, complete slope covers exist only fragmentarily, because fine weathered material was removed form majority of them by natural geomorphic processes, especially sheetwash. Human activity is the other important factor of land degradation. Material removed from slopes is partly accumulated in valley bottom. Even in small valleys up to 10 m deep layer of sediment exists. Valleys are of different shape and size. Width of valley bottoms varies from few tens to few hundreds meters. Below outlets of hemispherical slope hollows relatively large alluvial fans develop there. Their structure is built with following layers of unsorted material (silt, sand and gravel) with fine material on top. Occurrence of hanging fragments of valleys, especially their uppermost parts, is characteristic feature of the area. They work as local sediment traps. Broad basins like Nongkrem also occur. Dome shape surfaces of bare solid rock occupied fragments of its bottom. Boulders cover some of such surfaces. Narrow (2-3 m width) and relatively shallow (1-2 deep) stream channels incise alluvial valley bottom fills. The differences in landform development between studied areas may be caused by lithology and geological structure. But man activity also should be taken into consideration, especially when degradation of slope cover is discussed.

Global volcanism and tectonism on Jupiter's moon Io as manifested in surface features

Radebaugh J.[1], **Barth B.**[1], **Schleiffarth K.**[1], **Lopes R.M.C.**[2], **Christiansen E.H.**[1]

[1]*Department of Geological Sciences, Brigham Young University, Provo, UT 84602, (jani.radebaugh@byu.edu)*
[2]*Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109*

Jupiter's moon Io is one of the most volcanically active bodies in the solar system, with over one hundred active sites of silicate eruptions observed by the Voyager, Galileo, Cassini, and New Horizons spacecraft and groundbased telescopes. Mountains over 17 km in height and with steep slopes indicate a history of active tectonism. Studies of the distribution of volcanic and tectonic features have yielded some fruitful analyses, yet the global implications of the distributions and morphologies of volcanic and tectonic features have yet to be fully discerned. Key questions remain, such as, does the distribution of paterae (volcano-tectonic depressions similar to calderas), with more paterae found at the sub- and anti-jovian hemispheres, indicate enhanced tidal forces along the Jupiter-pointing axis of Io? Since these concentrations actually peak at 330° and 150°, has nonsynchronous rotation also played a role? Do other features corroborate these conclusions? What do the differences between equatorial and polar paterae, smaller and more angular vs. larger, deeper, and more round, indicate about differences in crustal properties across these regions? Why do these differences exist on a global scale? What can lineations on surface features reveal about tectonic processes? Is this tectonism the strict result of tidal action or do other processes contribute, such as convection, volcanism, burial and subsidence? These questions are being pursued through analyses of volcanic and tectonic features on Io. New ArcGIS margin mapping of 460 paterae from Voyager and Galileo images at 1-2 km resolution over ~80% of the body provides enhanced ability for analyses over previous studies. Paterae cover 2.5% of the surface of Io, consistent with previous work and have a mean diameter of 57 km, above previous results (42 km). Many paterae on Io deviate from round, as quantified in the revised mean being higher than in previous work, which used length/width measurements to find areas. The deviation of patera margins from round reflects a tectonic influence on their formation, which we hope to more fully determine by calculating margin angularity. Global patera distribution and proximity to mountains and other paterae are under study, with preliminary results corroborating those mentioned above, with peaks near the sub- and anti-jovian quadrants. Current studies (C.W. Hamilton, in progress) include nearest neighbor analyses on patera distribution. Lineations on surface features, typically a result of tectonism, can elucidate orientations and distributions of stress fields in the lithosphere. Mapping of straight patera margins, mountain crests, plateau edges, and chains of volcanic centers is underway and will be discussed. This work will highlight evidence of tectonic processes, while faults and folds are typically buried under continually replenished S and SO_2 frost deposits. These low-resolution, morphological studies of surface features are gradually illuminating crustal properties and subsurface volcanic and tectonic processes of Io.

Present forcings on coastal evolution: the coastlines of western France

Regnauld H.[1], Pian S.[1], Musereau J.[1], Mahmoud H.[1], Menier D.[2]

[1]*University Rennes 2, Costel Laboratory, UMR 6554 CNRS, Place H.Le Moal, 35043 Rennes France (herve.regnauld@uhb.fr ; haya.mahmoud@uhb.fr)*
[2]*Université de Bretagne Sud, Campus de Tohannic, 56000 Vannes (david.menier@univ-ubs.fr)*

The coastlines of western France belong to two main types. Along the English Channel they are tide dominated and along the Atlantic Ocean they are wave dominated. At the contact between these two parts, along the Mer d'Iroise a short part of the coast line is dominated by both tide and waves. Most of the coastal features may be explained by the slow and regular sea-level rise of the late Holocene, which has helped to build many barrier systems and has eroded many hard rock cliffs. In the marshes accumulation rates have kept pace with sea-level rise and, as a result the marshes have extended seaward during the Holocene. Extreme events, such as tsunami and storms are not known to have played a significant role in coastal evolution, even if locally, some impacts are clearly visible. During the second half of the 20th century human action has become the main agent for coastal evolution, mainly by eroding sand bodies and draining marshlands. During the 1980s a strong state controlled policy has turned the tide of erosion: most of the coast line is under protection and most of the sand dune systems, most of the barriers are accumulating sand again. More recently, as a probable consequence of global warming severe storms have been frequent and active, especially when they hit the coast during high water spring tides. This situation leads to a paradox: coastal management helps accumulation at a large scale, storms destroy these new accumulations. It is as if natural processes were going against man built sandy shorelines. A detailed study (out of air photos series) has been done on several tens of kilometers of coastlines, scattered from the Gironde estuary to the Rance River. The oldest photos are about the early 1950s, the most recent ones are from 2008 and 2009, depending on the site. They show that the evolution of the coastline has followed several steps. From the 1950s to the middle 1980s, retreat is dominant and is almost everywhere associated with over frequentation. From the mid 1980s to about 2000, the trend is to accumulation, mainly because of protection policies. Since 2000 new spots of erosion appear, which are not linked to an anthropic cause and which seems to be highly dependent on storm impacts. The highest retreat rates are not on sandy barrier which look as very resilient land forms but along soft rock low cliffs which may retreat by more than one meter a year. A new geography of coastline vulnerability is beginning to take shape. The most vulnerable parts are under the forcing of major storms and are not under the control of manmade protections. The less vulnerable parts are those which have the highest sediment supply and the highest resilience, because of local coastal management decisions. Some examples are presented and a discussion about a vulnerability index is started. It deals with natural forcing (mainly storms) and natural controls (mainly sediment supply). It includes human action, economic values and heritage value for the retreating coastline. It is based on a series of thresholds. It is presented as a conceptual model and is applied to the local sites. The first tests are positive and the work is on its way to be applied on other sites.

Soil productivity and food security in the central highlands of Ethiopia

Rosell S.

Department of Earth Sciences, University of Gothenburg, P.O. Box 460, 405 30 Göteborg, Sweden (staffan@gvc.gu.se)

Food security is a common problem in parts of rural Ethiopia. Soil erosion and low soil fertility are features haunting farmers to sustain a livelihood. Comparing soil properties at the slopes in Wenchi Woreda in west Shoa and a village in Tehuledere Woreda in South Wollo a situation not expected occurred. Some parameters indicates better soil productivity in South Wollo compared to west Shoa, which can be seen as opposing to the common picture environmental degradation of South Wollo. This opened up for further analysis to understand the vulnerability that rural societies are facing to obtain food security. The aim of this study is to compare soil productivity in two woredas in west Shoa and south Wollo in Ethiopia and to understand the problems to achieve food security. Geographical perspectives such as topography, population growth, land use and climate will be taken into account to understand the livelihood situation. Methods used were soil sampling at 20 cm depth at 9 spots in each cultivated field. The analysis was conducted at the Soil Laboratory in Addis Ababa. Analysed parameters were pH, organic matter, CEC, micronutrients, soil texture, among others. Physical observations and semi-structured interviews were also conducted. Results when comparing the two woredas indicate minor differences in terms of soil productivity and, in some cases, a better situation in South Wollo. Soil parameters that is interesting to highlight when comparing the two areas are the favourable values for crop growth of CEC and base saturation in the village in South Wollo. A conclusion is that there are several parameters that influence food security in Ethiopia. Topography, pressure on land which makes land holding size extremely small, access to labour, oxen and irrigation are factors of major importance for a sustainable livelihood.

A Geomorphological response model for predicting habitat change in non-perennial river systems: lessons from the Mokolo River, Limpopo province, South Africa

Rowntree K. M., Van der Waal B. W.

Catchment Research Group, Department of Geography, Rhodes University South Africa. (k.rowntree@ru.ac.za)

Protection of aquatic ecosystems is a legal requirement emanating from the water laws of many countries globally and in Africa. Methods to assess environmental flows are being developed and applied throughout the world, with an emphasis on perennial rivers. Many of Africa's rivers are non-perennial, highly variable and are data poor. South African scientists addressing environmental flow needs for non-perennial rivers are developing a different approach to those applied to perennial rivers. This approach integrates expert knowledge into a decision support system that can be used to explore different scenarios of system change. Geomorphological processes shape habitat for aquatic and riparian biota and the ecological response to a changing flow regime is largely the result of geomorphological change. Geomorphologists therefore play a key role in predicting the long-term change in ecosystem structure following water related developments. In this paper we present a case study from the Mokolo River, a tributary of the Limpopo River, where we develop geomorphic response curves that can be used to predict channel change in rivers for which there is limited hydrological or geomorphological data. These response curves, together with biological response curves, are integrated into a decision support system used to evaluate the ecological response to different water management scenarios. The process of developing these curves, and the manner in which they support the biological response, will be explained in the paper.

CO_2 ventilation in karst systems

Sánchez-Cañete E.P.[1], Serrano-Ortiz P.[1], Kowalski A. S.[2], Oyonarte C.[3], Domingo F.[1]

[1]*Estación Experimental de Zonas Áridas (EEZA), CSIC, Carretera de Sacramento S/N, E-04120 Almería, Spain (enripsc@ugr.es; penelope@eeza.csic.es; poveda@eeza.csic.es)*
[2]*Departmento de Física Aplicada, University of Granada, Av FuenteNueva, S/N, E-18071 Granada, Spain (andyk@ugr.es)*
[3]*Departmento de Edafología y Química Agrícola, University of Almería, E-04120 Almería, Spain (coyonart@ual.es)*

Carbonate soils that outcrop on ca. 12-18% of the water-free Earth present an enormous capacity to store CO_2 in subsurface cracks, pores and cavities. The amount and rate of CO_2 entering a cave follows seasonal patterns because it depends on the rate of the drip water entering the cave and biologic activity in the surface soil. Later, through the venting of these subterranean spaces, stored gaseous CO_2 can be exchanged with the atmosphere. However, due to the complexity and peculiarity of each karst system, as well as the variety of meteorological conditions that determine the degree and timing of ventilation, such exchanges are not well understood and moreover, their contribution for the regional CO_2 budgets are still unknown. What is more, such processes are not generally taken into account in ecosystem-scale carbon cycle research. The FLUXNET community investigating "net ecosystem exchange" (NEE) over numerous ecosystem types interprets CO_2 fluxes as a biological flux defined as the sum of photosynthetic and respiratory components, neglecting non-biological processes. However, recent studies over carbonate ecosystems reveal a possible contribution of abiotic fluxes to net CO_2 exchange, with magnitudes relevant at least on short time scales (hourly, daily and annually). Soil CO_2 emissions during dry periods, measured in semi-arid ecosystems, are only explicable in terms of subterranean cave ventilation processes. In this study we analyze several episodes of soil CO_2 discharge and ventilation processes that occurred during a dry period in a carbonate ecosystem located in Southeast Spain. The results show that stored CO_2 can accumulate or escape to the atmosphere depending on several factors. Dry season measurements of CO_2 molar fraction in the soil and in bedrock (a sealed borehole) reveal that atmospheric turbulence appears to be a determinant of subterranean ventilation. In addition, concurrent emissions of CO_2 were detected with an Eddy Covariance system contributing to the ecosystem CO_2 exchange.

The influence of surface and tectonic processes in the late Miocene to Quaternary landscape evolution of western Alps: a quantitative geomorphological analysis

Scotti V., Molin P., Dramis F.

Department of Geological Sciences, "Roma Tre" University, Rome, Italy

First-order topographic features in a tectonically active landscape including relief, drainage patterns, and stream gradient slope represent ways to quantitatively characterize the interaction between tectonics and geomorphology, providing a basis for modelling landscape evolution. We analyzed the topographic features of the Western Alps, a double vergent mountain chain, thought to be a post-orogenic collapsing belt as neotectonic, seismotectonic and geodetic data suggest. Moreover, AFT data show high cooling rates during latest Miocene-Pliocene final synchronous exhumation of the External Crystalline Massifs, but also provide evidence for diachronous Neogene evolution along and across the internal arc. In this work we show the morphometric analysis that has been carried out in the Western Alps, focussing on local relief, swath profiles, drainage pattern, and stream longitudinal profiles. Our main data source is a ca. 1 km pixel size DEM (GTOPO30), whereas bedrock erodibility and denudation rates are taken from literature. Our results reveal that both lithology and tectonic structure are the main factors ruling the topography and drainage pattern of the study area. Nevertheless the high values of concavity and steepness indices of the stream long profiles suggest a strong influence of glacial erosion as well as uplift rates. The regional water divide tends to migrate westwards. Such a migration is consistent with the faster uplift occurring in the external arc prevents the regressive erosion of French rivers. The axial sector of Western Alps is characterized by a low local relief that is interpreted as a record of a previous gentle topography now almost completely eroded and testified by the position of peaks at about the same elevation. This smoothed landscape may be related to different processes and genetic environments occurred before the post-Miocene uplift of the chain. Finally, an integrated geological, morphological and morphometric study of the lower Sesia River valley (Piemonte, Italy) allowed to reconstruct the 0.8 Ma stream long profile, and to calculate an incision rate of 0.2 mm/yr for the Middle Pleistocene-Present interval. This value is compatible with the sedimentation and erosion rates inferred from the surrounding areas.

Tectogenic lakes of the Baikal Rift Zone

Shchetnikov A., Filinov I.

Institute of the Earth's Crust SB RAS (shchet@crust.irk.ru)

Tectogenic lakes of the Baikal rift zone are numerous and diversiform. The following types of lakes are distinguished: 1) large rift lakes (Baikal and Khubsugul) that occupy almost the whole bottom of the basins. 2) Lakes that fix local segments of intensive neosubsidence of the basin bottoms. The latter are subdivided into: 2.1) stream extensions that are shaped like a lake; 2.2) lakes embedded into the residual low massifs of marginal tectonic steps and intrabasin basement swells; 2.3) lakes in the background part of tilted blocks of intermediate tectonic steps, bounded by listric faults. 3) Fallen-dammed lakes (produced by seismogenic falls in intermountain valleys). 4) Valley-graben lakes. 5) Crater lakes. The lakes of the Baikal rift basin that resulted from an intensive sagging of separate segments of the basin bottoms have one specific feature. They are very seldom confined to the areas of the deepest initiation of blocks of the basement. Almost all of them are displaced towards residual low massifs of marginal tectonic steps and intrabasin basement swells. The ingress of lakes into them occurs actively, filling the angles of basins entering their mountain framing; in this case the lakes press themselves closely to the basin slopes. From the mountain framing the coastal zone of these lakes is characterized by the absence of mature forms: the coastline follows both large features and small details of the sub-aerial topography. The morphologically distinct ancient coastlines are observed everywhere at the accumulative plains. Geodynamics of lake basins of this kind is always integrated to the drainage reconstruction, expressed in displacement of streams towards these lakes. Lake-shaped stream extensions, widespread in Pribaikalye, can also fix accelerated subsidence of basement swells of the basins, already buried by their sedimentary filling. For example, the Koimorsky group of lakes of this kind in the Tunka basin is projected to the 400 m high basement swell of the basin, buried beneath the 2 km thick Cenozoic sedimentary unit. In this area the lake shaped stream extensions and centripetal pattern of drainage area are not the only evidences of recent intensive subsidence of this part of the rift bottom. Some remnants of the agricultural buildings were found on the margin of the Koimorsky lakes group, beneath sedimentary unit of more than 12 m thick in the basin in the low flood-plain terrace of the Tunka village. All this testifies to the fact that these endogenous varieties of lakes are the indicators of young tectonic inversion motions of blocks of basement of the basins. As it takes place, the tectonic blocks are subsiding more intensively than the segments of adjacent accumulative plains, irrespective of their position in the central or peripheral parts of the rift basins.

Volcanic geomorphology of flood basalt provinces: an overview of the Deccan Traps and similarities with the Ethiopian Traps

Sheth H. C.

Department of Earth Sciences, Indian Institute of Technology Bombay (IITB), Mumbai, India (hcsheth@iitb.ac.in)

The Deccan Traps (India) constitute a large continental flood basalt (CFB) province formed at the Cretaceous/Tertiary Boundary (~65 Ma). They are made up of thick and extensive lava flows, dominantly of tholeiitic basalts. They have been deeply eroded since their formation, and the province has a present-day areal extent of 500,000 km^2 and average thickness of 700-800 m. The lavas are thickest (~2000 m) in the Western Ghats (Sahyadri) escarpment, including ~500 m in the subsurface. The highest elevation of the Traps is found in this region (Kalsubai, 1646 m above sea level). The Western Ghats escarpment forms a major topographic feature and continental drainage divide in western India. It is one of many similar great escarpments of the world, one of the world's great biodiversity hotspots (Ollier and Powar 1985; Gunnell and Radhakrishna 2001), and a region of great scenic beauty. The escarpment runs for 1500 km parallel to the western Indian rifted margin. It is cut across the Deccan Traps in its northern half, where it is scalloped and contains many huge scarps and great amphitheatrical valley heads. It cuts across Precambrian rocks in southern India, whose highest summits (with charnockite exposures) reach 2700 m above sea level. The major drainage of the Deccan Plateau, east of the Western Ghats escarpment, is towards the east. Many major rivers originate on the Western Ghats and instead of flowing westwards over the western coastal strip (Konkan) into the Arabian Sea (which is a few tens of kilometres), they flow hundreds of kilometres eastwards over the Deccan Plateau and then over the basement rocks, into the Bay of Bengal. This drainage pattern has been speculated (Cox 1989) to be due to a mantle plume which caused lithospheric doming as well as radial-eastward drainage. This speculation has been challenged and argued to be untenable (Sheth 2007). The eastward drainage might merely reflect the slope of the original basaltic pile, which is thickest in the west and thins to only ~200 m or less along the province's eastern and southeastern fringes. Also, the east-flowing major rivers of the Deccan Plateau and the Indian peninsula show no anomalies as they leave the Deccan province and emerge on the Precambrian basement (Ollier and Powar 1985). It has been debated whether the escarpment itself has remained fixed over time or has receded eastwards due to parallel scarp retreat. The latter explanation appears a more plausible model; scarp retreat has left many substantial outlier plateaus on the Konkan Plain, such as the 803 m high Matheran tableland. The hydrological conditions of the Deccan basalts depend on the internal architecture of the lava flows, which can be divided mainly into compound and simple flows. The compound flows contain hundreds of individual small lava toes or units, whereas the simple flows are more extensive and consist of thicker sheets, usually with columnar jointing. The Western Ghats summit ranges as well as outliers like Matheran are capped with thick (25-50 m) ferricrete which represents advanced tropical weathering of some of the uppermost basaltic flows in Tertiary times. Ferricretes have developed on both compound flows (as at Matheran) and simple flows (as at Mahabaleshwar, 1436 m). Even the ferricrete cap stands highly eroded today. However, whereas this ferricrete has been suggested to mark the original top of the volcanic pile, the dendritic pattern of the present-day ferricrete remnants has been suggested to reflect a palaeo-river valley system, with later inversion of relief (Ollier and Sheth 2008). This is consistent with many ferricrete occurrences worldwide (e.g., Australia) involving inversion of relief. From the pattern of the ferricrete remnants, the palaeoriver (termed the Bamnoli palaeoriver) flowed NNW; all modern rivers flow SE instead. There has been post-Deccan uplift of uncertain magnitude (possibly several hundred metres). The coastward downwarping model of Ollier and Pain (1997) may explain the differing elevations of the ferricrete cap in the Western Ghats and the outlying plateaus such as Matheran. Erosional features of the Deccan Plateau are also very interesting. The basalts being horizontal here, vast plateaus and tablelands are common. Many parts of the plateau are semi-arid to arid due to the rain shadow effect of the Western Ghats on the seasonal southwesterly monsoon winds. Many mesas, buttes and pinnacles are seen. Along the western coast, such as at Mumbai, the lava pile shows significant westerly dips (towards the Arabian Sea) along a 150 km strike length. This flexure (Panvel flexure) is a tectonic feature (Sheth 1998). Well-developed cuestas have formed on these dipping basalts (Subramanynan 1981). The northwestern part of the Deccan province also has semi-arid climate today, and exposes some large subvolcanic complexes, which have distinct topographic patterns. Mount Girnar (1113 m) rises 1 km above the surrounding Saurashtra plains, with annular and radial drainage; rhyolitic ring dykes of the Alech Hills, a possible caldera remanent, have given rise to annular drainage. The geomorphology of the Deccan Traps has significant similarities with that of the Ethiopian Traps (Coltorti *et al.* 2008).

Geoheritage of Baikal lake coast zone

Skovitina T.[1], Angelelli F.[2]

[1]*Institute of the Earth's crust of SB RAS, Lermontov str., Irkutsk, Russia, RU-664033, (skovit@crust.irk.ru)*
[2]*ISPRA- Istituto Superiore per la Protezione e la Ricerca Ambientale, Via Curtatone, 3, I-00185 Rome, Italy (francesco.angelelli@isprambiente.it)*

The Baikal Lake (since 1996 included by UNESCO in The World Heritage List) is located in the center of the Asian continent, in the southern part of Eastern Siberia. Lake coastal line extent is about 2000 km and contains multiple landforms, varying in genesis and morphology, which either already have or deserve the official status – geomorphosite. We suggest defining geomorphosite ranks of the Baikal coastal zone and tracing their hierarchical sequence. Geomorphosite ranks and their dimensions are, as a rule, in proportional dependence, this in the first place defines approach to their study, peculiarities of nature preservation efforts and demonstration. In addition, geomorphosite ranking (according with their size) provides future creation and use of other classifications, effective for forms of within the boundaries of certain ranks. In capacity of additional criteria we consider representativeness (morphologic expressiveness, aesthetic properties, preservation, ease of access and other) and possibility of applied use of the object (educational, excursion, tourist, recreational and other). Geomorphosites of the first rank unconditionally include the Baikal rift itself – the central part of the largest continental rift system in the world – and mountain highs, surrounding it from all directions. Most valuable scientific data concerning all branches of modern geology was collected during the almost 300 year history of the Baikal basin study. It is a perfect world-class scientific ground and unique natural laboratory for study of ancient and modern geodynamics and tectonics, geomorphology, paleogeography and limnology. Second rank geomorphosites include groups of lesser in size coastal zone relief forms – monolith grand fault escarps of the Primosky, Barguzinsky and Baikalsky ranges, whose integrity is broken by transversal valleys of huge rivers falling into Baikal. Some of them are highly unusual in genesis and thus are key objects for the solution of paleogeographic riddle, concerning the presence of the paleodrain out of Baikal into the Lena River basin. This in the first place applies to the system of pristine through valleys of the western coast. The most picturesque and original coastal landscapes (ria coasts) in the regions near Maloe More and Ol'khonskie Vorota straights can also be attributed to this group. Simple coast, low and swampy, on the eastern side of the lake near the Proval bay are in truth unattractive and common, but bright history of the bay formation cannot help attracting specialists and nature devotees. The catastrophic Tzagan earthquake (magnitude 7.5) occurred in 1862. The following submersion of the significant part of the Selenga River delta and the adjoining area of the Tzagan Steppes augmented the water area of the already enormous lake per 260 km^2. This is a distinctive monument to the huge catastrophic event of seismogeodynamic character. The mentioned above Selenga River delta is unconditionally on of the largest and representative on the Baikal coast. Especially effective this delta is looking on the space images, staggering an observer with countless number of canals, branches, small lakes and little islands of peculiar shape. Third rank objects represent separate and grouped simple uniform elements, such as local terraces of the Ushkanji Islands (facing the Sviatoi Nos Peninsula in the middle Baikal). Clue to their genesis has not been found yet, or, more correctly, there is no single opinion on this point among local scientists. These islands are a complex natural monument of geologic, tectonic, zoological, botanic type with the official status of the natural monument of the Buriatia republic since 1980, and since 90s a monument of the federal importance. This group also includes multiple Baikal bays and beaches, huge fans on the eastern and western coasts of the Middle and North Baikal. It is difficult to specify all the morphologic diversity of bays, gulfs, beaches and other coastal relief forms, because all of them deserve detailed description, and, even better, live observation. Multitude and variety of the lakes, located on above-water coastal slopes and coastal planes and lowlands define the landscape-aesthetic attractiveness to the coastal morphologic landscapes. Many of the lakes, located around Baikal are listed in the Buriatia republic and Irkutskaya oblast official registers of monuments of nature. To the geomorphosites of the forth rank in the relief of the Baikal coastal zone we attributed "simple" forms of endogenous and exogenous relief: capes, rocks, seismogenic structures (marks of intense and catastrophic earthquakes), small rocky islands, sand necks and bars, shore dunes and etc.

Drivers of landscape change during the present century

Slaymaker O.

Department of Geography and St. John's College, The University of British Columbia, Vancouver, Canada (olav.slaymaker@ubc.ca)

Over geological time scales, landscapes evolve under the influence of tectonic plate movements, cyclically changing Earth-Sun relations, spatial variations in rock strength and cyclically changing climate. However, within the time frame of the present century, it is proposed that there are four different drivers of landscape change, namely relief (an expression of the current state of tectonics which propagates its effect into erosion potential), warming climate, rising sea level and increasing human activity. It can be argued that sea level is a derivative of climate but it is useful to consider it separately because of its distinctive mode and place of action. Climate, especially temperature change, is probably the least important of these four drivers in most temperate and tropical environments. Arctic landscapes are different in the sense that phase changes in the cryosphere are of such overriding importance. It is further claimed that human activity, in the form of land use and land cover change, has become the most important driver of landscape change globally. It is anticipated that human activity will become increasingly dominant as the 21st century progresses. The integrity of the argument depends on defining and comparing effects at specific temporal (century) and spatial (landscape) scales. If the argument is valid, firstly, models of future landscape change extrapolated from paleo-environmental reconstruction models are fundamentally flawed; secondly, the investment of capital in detecting temperature change to the neglect of losses of soil, water, water quality and prime agricultural land following intensification of human activity seems unwise; and thirdly, the landscape change debate should open itself to the possibilities of landscape enhancement as well as land degradation. Geomorphology, geoecology and landscape ecology have much to learn from each other in this context.

Present-day development of gullies in semi-dry areas: examples from the Gabes region (northern Tunisia)

Smolska E., Dłużewski M., Biejat K.

University of Warsaw, Faculty of Geography and Regional Studies, Poland (e.smolska@uw.edu.pl)

Valley slopes of large wadis developed in loessial region of south-eastern Tunisia are frequently dissected by gullies. The incisions are usually relatively small but they are connected to create complex networks. Sporadically, the gullies occur as singular incisions. Sparse vegetation and rainfall, occurring rarely but with great intensity, favour quick gully erosion. The study focuses on the morphology of the gullies and their contemporary development. The surface of the coastal plains in south-eastern Tunisia is located at 170 m a.s.l. and it is dissected by numerous wadi valleys of different size. Between the valleys, the plain is slightly undulating with denivelation ranging from 5-7 m. The study was conducted SW of the town of Gabes, within the valley of the wadi Gabes, which is incised into loess cover down to over 10 m. The network of secondary incisions was analysed based on digital data from ASTER satellite processed with the ER Mapper, ENVI and Map Info software. Two relatively small gullies, developed within the slopes of the Gabes valley in the middle course of the wadi, were selected for the field work. Mapping and geodetic survey was performed in years 1995 and 1998. Three factors are the most important in determining the effectiveness of gully erosion: 1) lithology, 2) amount and intensity of rainfalls and 3) vegetation cover. Compact loessial sediments, cemented with calcium carbonate, occur in the study area. The fine grained sediment is interbedded with gravelly-sandy and gravelly-stony layers (including rounded pebbles and cobbles with diameters of 5-15 cm). There are also several layers of old, crystalline gypsum. The climate of the study area is semi-arid with mean annual air temperature of +17,7^{o}C, and mean annual rainfall of 190 mm. In the wet season of 1995-96, the area received an exceptionally high amount of rainfall reaching 551.6 mm (maximum diurnal rainfall was 91.5 mm), however only 82.6 mm fell during the next wet season (1996-97). The vegetation cover is very sparse with only patches of small shrubs. The morphology of both the studied gullies is diverse. Their forms, the inclination of their floors and their sinuosity, frequently change - sinusoid with side erosion adjoin straight ones. Overdeepenings and knickpoints are frequent. The cross-sections of the gullies are relatively simillar: at the floors are box-shaped, with vertical sides 1 to 2 m high (locally over 5 m), higher above the gully floors the incisions are V-shaped. The length of the two gullies was 185.6 m and 288.6 m in 1995, however, in 1998 it increased to 198.1 m and 323.7 m respectively. This was an effect of headward erosion and side erosion (the sinuosity increased mainly in the middle course of the gullies). The mean inclination of the floors (10% and 6%) was relatively stable, because erosion acted mainly on the knickpoints. Side erosion was usually limited to slopes up to 1-2 m above the gully floors. Locally it leads to rockfalls or landslides affecting whole slopes. The observed changes resulted from several short-term rainfall events occurring in years 1995-1998. The events did not cause significant changes in the morphology of the studied gullies. Simillar conclusion can be drawn from the analysis of the gully networks seen on the satellite pictures. The network is relatively stable with changes occurring only locally. The effectiveness of the gully erosion, despite significant rainfall and sparse vegetation, is limited due to compactness of the calcareous loessial sediments.

A multi-technical integrated approach to investigate lateral spreading phenomena in the north-west coast of Malta

Soldati M.[1], **Bruschi V.M.**[2], **Devoto S.**[1], **González Díez A.**[2], **Mantovani M.**[3], **Pasuto A.**[3], **Piacentini D.**[1]

[1]*Dipartimento di Scienze della Terra, Università di Modena e Reggio Emilia, Largo S. Eufemia 19, 41121, Modena, Italy (mauro.soldati@unimore.it; stefano.devoto@unimore.it; daniela.piacentini@unimore.it)*
[2]*Departamento de Ciencias de la Tierra y Física de la Materia Condensada, Universidad de Cantabria, Avda. De Los Castros s/n, 39005 Santander, Spain (viola.bruschi@unican.es; gonzalea@unican.es)*
[3]*Istituto di Ricerca per la Protezione Idrogeologica, CNR, Corso Stati Uniti 4, 35127, Padova, Italy (matteo.mantovani@irpi.cnr.it; alessandro.pasuto@irpi.cnr.it)*

In recent years, coastal instability has become a serious threat not only for the increasing number of exceptional meteorological events that can trigger slopes failures, but also for the growth of settlements and human activities in hazardous areas. For these reasons investigation on coastal landslides – including lateral spreading – is an issue of paramount importance and recently the awareness that environmental protection should take place through a deep knowledge of natural processes has increased. However, it should be noted that landslide hazard investigations tend to focus on the prediction of rapid mass movements – since the may more severely threaten human lives and cause more significant damages to buildings and infrastructures – while lateral spreading phenomena are generally overlooked due to their slow rates of movement. Nevertheless, it should be emphasized they can be highly hazardous for engineering structures (e.g., bridges, dams, tunnels), since they may act over long periods of time. Moreover, rock spreads may evolve into faster movements, which can determine catastrophic failures (i.e. block slides) or they can favour and trigger a series of collateral landslides (i.e. rotational slides, earth and debris flows, rock falls and topples) occurring at the edges of the areas affected by spreading. Given these premises, it becomes clear that the awareness of the role played by rock spreading on coastal instability is fundamental when landslide assessment and monitoring activities have to be planned. Actually, mitigation measures can be scarcely effective – especially in long terms – if the occurrence of lateral spreading is not recognized or poorly understood. In this respect, the application of traditional and innovative survey and monitoring techniques is essential to understand the kinematics of the movements and predict evolutionary scenarios. The development of new remote sensing techniques and high accuracy in situ instrumentations makes it possible to measure small-scale deformations over large areas affected by such type of instability. The integration of measured displacement rates with geotechnical parameters of the materials involved provides significant data for the quantitative characterization of the rock spreading processes. Within this framework, a research based on a multi-technical integrated approach to investigate lateral spreading phenomena has been carried out on the north-west coast of Malta, which can be considered as an open-air natural laboratory for the study of landslide phenomena and their influence on the coastal geomorphological evolution. In fact, the super-imposition of two different lithologies (limestones and clays) characterised by different mechanical behaviour and the marked jointing of the rock masses determine the development of exemplary cases of rock spreading and related landslides. Particular attention has been given to the instability phenomena affecting the coastal areas of Il-Prajjet and Ghajn Tuffieha Bay because of the high-risk conditions associated to presence of tourist facilities and hiking trails in the surrounding areas. The investigation methodology – beside geological and geomorphological surveys and geotechnical tests – has included digital aerial photogrammetry analysis, A-DiNSAR (Advanced Differential Radar Interefometry) analysis and the creation of a monitoring network consisting of GNSS (Global Navigation Satellite Systems) benchmarks, extensimeters and fissurimeters. The results provided so far are promising and demonstrate the efficiency of this multi-technical integrated approach, with respect to the recognition of the causes and definition of the evolution of the investigated lateral spreading phenomena, which are essential for the assessment of landslide hazard and for its zonation.

Soil reconstruction in limestone quarries in semiarid southeastern Spain

Solé-Benet A.[1], **Contreras S.**[2], **Miralles I.**[1], **Lázaro R.**[1]

[1]*Dept. of Desertification & Geo-Ecology, EEZA-CSIC, Almeria, Spain (albert@eeza.csic.es)*
[2]*CEBAS-CSIC, Murcia, Spain*

Mining and quarrying disturbs ~240.000 km² of the Earth surface. To minimize the environmental impacts of these activities, regional, national or federal governments establish regulations that require the operator to restore the land once the extraction activity has ceased. At present, most of the quarry restoration projects in Spain follow criteria and procedures well described in "quarry restoration" manuals. However, the application of these guidelines is questionable in semiarid regions with precipitation values below 300 mm y^{-1} and heavy rainfall events which promote soil erosion. The main objectives of this presentation are to show the main results of an experimental soil restoration project started in early 2008 in a calcareous rock quarry in SE Spain, under semiarid conditions, where essential principles have been considered: a) revegetate with local plant species, b) assure minimum soil conditions of water and nutrients by means of drip irrigation and the addition of organic amendments, and c) achieve minimum soil losses by water erosion. Two different substrates have been chosen in the experimental site. One (named A) was prepared for the occasion and consisted in inert marl bedrock Another (named B) very heterogeneous, calcareous topsoil was laid down ten years ago, with a considerable cover of opportunistic species. Both substrates were amended with two different organic wastes. Two different mulches, mineral and organic, were also tested to mitigate soil water losses. Three perennial species from nursery (*Stipa tenacissima*, *Antyllis terniflora* and *Anthyllis cytisoides)* were planted in subplots within every one of 16 experimental plots, eight on each substrate. A drip irrigation system was implemented to provide support water to every seedling under critical soil water conditions during the first year after plantation. Different qualitative and quantitative variables related with vegetation survival and "plant health" traits were measured 6 months after the plantation. These variables were: 1) State of the plant (dead-alive), 2) Height (quantitative), 3) Maximum and minimum width (quantitative), 4) B*iovolume* index, i.e. height x average width, 5) Amount of leaves or stems (qualitative, from 1 to 4 depending on the number of leaves-stems), 6) Colour of the leaves (qualitative: 1-green, 2-yellow, 3-brown). The survival rate, defined here as the ratio between the number of alive plants and the total of plants planted, were also computed at the area, plot and sub-plot experimental scales. Four factors (soil substrate, organic amendment, mulch and plant type) were considered to evaluate their impacts on the vegetation variables measured, as well as the impact of possible significant interactions between factors. This was carried out by a General Linear Model (GLM) analysis with quantitative variables. Kruskall-Wallis and chi-square tests were used, for quantitative and qualitative variables, respectively". The general survival rate reached after six months from the plantation was 73%, and after 24 months, 68%. Higher survival rates, although not significant, were measured in those revegetated plots on the substrate A than on the substrate B despite the higher OC and N contents measured in the last ones. *Biovolume* index was significantly higher in the A plots than in the B ones. *Stipa tenacissima* showed the highest survival rate followed by *Anthyllis cytisoides* and *Anthyllis terniflora*. However, the biovolume index was the highest in *Anthyllis cytisoides*. The positive impact of organic amendments on *biovolume* was highlighted in the experimental plots with a marly soil substrate (area A). However, in area B, the theoretical better quality of the topsoil might have had some negative influence on both survival and biovolume. In general terms, the use of sewage sludge as an organic amendment performed much better than the compost derived from municipal wastes. The addition of organic amendments had a little effect on the plant survival rates observed in both A and B sites (Fig 2) but better positive effects on the *biovolume* indexes. Such positive effects on the *biovolume* were better highlighted in experimental plots on a marly soil substrate (area A) than in plots with a topsoil and a seed bank of opportunistic plants (area B). The emergence of these opportunistic plant species after the addition of the organic amendments, and their effects in reducing the soil moisture availability, may explain why survival rates and biovolume indexes had lower values in area B. In general terms, the use of sewage sludge performed much better than the compost derived from urban wastes. Because their role in maintaining soil moisture, mulches had a positive impact on the survival and *biovolume* of planted vegetation. Average soil moisture content was 20% higher under mulched substrates. The highest *biovolume* indexes were reached when gravel mulches were used. However, the use of a forest residue had a negligible effect on this variable, as no statistical differences were found when those plots were compared with the control plots without mulch. Two years after the plantation the amount of opportunistic species is significantly higher in plots where organic amendments were added. The General Linear Model (GLM) analysis indicated that the addition of organic amendments and the use of mulches were the main factors in explaining the success in the vegetation establishment and growth in this semiarid environment.

Evolution of a fault-line scarp after the 8 June, 2008 earthquake, in the western Peloponnese (Greece)

Stamatopoulos L.[1], **Pavlides S.**[2], **Kamberis E.**[3]

[1]*University of Patras Department of Geology, Patras, Greece*
[2]*Aristotle University of Thessaloniki, Department of Geology, Thessaloniki, Greece*
[3]*Hellenic Petroleum (Exploration and Exploitation of Hydrocarbons Division), 199 Kifissias Av., 15124 Maroussi, Athens, Greece*

A strong earthquake (Mw=6.4) occurred onshore the area of NW Peloponnese, Greece on June 8, 2008. The event, caused by a blind right-lateral strike-slip fault trending NNE-SSW according to the focal mechanisms, generated severe secondary effects and structural damages. Ground deformations triggered by the event were spread over a wide area, though the most severe ones were reported in the direction of the strike-slip fault. Moreover, landslides were observed close to the epicenter, while rock falls and liquefaction were observed over a broader area. Coseismic ground ruptures with local normal character and slight strike-slip component (up to 20 cm vertical and 15 cm horizontal displacement) were observed close to the village of Nisi. The earthquake affected area is dominated by a vast terrace, which separates the coastal plain from the mountain front (Mt. Skolis) extending without significant breaks in its transversal sections. The terraced sedimentary sequence consists of alternating sandy, silty and silty-clayey beds with sedimentary structures suggesting lagoon and shallow marine depositional facies. In these sequences three lithostratigraphic units/cycles can be recognized. The first belongs to the isotopic substage 7.1, the second, which pinches on the first, to the substage 5.5, and the third to the substage 5.3. Locally, the above units/cycles are covered by a veneer of reddish continental sands or gravelly sands. The terrace surface is incised by a dense hydrographic network and dips towards the sea with a uniform, low angle, slope. The seismically induced surface effects and the morphotectonic features of the earthquake affected area have been investigated based on geological/geomorphological field observation, sedimentogical analysis and radiometric dating of near-surface deposits, digital elevation modeling, and geophysics. The resulting data seem to indicate that the observed ground ruptures reflect a fault-line scarp corresponding in an old fault.

Geodiversity and geoconservation in the lagoonal littoral of Romanian Black Sea coast

Strat D.

University of Bucharest, Faculty of Geography (danastrat6@yahoo.com, dstrat@geo.unibuc.ro)

Located on the Western Coast of the Black Sea there is one of the greatest and interesting lagoonal-deltaic wetland from Europe: Dranov – Razelm – Sinoe system, with an area of 1300 Km^2. The geological, geomorphological and hydrological variety and complexity represented a favourable environment for a remarkable biodiversity development. The objective of the current analysis is to characterize the geodiversity of the Dranov – Razelm – Sinoe lagoonal system and the neighbourhood region. This wet region is situated at the South of Danube Delta and protected as part of the Danube Delta Biosphere Reservation, within the World Network of Biosphere Reserves (WNBR). The protection regime is both in conformity with the WNBR status and the environment protection law in Romania (no. 137 from 29 of December 1995). The study area is located in the central part of the Western coast of the Black Sea. From the geological point of view, the region is overlapping a great variety of rocks: (green schist) of neoproterozoic age, Triassic limestones, Cretaceous limestones, loess, and reshuffled marine sands. The originality of the geodiversity resulted from the contact between the old continental geological formations (1.5 – 2 billions years old) and the recent marine formations (< 5000 years old), as well as the most recent biogenic relief (< 200 years old). Our analysis is focused on the knowledge of geodiversity elements, identification and distribution of the geomorphosites with scientific, aesthetic, cultural, educational and evaluation the vulnerability of these geomorphosites, and finally, the management problems in this wetland. The geodiversity elements have been identified following geological, geomorphological and hydrological criteria, and have been mapped using comprehensive field survey and photointerpretation. Following this process 8 geological elements have been identified, the most representative being the green schists, Triassic limestone with ammonites, Cretaceous limestone, and loess. The geomorphological elements have been classified in 7 categories: polygenetic relief (pediment, inselberg, fracture valley, escarpment, tor, loessoid glacis, structural relief, isle), littoral (chennier plains, lagoon barrier, tombolo, paleoshore, longshore bar, biogenic bench), aeolian (sand dune, deflation depression), fluvial (14 elements), slope and mass-wasting (16 elements), biogenic (8 elements). Hydrological elements have been classified in 7 categories: lake, pond, marsh, river, channel, stream, spring. The distribution of these elements of geodiversity has been analysed by using a spatial grid system of 500 m x 500 m. Our analysis concludes at the existence of some concentration sectors in geomorphosites with high value for geomorphological studies in Romania, Black Sea basin and Europe. These sectors have been classified taking into consideration the genetical criteria, as following: 1) pediments on the green schist in the Casimcea plateau; 2) pediments and inselbergs on Cretaceous limestone from Babadag Tableland, Cape Doloşman escarpment and Popina Isle (with a composition of Triassic limestone with ammonites); 3) Sarinasuf deflation depression with salt marshes and ponds in Dranov region; 4) Chituc chennier plain; 5) Portița – Perişor sand barrier. For all the geomorphosites the geodiversity value has been specified: intrinsic value, scientific value, ecological value, cultural heritage value, educational value, and potential vulnerability to external pressures for changes. The great diversity of non-living nature due to its geodiversity urged to develop a remarkable biodiversity for the continental regions in the Black Sea basin, concretised in the existence of almost 7000 species of plants and animals and 16 representative ecosystems. Our study is intended to be a support for the decision makers concerning the sustainable development and the preservation management, being as well representative for lagunar wetlands in continental regions in Europe.

Mapping of southern Baltic submarine landscapes and habitats

Szefler K., Tęgowski J., Nowak J.

Maritime Institute in Gdansk, Dlugi Targ 41/42, 80-830 Gdansk, Poland (kszef@im.gda.pl)

The techniques of submarine landscapes and habitats investigation for scientific and commercial purposes can be divided into two groups: remote sensing and contact methods. The contact method depends on seafloor samples collection using complex sampling devices operated from the ship, where the most commonly used are: gravity, piston and box corers and dredges. Also, the underwater observations and samples collecting by divers are frequently used for bottom exploration. All contact methods have some serious limitations. Beside time-consuming nature of such work, these are mainly small possibilities of sampling spatial density. Moreover, a great effort to collect samples from individual points of the seabed usually does not reflect the exact geomorphology of the whole investigated area. Such limitations led to the development of contactless remote sensing methods - optical, based on aerial and satellite photographs or bathymetric laser scanning (LiDAR) and hydroacoustic method, based on the monitoring of underwater landscapes and habitats using different types of echosounders and sonars. Remote sensing, hydroacoustic methods allow for fast and relatively non-expensive collecting of information from large areas, as opposed to classical contact methods, can be extensively used as the basis for mapping of south Baltic submarine landscapes and habitats (especially in areas having low transparency of water, where use of photographic methods is limited and sometimes impossible). Moreover, acoustical methods have much higher resolution than other contact and contactless measurement techniques. It should be stressed, that classical direct contact methods are essential in the initial stages of measurements for calibration of remote sensing acoustical methods. The results of study on structure, size and spatial distribution of geomorphologic forms, which shape submarine landscapes and habitats in southern Baltic Sea area is presented. The detailed images of bottom surface, high resolution bathymetry and nature of habitats dislocation were obtained with use of underwater acoustical tools, which utilise swath technique. The side scan sonar imageries of seafloor deliver information about types of sediments, texture of seafloor and habitats spatial distribution. Other acoustical tool, multibeam echosounder delivers high resolution (up to 0.05m in horizontal direction) 3D bathymetric maps of investigated area. The bottom geomorphologic forms of seabed and benthic habitats were investigated mostly in the narrow euphotic zone of the depth between 4-20m elongated parallel to the Polish cost. The total length of the surveyed area was about 220 km and of a width slightly above 1 km. The most of investigated polygons have bottom relief having polygenetic origin with relicts of periglacial forms together with contemporary forms of marine origin. In the studied area were found different forms of sand accumulation from small ripplemarks to big sandy waves. In the seabed erosion zones the bottom surface is rough and varied with clearly formed embankments, abrasive platforms, inselbergs and stony gravely abrasive pavements on the bottom surface. The embankment slopes are furrowed with numerous, relatively broad erosion gorges. As the result we show the maps containing values and directions of steepest descent bottom slopes, drainage maps presenting areas, which are capable of sediment delivery to a specific point of the bottom in the event of redeposition. Moreover, acoustic signal parametrical methods helpful in identification of morphological forms and benthic habitats were developed and tested. This identification methods were based on recorded imagines of the bottom taken by side scan sonar, multibeam echosounder backscattered intensities and bathymetric 3D maps. The echo signal parameters (spectral, wavelet, fractal and statistical) and backscattered intensities were the input to fuzzy clustering classification algorithms and neural network classification algorithms, which produced maps containing morphologically classified seafloor areas. All of developed bottom imagery segmentation schemes have many promising features which allow them to be applied for extracting morphological forms of seabed and habitats. Used techniques precisely indicated areas of relicts of periglacial forms as well as contemporary forms of marine origin. The correctness of the method was verified by the results of underwater video recordings, single beam echosounder registrations and biological samples taken *in situ*. The obtained results revealed that acoustical technique provides many useful capabilities for the seafloor characterisation.

Hazards zonation and assessment of the associated risks in the mount Manengouba caldera (Cameroon Volcanic Line)

Tefogoum G. Z.[1], Dongmo A. K.[1], Nkouathio D. G.[1], P. Wandji[2]

[1]*Department of Earth Sciences, Faculty of Sciences, University of Dschang, Po Box 67, Dschang, Cameroon (zantefo@yahoo.fr)*
[2]*Laboratory of Geology, High Teacher Training School, University of Yaoundé I, Po Box 47 Yaoundé, Cameroon*

Mount Manengouba is polygenic stratovolcano of the Cameroon Volcanic Line, built between 1.5 Ma and 0 Ma (Kagou Dongmo *et al.,* 2001). It is situated at about 120 km NE of mount Cameroon, located between the Tombel and Mbo plain, precisely between 09°42' and 10°10' East and, 04°49' and 05°15' North. This volcano covers an area of 500 Km^2 and culminates at 2411 m (Eboga peak). The upper part of this volcano is made up by two fitted explosion and collapse sub-circular calderas (Elengoum and Eboga). The mount Manengouba calderas settle down led them giving rise to different natural hazards of volcanological, meteorological and of anthropogenic origin. Hazards of volcanological origin are triggered by volcanic eruptions. There are gases eruptions from crater lakes (Male and Female) encountered in the central part of Eboga caldera; precisely on the South West-North East axis. The most threatened villages are Bororo (located in the Eboga caldera) and Mbat, Muabi, Ntak, Ekangté and Ekambeng (situated on the North West external sides of the volcano); where the opening of the caldera is found. Moreover, lava flows occur in different calderas (along fissures) and on the volcano flanks where several vents (materialised by cones) are scattered. Bororo and Mbouroukou, Mwamdong and Nsoung villages are more exposed to this hazard. Hazards of meteorological origin are set off by aggressive climate conditions and include mass movements (landslides and rock falls) and floodings. Mass movements occur on the caldera rims and on the external limbs of the volcano; where are found steeper slopes precisely in the South, South East, South West and North East. Floodings occur along streams found in overall volcano and in the Eboga caldera due to its sub-horizontal bottom. Hazards of anthropogenic origin are triggered by the green space conquest between farmers and breeders and the movement of population from downward to upward to get cooler; these often led to tribal wars. Moreover bushes fire set off by the population and the worst exploitation of the natural resources have an imminent role in the climate change which constitutes the priority of reflexions worldwide today. We evaluated the financial potential of calderas based on the average income of breeding, beef milk selling, tourism, and investments (school fees and the cost of houses and equipments for each family). The calculation revealed that, the economy of the mount Manengouba calderas represents about US$1 million. Some recommendations are provided in order to prevent and reduce the potential losses (human patrimony and biodiversity) and the number of victims (in the case of threats resumption); in particular, by better land use planning and by the sensitisation of populations.

A Trade-off between fighting land degradation and water harvesting in northern Ethiopia

Daniel Teka[1], van Wesemael B.[2], Poesen J.[3], Hallet V.[4], Vanacker V.[2], Deckers S.[3], Taye G[1], Nigussie Haregeweyn[1]

[1]*Department of Land Resource Management and Environmental Protection, Mekelle University, Ethiopia*
[2]*Georges Lemaître Center for Earth and Climate Research, Universite Catholique de Louvain, Belgium*
[3]*Department Earth and Environmental Sciences, Katholieke Universiteit Leuven, Belgium*
[4]*Department of Geology, Fondation Universitaire Notre Dame de la Paix, Namur, Belgium*

Land degradation is a major bottle neck towards boosting food production in Northern Ethiopia. To tackle this problem, the regional government of Tigray has constructed different kind of soil and water conservation measures on degraded lands. However, these measures have a substantial impact on micro dams already constructed downstream. Unfortunately, this impact has never been foreseen during their hydrologic designs. As a result, the efficiency and effectiveness of these micro dams lag behind their intended purpose: less irrigated land than initially foreseen. The analysis of inflow hydrographs and hyetographs collected through Tigray Bureau of Water Resources, Mines and Energy and investigation of existing irrigated lands shows that they are over sized due to overestimated runoff coefficients and underestimated time of concentrations. Coupled with higher loss of stored water through combined evaporation and seepage losses, inefficient water management practices and higher sediment inflow rate, substantially less land has been irrigated than foreseen. For example runoff coefficients hardly reach 10% instead of the predicted 35%, time of concentration have been under estimated up to 123%, and combined seepage and evaporation losses under estimated by up to 74%. The site selection for micro dams has given less emphasis on the shape of the reservoirs so as to minimize evaporation losses. The reservoir capacity and reservoir area has showed a negative relationship ($R^2=0.235$). To assist further design of micro and medium sized dams, the assessment of the success and failure of these micro dams by installing hydro-monitoring stations and characterizing the impacts of SWC structures on runoff is of paramount importance.

A geomorphologic description of the High Juqueri drainage basin (southeast Brazil) as a contribution to comprehend urban occupation

Thiesen G. M., de Oliveira D.

Department of Geography, University of São Paulo (USP), Brazil (gustavo.thiesen@usp.br, debolive@usp.br)

Nowadays the water supply resources theme is more and more focused by media, academic debates and other interested specialists and companies. In this context, this abstract refers to a research held at the University of São Paulo and tries to contribute for a better understanding of the landscape of one of the most important water supply tank basin that supplies the biggest metropolitan area of Brazil. The High Juqueri drainage basin is the last sector of one of the biggest water supply system ever built in Brazil. This is called Cantareira System and drains water from 228 thousand hectares, producing an amount of 33 thousand liters of water per second, supplying 8.8 millions of people in the São Paulo Metropolitan Region. Even being the importance of this unit undeniable and its conservation highly necessary, the Paiva Castro Reservoir, the last reservoir of the system before the contact with the urban area, has been facing a strongly accelerated process of urban occupation in its surroundings. Therefore, a better comprehension of the geomorphologic aspects of the basin in which the reservoir is inserted appears as a demand of any planning project that aims a better control of the water resources involved. The geomorphologic scenario of the basin is based on a group of high mountain ranges (Serras Altas) concentrated on the SW and SE of the basin, with low plains and hills intercalated. The average slope gradient of the basin is situated between 20 – 45%, being the highest values found in the northern area. The predominant landforms are composed of convex tops, alternating rectilinear and concave slopes, and convex and concave basins. These features are supported by very heterogeneous lithology ranging from phyllites and schists in the lowlands, to granitic intrusions that maintain higher altitudes. The difference between the resistance of the solid granitic rocks and the softer metamorphic schists and phyllites produces, by weathering processes and differential erosion, two main granite units, the Cantareira Batholiths and the Mairiporã Stock. Besides, the metamorphic softer rocks are disposed according the SSW-NNE, Brazilian Direction, in a stretched belt where the drainage network is incised. The region is also marked by the presence of fault lines, due to a previous regional tectonics, classified by some researchers as wrench faults, which control partially the river flow. By analyzing the urban settlement distribution we can identify at least four urban nuclei that might probably directly threaten the integrity of the water resources available in the High Juquery Drainage Basin: Mairiporã, Franco da Rocha, Caieiras and Francisco Morato. These cities faced a very intense process of expansion in the last forty years, led by the proximity to the capital São Paulo and the Brazilian politics of growth. This expansion has not been followed by an environmental concern in some cases, and in others, the political measures have been disrespected. It's not our objective to explain the whole process that led to the complex growth of these cities, but to offer some geomorphologic subsidies to further researches and planning politics. In this aspect, we can sketch some trends that this process has assumed along these years that involve a very close relationship between the geomorphological setting of the area and the selective urban expansion. As an example, the lithologic contact between the Cantareira Granitic Batholith and the Estrada dos Romeiros Formation (schists and phyllites) occurs in a gradual way due to the lenticular form of the granite intrusion, the same doesn't occur with the contact between the Mairiporã Stock and Estrada dos Romeiros Formation. The above structural setting has generated of a very steep slope on the right border of Juqueri River and a soft inclined slope on the left border. This scenario has directed the majority of urban settlements to the left side of the river and left the right border more preserved. It is not that the nature determines *in stricto* all the ways in which the human being uses the space, but it definitely helps to understand this process.

Geodiversity and landscape sensitivity – engaging geomorphology in a new dialogue about geoconservation

Thomas M.

University of Stirling, Scotland, United Kingdom (m.f.thomas@stir.ac.uk)

Geodiversity emerged as a concept in the 1990s, a decade after Biodiversity became established in conservation science. Spurred by concern for the conservation of fossil evidence for evolution and by recognition that the properties of the substrate are fundamental to ecosystem functions and to landscape quality, the use of the term has expanded rapidly, but often with too little regard for the scientific issues involved. Geodiversity is the expression of the varied physical landscapes that are the products of earth history, maintained and continually altered by magmatic and meteoric forces. It straddles the artificial divides between geology, pedology and geomorphology. This presentation will explore the varied components of geodiversity; their links to biodiversity; and the sensitivity issues involved in understanding landscape changes arising from fluctuations in the operation of earth surface processes over varied timescales. Geodiversity is a property of the earth's rocks, landforms and soils, all of which interact to provide the essential underpinning for plants, animals and human beings to flourish. It is, therefore, an asset of national and international importance that informs us of the globally significant geological processes that shape our world in ways that we rarely fully appreciate: from the drivers of tectonics, volcanism and long-term climate evolution to the changing meteorological forces that model the earth's surface. The spatial aspects of Geodiversity are often expressed in terms of geological patterns, but the study of Geodiversity requires major inputs from geomorphology and pedology. Geomorphology tells us that diversity arises from constant change and flux in dynamic earth-surface systems and is closely linked to issues such as landscape sensitivity, geomorphological complexity and evolutionary geomorphology. The interface between Geodiversity and Biodiversity is also mediated by the fragile mantle of soils and regolith. Geodiversity has a wider relevance as an expression of landscape character and quality, and as a key influence on habitats and species, on sustainable management of land, river catchments and the coast, and on economic activities, historical and cultural heritage. It is also of crucial importance to how we adapt to, and mitigate the impact of, climate change. Discussion is needed of the 'Geodiversity Services', which can potentially be offered in the fields of Geoconservation, Geotourism, and Geoeducation, while its application to development planning and environmental management requires careful elaboration. In many countries the lead position is being taken by geological surveys, sometimes with little consideration of geomorphology. This paper will stress the importance of geomorphology in debates about geodiversity, and the relevance of geomorphic concepts and theory to the full understanding of biodiversity and geodiversity studies to the conservation of our natural heritage.

Microcatchment hydrological response and sediment transport under simulated rainfall, Guarapuava – Brazil

Thomaz E.L.

Universidade Estadual do Centro-Oeste do Paraná – UNICENTRO, Department of Geography, St. Simeão Camargo Varela de Sá, 03 – Mail Box, 3010. ZIP CODE 85.040-430 – Guarapuava, Parana State, Brazil (thomaz@unicentro.br)

Water erosion is one of the major geomorphological processes that operate on hillslopes. Erosion is composed of three phases: detachment, transport and deposition of particles. The erosion process in a well-developed rill system occurs by the combined action of splash, sheetwash and rillwash (interrill erosion and rill erosion). These erosion processes exhibit great capacity for both sediment production and sediment transport. Severely eroded and degraded areas are important sources of sediment because they contain completely bare soil. Even if erosion is limited to small patches in the landscape (restricted areas), the sediment yield is higher than in the adjacent areas. In addition, there has been little quantification of sediment production in degraded areas, in relation to the hydraulic runoff characteristics and sediment transport on the whole rill system. The objectives of this experiment were the following: 1) to evaluate the hydrological and sediment transport in a degraded area that was severely dissected by a well-developed rill system; 2) to assess the hydraulic flow characteristics and its aggregate transport capacity in the rill system; and 3) to measure the initial rate of splash erosion. The study area is located in the Guarapuava municipality in the state of Parana, Brazil. The degraded area is around of 0.5 ha, and the severely degraded area has approximately 1300 m^{-2} (nucleus with a well-developed rill system). The soil in the study area is classified as Cambisol (Embrapa, 1979). The soil originated from basalt rock and is heavily clayed (sand 0.116 kg kg^{-1}; silt 0.180 kg kg^{-1}, clay 0.704 kg kg^{-1}), with a moderate depth of approximately 1 m^{-1}; in addition, the topsoil bulk density is 1.24±0.05 g cm^{-3}, the total porosity is 53.1±0.02% and the carbon content is 1.54 g dm^{-3}. The slope degree is 8%, and hillslope form is convex-concave. According to Köppen (1948), the climate is classified as Cfa: mesothermic subtropical wet. The average temperature in the hottest and coldest months are 20.8^{o}C (January) and 12.7^{o}C (July), respectively, with an average annual temperature of about 17°C. The average annual precipitation totals 1914.9±361.7 mm, which is distributed throughout the year (long term 1976-2008) (Instituto Agronômico do Paraná, 2008). The simulator consists of a framework of iron pipes (¾"), a 5-m-tall nozzle (SPRACO) and water that was supplied by a 2.5-HP gasoline water pump. The simulated rainfall was launched from a height of 5 m during a time of 35-54 minutes. The diameter of the drops varies from 0.35 to 6.35 mm, with an average of 2.40 mm. The device produces rain with 90% of the natural rainfall kinetic energy with similar intensity (Bryan, 1994). The approach of this research was based on microcatchments, which was previously formed in the ground, to study the hydrological response and sediment transport. A total rainfall of 33.7±4.0 mm was produced by a rainfall simulator over a 35- to 54-minute period. Also, a total of eight rill system simulations were performed in dry and wet conditions. The equipment was installed, and a trough was positioned at the end of the rill outlet to collect sediment and water. During the simulation, the following variables were measured: time to runoff, time to ponding, time to recession, flow velocity, depth, ratio of the initial splash and grain size. The results display that rainsplash in dry topsoil conditions was more than two times greater than in moist conditions; 5 g m^{-2} min. and 2 g m^{-2} min. respectively. The particles detached by splash; 42.3±7.8% of the macroaggregate was greater than >0.250 mm, while 57.7±4.5% of the microaggregate was less than <0.250 mm. The aggregates in the degraded area (>2.0 mm) displayed a low stability when submitted to the wetting process, which caused slaking into smaller particles. The characteristics of the flow hydraulics indicate transitional conditions among laminar and turbulent flow (Re 1000 to 2000). In addition, it was observed that a flow velocity of 0.12 m s was the threshold for turbulent flow (Re> 2000), especially at the end of the rainfall simulation. The rill flow tended to be subcritical (Fr <1.0). The hydrological parameters (infiltration and runoff) had less variation, while the sediment yield was extremely variable in the rill systems. The erosion in the rill system was characterized as transport limited, although the degraded area (rill system) generated a lot of sediment during the event with an average of 394 g m^{-2} and a maximum of 916 g m^{-2}.

The unpaved road role on the connectivity and sediment transfers in a tropical rural headwater, Guarapuava, Brazil

Thomaz E.L.[1], **Vestena L.R.**[1], **Antoneli V.**[2]

[1]*Universidade Estadual do Centro-Oeste do Paraná – UNICENTRO, Department of Geography, St. Simeão Camargo Varela de Sá, 03 – Mail Box, 3010. ZIP CODE 85.040-430 – Guarapuava, Parana State, Brazil (thomaz@unicentro.br, lvestena@unicentro.br)*
[2]*Universidade Estadual do Centro-Oeste do Paraná – UNICENTRO, Department of Geography, Road PR 153 km 7 – Riozinho, CEP 84500-000, Irati, Parana State Brazil (vdantoneli@pop.com.br)*

The rural road has been recognized in many studies as an important element of land degradation, sediment sources as well as connection element between hillslope and river. The government integrated programs for soil and water conservation in catchment have obtained significant results, mainly in North, West and Southwest in the Parana State regions. In these regions, pedogeomorphological conditions (gentle slope and deep soil) facilitated the integrated planning of rural properties within the catchment approach, including road design, road installation and upgrading of rural roads. However, other regions (e. g. study area) with unsuitable pedogeomorphological characteristics (dissected relief and shallow soils); this management model was not applied. Consequently, many principal roads, particularly trail and internal paths of the rural properties become impassable due to the rill formation on the roadbed of these traffic routes. The road maintenance generally comprises two steps: leveling and spread up gravel over to the roadbed. The leveling provides fine material for runoff transportation and roads with deep roadbed could intercept the subsurface flow. Moreover, the road network overlaps the fluvial drainage network that could facilitate the sediment and contaminants entrance in streams. Several measurements are carrying out in Guarapuava region in order to evaluate the role of the unpaved road on connectivity and sediment transfers on rural headwater. The Guabiroba catchment is located in the Guarapuava municipality, Brazil. The predominant rock is basalt and the climate is classified as mesothermic subtropical wet with annual precipitation and temperature is around 1961 mm and 17ºC, respectively. Different approach has been applied to quantify sediment transfer on a small pilot headwater with 1.1 km^2 as erosion pins, bedload trap, gravel properties (morphology and color), small sediment reservoir assessment, rainfall simulation, manual sediment collecting on road and stream crossing and sediment fingerprinting techniques (Energy Dispersive X-ray Fluorescence – EDXRF). The soil loss on the roadbed with simulated rainfall was of 291.2 g/m^2 (n=8), whilst the coefficient runoff average reach 69.2% (simulation of 30 min. and 115.5 mm/h). The sediment production on the roadbank was superior in comparison to the riverbank. Since the erosion pins on the roadbank registered a degradation average of 2 cm/year (13.9 kg/m/year) (n=155), in opposition to 0.8 cm/year (6.5 kg/m/year) (n=108) average on the riverbank. The assessment of suspended sediment in the river and roads crossing indicated that there was an increase of over 300% at the entrance of sediment in the creek (upstream 0.05 g/L and downstream 0.15 g/L, n = 40). Finally, the EDXRF permitted to find out distinct characteristics between sediment sources (forest, road, riverbank and fluvial sediment deposits). It was also verified that the recently deposited sediment in river channel display greater similarity with the road sediment than riverbank materials. It was concluded that the unpaved agricultural roads was the main sediments sources in the study area (46.5%), although it represents only 1.6% of the occupied area. The agricultural roads had increased the headwater drainage density in 48.7%. Also, the unpaved roads constitutes a linking between the sediment sources on hillslope and the fluvial channel, as a result it's enhance the runoff and sediment transfer.

Formation and characteristics of Nitisols in southwest Ethiopia

Alemayehu Regassa Tolossa

College of Agriculture and Veterinary Medicine, Jimma University, P.O.Box 307, Jimma, Ethiopia (alemrega@yahoo.com)

Information on Nitisols worldwide in general, and in Ethiopia in particular is very limited. This study was thus conducted to illustrate the characteristics and formation of Nitisols. For this purpose, soil profiles along a toposequence in the Gilgel Gibe catchment (South-West Ethiopia) were studied. All studied Nitisols are derived from porphyritic-textured hawaiites, and are quite similar in their morphological, physical, chemical and mineralogical characteristics. Organic carbon content was strongly related to the topography and decreased down slope. Very typical are the abundant shiny ped faces in the B horizons and deeper subsoil, as well as the blackish manganic patches, and manganese concretions and nodules, indicating the importance of the metallization soil forming process. The clayey (65 to 80% clay) Nitic horizons have some characteristics which deviate from the diagnostic criteria for Nitic horizon in WRB (2006); they have (1) a silt/clay ratio of 0.20 to 0.47 (should be less than 0.40 for Nitic horizon according to WRB) and (2) a high (0.19 to 0.31) water dispersible clay to total clay ratio (should be less than 0.10 for Nitic horizon). These ratio values above 0.10 are due to the presence of 2:1 clays with variable basal spacing (detected by XRD), besides the dominant mineral components, kaolinite, iron oxides and mica. These 2:1 clays are also at the origin of the rather high (28-45 $cmol_c$/kg soil) CEC in the Nitic B horizons.

Morphotectonics and lakes of the inner and eastern Asia Rift Systems

Ufimtsev G., **Shchetnikov A.**

Institute of the Earth Crust SB RAS (ufim@crust.irk.ru)

The intracontinental Baikal rift zone, the marginal continental large grabens and of the Lower Amur River region have complicated morphotectonics structures and different lake types. Most big lakes of the Lower Amur River region are situated along the main river stream and are connected with the river by short channels. These lakes receive sediment load, including harmful substances, from the main stream and regulate water discharge and hence have ecological significance. The biggest lakes of the Eastern Siberia and Northern Mongolia – the Baikal and Khovsgol lakes – are located in the bottom of rift valleys. Large parts of the other rift valleys are occupied by a small lakes or lake-shaped extensions of rivers. These features are affected by recent tectonic subsidence (as in the case of the Tunka or Barguzhin rifts). In the mountain surroundings of the grabens, small graben - lakes (fissure - lakes) and dammed lakes are present as evidence of strong prehistoric earthquakes. Along the Eastern Baikal Lake coast there are some lakes located within small grabens, wich compose a row of tectonic landforms spanning from the mountain basins to the Baikal Lake gulfs. These lakes are affected by inversion subsidence. Climatic morphogenesis caused the formation of some types of glacial lakes and thermokarst lakes. The southern and middle Baikal Lake coasts are affected by strong anthropogenic impacts.

Glaciation, deglaciation and postglacial history of the Ethiopian mountains

Mohammed Umer

Department of Earth Sciences and The Paleoanthropology and Paleoenvironment Program, College of Natural sciences, Addis Ababa University, P.O.Box 1176, Addis Ababa, Ethiopia (Moha_umero@yahoo.com, umermm@geol.aau.edu.et)

The high summits of Ethiopian mountains contain traces of glaciations. So far no age has been assigned to these events. In the Last Glacial Maximum, which was colder, dry and arid in lowland basins, lake levels were low up to desiccation. Therefore, the process of ice building on high mountains, could have taken place at the previous cold and dry phases. At around 17,000 years ago, cold and dry tolerant vegetation types developed. This took place, at high altitudes, with stepwise melting of ice. Starting from about 11,000 years ago, species growing under warmer and wetter conditions prevailed. Dry evergreen forest with *Podocarpus* and *Juniperus* expanded on the mountains during the last 4 to 5 thousand years when lake levels started to fall in lowland basins. This could be in response to arid and perhaps intensified seasonality. Intensified seasonality could have been a promoter of the Mid- to Late- Holocene agricultural activity, when arid and semi-arid conditions were established in lowlands may have created conditions leading to the development of pastoralist livelihood. Following these, phases of forest clearance/regeneration and soil erosion/development continued, modulated by both climate and human impact.

Differential tectonic impact on fluvial evolution (Huang Shui, China)

Vandenberghe J.

Institute of Earth Sciences, VU University, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands (jef.vandenberghe@falw.vu.nl)

Many major river systems are characterized by a flight of terrace staircases, which are traditionally attributed to glacial-interglacial cycles. However, climate-controlled terraces are preserved only because of long-term tectonic uplift. In addition, due to the structural setting the tectonic motions may be highly variable. Subsiding gives rise to accumulation terraces while uplift causes the formation of strath terraces. The Huang Shui river system in northern China (main tributary of the Huang He or Yellow river, northeastern Tibetan Plateau) is a catchment where different tectonic movements alternate at short distance. This tectonic setting results in a series of highly variable terrace remnants which are difficult to correlate with each other on the base of their elevation. On the other hand the terrace sequences at various parts of the catchment enable to define phases of tectonic stability or instability, and in the latter case the type of instability. Finally, evaluating the differentiated tectonic causality for fluvial incision and sedimentation and terrace morphology in a region of pronounced tectonic movements enables also to attribute the relative impact of climate versus tectonics on fluvial development. In the case of the Huang Shui catchment the initial morphology is formed by a beveled surface in Miocene to Pliocene times. First signs of incision date from around 8 Ma ago due to slow general uplift of the Tibetan Plateau. A major break in uplift rate caused a strongly increased incision of the river. A flight of more than 23 terraces of different nature is distinguished until now. Dating is underway and based on soil stratigraphy, palaeomagnetism and luminescence analysis of the overlying loess cover.

Geomorphology of the western continental margin of the Black Sea

Vespremeanu E.

University of Bucharest, Faculty of Geography (evespremeanu@yahoo.com)

The Black Sea Basin is a result of continental rifting tectonical processes followed by subsidence being started 125 million years ago during Lower Cretaceous. A deep sea basin resulted and has been developed on oceanic crust, with well shaped continental edges. The western continental edge of the Black Sea (850 km long), the object of the current analysis, is the most complex due to the mixture of geologic and tectonic elements constituting the structure of the relief pattern. From North to South the specific tectonical elements are: East-European Platform, North Dobrogean Structurogen, Moessian Platform, Prebalkanic Platform and Balcani-Istrangea structurogen. Initially, they presented an independent evolution, continued in the last 35 million years with a unitary evolution in the frame of the Western continental edge of the Black Sea. As a consequence of the above morphogenesis, the current morphology of this continental edge is defined by the presence of three regions: (i) the North-Western region, situated between Odessa and Constanța, has a composition profile of coastal plain**,** deltaic and lagoonal littoral plain, continental shelf, continental slope and continental rise, all of them widely extended, with 0,01 – 0,015 gradient range; (ii) central region situated between Constanța and Burgas, in which the coastal plain disappeared, the littoral plains are narrow, the continental shelf is also narrow, continental slope is steep, continental rise is narrow and steep; (iii) the South-Eastern region situated between Burgas and Istanbul, in which all the relief elements in the frame of the cross profile of the continental edge is becoming narrower and steeper. The general geomorphological background is defined by coastal subregions, deltaic, lagoonal with cliffs, pocket beach and rocky cliff. Every subregion has a special morphodynamic regime determined by the natural conditions and the human pressure caused by the hydrotechnical works for portuary and touristic rehabilitation being very specific in the four riverside countries (Ukraine, Romania, Bulgaria and Turkey). In our current analysis, every subregion is considered a subsystem of the Western Coastal system of the Black Sea, requesting a unitary approach of the complicated problems of the coastal zone management.

Prediction of shallow landslides using SINMAP model in Serra do Mar, Brazil

Vieira B. C., Nery T. D.

Department of Geography, University of São Paulo, São Paulo, Brazil (biancacv@usp.br,tuliusdias@usp.br)

Serra do Mar is a mountain range that extends for about 1,500 km along the southeast coast of Brazil. This region has a significant economical importance since it is crossed by the rail- and highway connections that link Brazil's largest metropolis: São Paulo and Rio de Janeiro, to their hinterland as well as to the port of Santos, the busiest in the South American continent. This is basically composed of Precambrian metamorphic and igneous rocks consisting of a complex mixture of gneisses, granites, migmatites and biotite-schists. Hillslopes are very steep, often more than 35° and the gentler slopes are covered by colluviums and talus deposits overlaying bedrock and residual soils. Since the 1920s there are records of landslides in this region, mainly debris flows and shallow landslides that caused many casualties and destroyed partial or totally highways and industrial plants. On 23 and 24 January 1985, during an intense summer rainstorm (380 mm in 2 days), thousands of shallow landslides and debris flows were triggered. Thus, the main objective of this research is the prediction of shallow landslides using SINMAP model, in a pilot catchment located at Serra do Mar mountain range, São Paulo State, southeastern Brazil. In this research the topographical parameters were generated from a high-resolution (4 m²) digital elevation model (DEM) obtained from a topographic map (1:10 000 scale) and the landslide scars were mapped on 1:25 000 aerial photographs to delineate polygons where landslides occurred. The SINMAP is a mathematical model based on the infinite slope equation and the hydrological model and its results are expressed in values of stability index divided into six instability class. However, in this paper, these classes were divided in 2 groups. The first correspond to stable areas, without landslides (stable, moderately stable and quasi-stable), and the second group, unstable class (lower threshold, upper threshold and unstable), with landslides. The results shows that Ultrafértil basin concentrated around 216 landslide scars, occupying an area of 108.420m², with 135.525 m³ of sediments in a 2.5 km² area only. The susceptibility map shows a high susceptibility of the basin, with 75% of unstable areas group. Into this group, the "upper threshold" class was most susceptible, with 33% and 114 landslide scars. In the stable class was mapped 5 landslide scars on the gentle slope, with angle above 30°. In studies in Serra do Mar, usually, landslides occur on slope angle more than 30° and submitted on saturated soil conditions, but in this paper the landslides were located, in great part, on partial or unsaturated conditions, indicated by SINMAP model. This mathematical model mapped a great susceptibility of this basin and may help identify unstable areas in Serra do Mar as well as provide basic information for land use planning. It is still necessary to map other events, associated with severe rainfall, to validate and understand the relation between rainfall events, topographic parameters and landslides in Serra do Mar.

Impacts of climate change on the sensitivity of agricultural land to erosion hazard

Viel V., Le Gouée P., Delahaye D.

Geophen-UMR LETG 6554 CNRS – Université de Caen-Basse Normandie, Esplanade de la Paix, BP 5186, 14032 Caen cedex, France (vincent.viel@unicaen.fr; patrick.legouee@unicaen.fr, daniel.delahaye@unicaen.fr)

Soil erosion is a major and increasing source of deterioration of soil in many European countries. This erosion process leads to displacement of soil particles by the action of water which may damage crops, infrastructure, buildings and environment in general. Erosion caused by runoff occurs when the rainfall intensity exceeds the surface infiltration capacity (generally induced by crusting soils) or when rainfalls fallen in a saturated-surface due to antecedent wet conditions or underlying water table. Models of soil erosion hazard provide an accurate assessment of soil degradation indentifying the spatial distribution of sensitive areas. These models are also frequently used to implement restoration projects or to establish preventive measures to fight against erosion hazard. In this study, we try to evaluate the variability of results produced by these models in the context of climate change. Indeed, in France, IPCC scenarios (A2, B2) indicate clearly a reduction of the YTD precipitation but also an increase in extreme events especially during spring and summer period. Based on these projections, we analysed the consequences of these changes on agricultural land sensibility to soil erosion hazard. We specifically focused our researches 1) on the impacts of the increase of runoff processes during the winter due to the saturation of soil; 2) on the impact of extreme events on soil erosion sensibility linked to the aggravation of rainfall erosivity. In order to address this objective, a modeling approach focused on watersheds located in the northern-western part of France, in Europe is proposed. The implications of climate change on soil erosion hazard are tested using SCALES (a large-scale assessment and mapping model of soil erosion). This proven model allows mapping sensitive areas based on soil characteristics and agricultural practices collected at parcel scale witch guarantee a large accuracy on the local level of soil erosion sensibility.

Rock-soil-relief relationship in the transition of the Atlantic Plateau to the peripheral depression of Sao Paulo (Brazil)

Villela F.N.J. [1], **Ross J.L.S.**[2]

[1]*Federal University of Sao Carlos, Sorocaba, Brazil (fernando.villela@ufscar.br)*
[2]*Department of Geography, University of Sao Paulo, Sao Paulo, Brazil (juraross@usp.br)*

The relationship between rock basement, soils and relief forms is an integrated approach from landscape factors in its origin, structure and processes that lead to better understanding of the numerous existent time-spatial dimensions. The understanding of factors – which they are and what they mean, the dynamics involved and their resultant features – allow comprehending Nature in a detailed, behavioral, physiologic way. This work aims to make a geomorphopedological compartmenting in detailed scale of an area located between two great geomorphologic units, the Atlantic Plateau, crystalline shield of rough landforms, and the Peripheral Depression, transition unit from the plateau to sedimentary basin of Parana, whose smooth landforms are generally sculpted over sedimentary terrains. The transition of these two macro-compartment domains creates contrasts of relief forms according to the basement structure and soils resulting from weathering and erosion. Smooth landforms filled with sedimentary litotypes alternate with small hills of abrupt slopes sustained by igneous or metamorphic rocks, and very red clayed soils originated from weathering of siltstones, can rapidly change to brownish and pale colors indicating loss of material and weathering of stratified sandstones or massive structured quartzites. 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 about the relationship of the above mentioned factors, aiming at a diagnosis of the physical environment in question, it was necessary to make a geomorphopedological compartmenting initially delimiting units according to landform, and secondly combining them with the different litotypes and soil types, adding other themes like hypsometry and declivity as well. Combining all thematic maps, the geomorphopedological compartment chart was created, namely: smooth landforms, convex hills and steep convex hills, denudation processes predominating in all units. Each one of these compartments has peculiar features concerning soil formation, either developed or undeveloped, with mineralogy and structure very often linked to subjacent rock. The landform sculpturing is alternatively controlled by geologic structure or originates from in situ processes that include interfluvial depressions at the secondary watershed divides.

Geological, geomorphological and climatic aspects of the Serra Geral do Tocantins ecologic station, Brazil

Villela F. N. J.

Federal University of Sao Carlos, Sorocaba, Brazil and University of Sao Paulo, Sao Paulo, Brazil (geovillela@usp.br)

This work presents a basic description of Serra Geral do Tocantins Ecologic Station, located in the eastern part of Tocantins State and western part of Bahia State, Brazil. Three main factors of physical environment are treated: the relief forms, due to mesetas and inselbergs predominance in region, famous for Jalapão Dunes on the north; geology, composed by sedimentary lithotypes; and typical savanna climate (humid summers and dry winters). The interaction between these factors has turned out into a mosaic series with huge landscape peculiarities. Serra Geral do Tocantins is a sedimentary plateau sculpted at Sedimentary Basin of Parnaiba. The Ecologic Station's area is featured by sedimentary packs mainly continental, subsequent from basaltic extrusion that occurred during Wealdenian Reactivation in the Jura-Cretaceous period. It is composed by extremely friable sandstone whose colors vary from pale to red, originated from dry paleoclimate accumulations (arid to semi-arid ones) of Mesozoic. It is possible to be related to contemporary dry Mesozoic period of Parana's Basin (Botucatu Desert), though upper layers can be from fluvial-lake environment. The relief forms involve mesetas and level sequences characterized by structural features with retreated edges and step levels into erosive forms. The mesetas are filled with cretaceous sediments and configure great plateau relief units penetrated by pedimented valleys, with scarped edges and large amphitheatres. Its attack by post-cretaceous erosion resulted into step levels whose softened surface produced pediplains that run to Tocantins River course. The very existence of considerable numbers of residual landforms contributes to the geomorphologic contrast. The morphoclimatic domain that sculpts these mesetas and step levels overlain by savanna types and agricultural fields has mechanical morphogenesis. The thermal amplitudes are small, but temperatures are high, above 22ºC the entire year, and the dry season lasts more than the humid season. This work approaches some factors about this physical environment from the point of view of geology, geomorphology and climatology that built the peculiar present scenario at the Serra Geral do Tocantins Ecologic Station. It describes geomorphologic compartments, its basic geologic substratum relationship and a climatic characterization taken from rainfall and temperature historic data. Besides, notable features in the landscape (e.g. domes, residual landforms, structural drainage control, pediplains, sedimentary geologic structures, laterite and dunes) and some important denudation processes are also considered, like hydrographic basin coalescence of Tocantins and Sao Francisco rivers.

Extent of the Middle Polish Glaciations (Warta Stadial, Late Saalian, MIS 6) in central Poland in the light of a petrographic analysis

Wachecka-Kotkowska L.[1], **Górska-Zabielska M.**[2]

[1]*Chair of Quaternary Research, Faculty of Geography, University of Lodz, Kopcinskiego 31, 90-142 Lodz, Poland (kotkow@geo.uni.lodz.pl)*
[2]*Institute of Geoecology and Geoinformation, Adam Mickiewicz University, Dziegielowa 27, 61-680 Poznan, Poland (gorska@man.poznan.pl)*

The investigated area is located at the border between The Middle Polish Lowlands (The Belchatow Plain, The Piotrków Plateau) and The Polish Highlands (The Radomsko Hills, The Przedborz-Malogoszcz Range), in the region, where the ice-sheet of the Middle Polish Glaciations (Late Saalian, MIS 6) has transgressed and subsequently regressed. The aim of the work is to recognize the limit of one of the younger stadials of that glaciation, the Warta Stadial in the light of a petrographic analysis. In 2009/2010 investigations have been made in glacigenic sediments derived from nine sites, lying in four zones of glacial forms. In the south, in the highlands zone (The Radomsko Hills, The Przedborz-Malogoszcz Range), are mezosoic denudation hills. The Wartanian accumulation morain hillocks connect them from the north. In the western part of the area investigated, on the Belchatow Plain, there are dead moraines and kames. This also is the area of the first order watershed of the Vistula and Odra drainage basins. In the northern and eastern parts of that area there is a flat till plain of The Piotrków Plateau, diversified by outwash and fluvioglacial plains and terraces of marginal valleys. Considerating possible limitations resulting from petrography it can be assumed, that glacial masses were coming from NE and NW, from the western and eastern part of the Baltic Sea, which indicates the existence of an interlobal zone. The glacial sediments building the surface of The Piotrków Plateau and the Northern part of The Radomsko Hills were accumulated within the duration of 178 000 – 129 000 BP (Warta Stadial, Middle Polish Glaciations, Late Saalian Glaciation, MIS 6). The results obtained may contribute to a reinterpretation of the Warta ice-sheet limit and, in the light of new petrographic data, it has been proved, that the Wartanian ice-sheet reached further south by about 80-90 km to the south of Lodz, leaning against the northern slopes of the Radomsko Hills, along the Radomsko-Przedborz line.

Ethiopia: a geotourist's perspective

Williams F.

Centre of Excellence for Environmental Luminescence, School of Chemistry and Physics, University of Adelaide, Adelaide 5005, Australia (frances.williams@adelaide.edu.au)

Ethiopia, with its unique location at a tectonic triple junction and its abundance of spectacular geological features, has great potential for geotourism. Currently Ethiopia receives approximately 100,000 international vacation visitors a year, a number which is increasing rapidly, and each of these may be regarded as a potential geotourist. Those (over 60% of the total) who are attracted mainly by Ethiopia's history and culture will have their experience enriched by an understanding of how these are influenced by its geology. The most casual visitor to any part of Ethiopia cannot fail to be impressed by its spectacular scenery, and the more discerning will want to know how its landscapes formed and what underlies them. Visitors who already have an interest in geology will be eager to discover and visit sites of particular geological significance. Several challenges are faced, however, by both the casual and the serious geotourist. Most visitors to the country are not made aware of Ethiopia's rich geological heritage, and those that are often find it difficult to locate or access sites of geological interest. Ethiopia's most spectacular and best publicised geological attraction, the volcanoes and hotsprings of northern Afar, is also the most difficult to access with the result that only about 5% of visitors to the country reach it. Some features such as the tectonic fissures and unique blister cones of Awash National Park are overlooked because local guides are not aware of them or do not consider them of interest, others because there are no directions on how to reach them. Perhaps the biggest frustration faced by a geotourist, however, is lack of information. Although vast amounts of specialist literature on Ethiopia's geology exist, almost nothing is available for the general reader. A notable exception to this is the excellent, recently published book "Geotourism in Ethiopia" by A.Asrat, M.Demissie and A. Mogessie (Shama Books, Addis Ababa, 2008), which focuses on the geology of Ethiopia's historic sites. It is to be hoped that the further three volumes planned for this series will soon be available. The following suggestions for the improvement of the geotourist's experience in Ethiopia are based on visits to numerous geosites in Australia, New Zealand, China, the UK, France and elsewhere, planning of group geological excursions in Australia, and extensive travels in Ethiopia both as a tourist and as a geologist. Examples will be drawn from the above countries' approaches to geotourism, and their application to Ethiopia discussed. Initially, much may be achieved simply and inexpensively by building on existing infrastructure; for example, by including geology as a component in tourism courses and guide training, by encouraging local tour operators to specify items of geological interest in relevant tours and to emphasise Ethiopia's geology as one of its attractions, and by providing information in the form of displays, brochures and inexpensive field and roadside guidebooks at outlets such as National Park Headquarters, hotels and bookshops. Suggested prototypes of such information material will be illustrated. Not only will such simple measures enhance the tourist's experience, but awareness of Ethiopia's geological attractions will in turn bring more visitors and encourage them to travel more widely. Since revenue from tourism currently constitutes one third of Ethiopia's foreign currency earnings, the country as a whole will benefit as will local industries such as guides, tour operators and those offering refreshment and accommodation facilities. Such positive outcomes have been proven by the numerous countries which now promote geotourism. As the scientific and commercial value of Ethiopia's geosites becomes apparent, government agencies and local authorities will be encouraged to take steps to preserve them as geological monuments and establish procedures for their protection and sustainable development as tourist attractions. Many sites in Ethiopia would qualify for such status: Awash National Park, the Rift Valley Lakes region, the caves of Sof Omar, the Dallol hotsprings and the Erta Ale volcanic region to mention but a few. Finally, the inclusion of wider regions of Ethiopia in UNESCO's Global Geoparks Network would bring many related benefits including worldwide recognition and the exchange of knowledge, expertise and experience with other Geoparks. The establishment of Kanawinka, Australia's first and currently only Geopark and a volcanic province with similarities to parts of Ethiopia may provide a useful analogy here.

Geomorphic evolution of the Ethiopian tributaries of the Nile: volcanism, tectonism, climatic change, and human impact

Williams M.

Geographical & Environmental Studies, University of Adelaide, Adelaide 5005, Australia (martin.williams@adelaide.edu.au)

The Nile is the longest river in the world (6 670 km), and its history closely reflects the influence of tectonic, volcanic and climatic events in its Ethiopian and Ugandan headwaters. Herodotus (ca. 485-425 BC) was among the first to recognise that the fertile alluvium in the lower Nile valley was derived from silt brought down from Ethiopia during the three months of summer floods, noting that Egypt was the gift of the Nile. The three major tributaries of the Nile are the White Nile, flowing from the Ugandan lake plateau, the Blue Nile/Abbai and the Atbara/Tekezze, both flowing from the Ethiopian highlands. The White Nile provides 83% of Nile discharge during the month of lowest flow and is responsible for maintaining perennial flow in the main Nile during extreme drought years in Ethiopia, while the Blue Nile and the Atbara provide, respectively, 68% and 22% of the peak flow and 61% and 25% of the total sediment load. The hydrological differences between the Blue and White Nile rivers reflect their very different geomorphic histories. The Blue Nile gorge is one of the most spectacular features in the Nile basin, and post-dates the Ethiopian flood basalts which were erupted within the space of a million years ~30 Ma ago. The volume of rock eroded from the Abbai and Tekezze basins since then ago amounts to 100 000 ± 50 000 km^3 from an area of 275 000 km^2, which is comparable to the volume of the Nile cone in the eastern Mediterranean, estimated at 150 000 ± 50 000 km^3. The concordance between these two independent estimates is consistent with an Ethiopian source for the bulk of the Nile cone sediment. The major drainage divides date back to 20-30 Ma and pre-date the rifting and break-up of the original Ethiopian volcanic plateau, which did not begin until after 20 Ma. Uplift of the Ethiopian plateau was in three stages (29-10, 10-6 and 6-0 Ma) with long-term erosion rates accelerating at ~10 Ma and ~6 Ma. Climatic cooling and progressive desiccation in the Ethiopian highlands at ~2.5 Ma ushered in an era of glacial-interglacial cycles characterised by cold, dry conditions during glacial maxima and warm wet conditions during interglacial phases, when the summer monsoon was stronger than today. During the last glacial maximum at 21 ± 2 ka, the Semien Highlands were glaciated down to 4 200 m, the lower limit of periglacial solifluction was a thousand metres lower (3 100 m), and temperatures were 4-8°C colder. Lake Tana became a closed basin until 17-15 ka. The rivers also became more seasonal and carried sands and gravels to the Nile until 17-15 ka, when they deposited silt and clay across their floodplain. Deforestation in the headwaters over the past hundred years has increased erosion by an order of magnitude, leading to widespread silting up of reservoirs downstream.

Geomorphological mapping for natural terrain hazard assessment, Hong Kong

Williamson S.J., Dias A.

AECOM Asia Company Ltd., Hong Kong (steven.williamson@aecom.com; alberto.dias@aecom.com)

The high population density and hilly terrain of Hong Kong has led to increasingly close proximity of steep natural slopes and dense urban development, and assessments of landslide hazard and risk form a significant and expanding part of geotechnical engineering practice. The application of geomorphological mapping is a fundamental part of Natural Terrain Hazard Assessment (NTHA), where the technique can contribute to the process of identification and delineation of potentially hazardous terrain and optimization of consequent mitigation measures. This paper will first introduce the subject of geomorphological mapping for natural terrain hazard assessment purposes, and then outline examples of applying the techniques to various sites in Hong Kong over the last ten years, charting the gradual evolution of the technique and technical advances made.

Application of Analytical Hierarchy Process (AHP) for GIS-based landslide susceptibility mapping; the case of northern highlands of Ethiopia

Kifle Woldearegay[1], Schubert W.[2], Klima K.[3], Aberra Mogessie[4]

[1]Department of Earth Sciences, Mekelle University, Mekelle, Ethiopia (kiflewold@yahoo.com) [2]Institute for Rock Mechanics and Tunnelling, Graz University of Technology, Austria
[3]Institute for Applied Geosciences, Graz University of Technology, Austria
[4]Institute for Earth Sciences, Graz University, Austria

Rainfall-triggered landslides are common hazards in the northern highlands of Ethiopia. In order to develop a GIS-based landslide susceptibility prediction model, a study was carried out, in northern Ethiopia, which involved: (a) evaluation of the characteristics of slope failures, and (b) defining the most relevant parameters contributing to the initiations of landslides. Results of the research revealed that the major types of slope failures in the northern highlands of Ethiopia are debris/earth slides, debris/earth flows, and medium to large-scale rockslides. Relationships between slope failures and various influencing factors indicate that landslides are dominantly controlled by bedrock types, slope shapes (plan and profile curvatures), slope gradients, drainage lines and vegetation cover. To develop the GIS-based landslide susceptibility prediction model, the Analytic Hierarchy Process (AHP) was used to assign factor weights for individual parameters and sub-parameters. The developed model was tested in Feresmay area, northern Ethiopia. Correlation of the hazard map generated by the model with locations of recent landslide distributions show that the model is capable of providing a degree of accuracy in predicting landslide potential of an area.

Geomorphologic system changes in river-lake of Yangtze River and the lacustrine sediments and pollen disposition responses

Ge Yu, Shen Huadong, Ke Xiankun

Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing 210008 (geyu@niglas.ac.cn)

We studied changes in a river-lake system of the Yangtze and analysed pollen from lacustrine sediments in the middle reach of Yangtze River. Studies focused on the relationships of changes on sediment grinsize, and climate-hydrological features during the past hundred years when the lake turned from an open water system into a closed basin. A high-resolution sedimentary core (1.5 yr/e) was taken from the Wanghu Lake and studies such as dating, grainsize as awell as pollen were conducted. Results showed that there were two major periods of lake-river connection and lake closing according to sediment and pollen features and to clustering analysis. Correlation analysis for time series of pollen, grainsize, catchment precipitation and river discharge, showed that there are significant linear relationships with 95% confidence interval. Major pollen types, including *Pinus*, ratio of evergreen *Quercus* to deciduous, sum of trees and shrubs, Cyperaceae, aquatics, upland herbs, and fern spores, showed a 27-40% synchronous changes with time series of granularity and precipitation during the past 130 years, and a 47-57% synchronous changes with time series of granularity and river discharge before 1960 when the lake naturally was connected with Yangtze River, suggesting pollen deposition controlled by sediments and catchment precipitation. We found different responses of the flooding mode and drought mode during the last 130 years, providing scientific basis to reveal water system changes and lake geomorphology and hydrology responses.

The influence of the changing climate on conditions of initiation, movement and discharge of debris flows on mountainous rivers in the northern Caucasus (Russia)

Zaporozhchenko E. V.

Sevkavgiprovodhoz Institute, Kirova 78, Pyatigorsk, Russia (skgvh@skgvh.ru)

The tendency for warming at all seasons on the territory of Russia began to manifest itself in 1910, more intensively – after 1976. In 2037 against 2007 a global temperature rise of 1.4 ±0.3^{o} for Russia is expected. With regard to the Russian sector of the high mountains of the Caucasus, it was accompanied by degradation of glaciers, which became especially significant after 1957. For a period of one hundred years lower margins of glaciers have retreated up to 1000 m in length and up to 300 m in absolute height. As the ice melted away, loose moraine masses got exposed; lake neoformations have appeared, disappeared and reappeared, their area increasing by up to 10 times. With all this in view, debris flow dangers and the level of their negative impact on vital facilities intensify. Factual material of debris flow events of the 1960s to the first decade of the 21st century has been analyzed. Outbursts of periglacial lakes and rapid outflow of waters from intraglacial hollows have become exclusive causes of disastrous debris flows of the last 30 years in basins of rivers on the Northern slope of the Caucasus Ridge – the Chegem, Baksan, Malka (lateral streams of the Kaya-Arty-Su, Kullumkol, Birdzhaly-Su, Bulungu rivers). Their power, hydrographs, negative impact on urbanized alluvial fans depend on the length and morphology of debris flow channels, possibilities of jamming phenomena on them both as a result of gravitational shifts of slopes (collapses, landslides), provoked by erosivity of streams, and due to the presence of natural narrowings (rocks narrowing) on the way of movement. The density of debris flows is >1.5 t/m^3, recorded discharge rates – up to 700-800 m^3/s, transported mass volumes – up to 1.5-2 10^6 m^3. Repeated outbursts of periglacial lakes have not been observed; a potential threat emerges from new water bodies forming. Protection of lands and settlements must be carried out based on a concept of engineered channelling of mud-and-stone flows and sediment-and-water floods from debris flow lateral tributaries into main receiving rivers using watering-down and transporting capacities of the latter.

Intra-seasonal sediment yield variability in response to catchment greenness as detected by hyper-temporal SPOT NDVI image analysis in Geba catchment, northern Ethiopia

Amanuel Zenebe[1], Atkilt Girma[1], Vanmaercke M.[2], Nyssen J.[3], Verstraeten G.[2], Mitiku Haile[1], Kassa Amare[4], Deckers J.[2], Poesen J.[2]

[1]*Mekelle University, Department of Land Resources Management and Environmental Protection, POBox 231, Mekelle, Ethiopia (amanuelzenebe@gmail.com)*
[2]*Department of Earth and Environmental Sciences, K.U.Leuven, Celestijnenlaan 200 E, B-3001 Heverlee, Belgium.*
[3]*Geography Department, Ghent University, Krijgslaan 281(S8), B-9000 Gent, Belgium*
[4]*Mekelle University, Department of Earth Sciences, POBox 231, Mekelle, Ethiopia*

Soil erosion by water is one of the most important geomorphological processes in the Northern Ethiopian highlands. Vegetation cover is one of the main controlling factors of soil erosion and sediment transport due to water. However, there are very limited studies that focus on temporal dynamics of vegetation cover and its impact on controlling sediment yield. The objectives of this research were to assess: i) dynamics of NDVI (Normalized Difference Vegetation Index) and ii) relationship between sediment yield and NDVI throughout the rainy season. Ten days daily maximum Spot NDVI images with spatial resolution of 1 km x1 km for the years 2004 to 2007 were used in the analysis. Depth integrated suspended sediment samples were taken from nine stream monitoring stations of Geba catchment during the rainy season from 2004 to 2007 and discharges measured. The subcatchment areas vary between 130 and 4,592 km^2. The extreme suspended sediment concentration was found to be 96.7 kg m^{-3}, and the area specific sediment yield ranges between 497 and 6,543 t km^{-2} $year^{-1}$. The NDVI results show that greenness increased in all subcatchements of Geba catchment as the rainy season progresses. The results of NDVI and sediment yield analysis (9 hydrological stations during 4 years) reveal three important phases in all subcatchments. During the first phase both NDVI and sediment yield increased at similar rate. In the second phase, sediment yield increases faster than NDVI. In this stage there is a lot of sediment export. During the third phase, vegetation, as measured through NDVI, controlled and reduced sediment yield at higher rate. This study demonstrates that sediment models and mitigative measures to reduce soil erosion and sediment yield should give special emphasis to the second phase. In addition, revegetating degraded lands contribute in reducing soil erosion and sediment yield.

Mechanims for the formation of dry planation surfaces

Xinbao Zhang

Key Laboratory of Mountain Environment Evolvement and Regulation, Institute of Mountain Hazards and Environment, Chengdu, Chinese Academy of Sciences (axbao@imde.ac.cn)

Planation surfaces are flat or gentle landforms, which are products of denudation and Planation processes. The surface cuts across all older strata and tectonic structures. Fluvial erosion, the basic mechanism for classic Davisian and Penck models of panalation surfaces, may not be able to explain the formation of dry land planation surfaces. The Savanna planation surfaces of Etchplain are one of dry land planation surfaces, which used to be explained by the mechanism of fast chemical weathering under tropical climate. In this paper, the processes of differential rain splash or wind erosion are proposed to explain the formation of dry land planation surfaces. On uneven dry land surfaces, vegetation is very poor and often bare at the crown of a mound because of dry soil moisture conditions while it is better at the nearby depression where soil moisture conditions are higher than the mound because of ground water supply. Therefore, the mound crown is prone to rain splash and wind erosion. The sediments produced from the mound crown by erosion mostly accumulate at the nearby depression because of limited runoffs on the ground under semiarid and arid conditions. Under a long term tectonically stable condition, uneven dry lands are gradually denudated to flat or gentle landscape forms.

Geodiversity of Tatra mts., Poland

Zwolinski Z.

Institute of Geoecology and Geoinformation, Adam Mickiewicz University, Dziegielowa 27, 61-680 Poznan, Poland (zbzw@amu.edu.pl)

The basic objective of this paper is to present a method for deriving a map of landform geodiversity in GIS environment as well as its application for indication of notably attractive scenes in the Tatra Mountains. The paper proposes a flowchart for the map of landform geodiversity compilation procedure. The basis for its creation is a set of different input maps for geoinformation analysis. For each input map assigned values from 1 to 5 according to Jenks Natural Breaks Optimisation which correspond to qualitative description of geodiversity: very low, low, medium, high, and very high. There are: (i) map of geology setting; (ii) map of relief energy (or local elevation) derived from SRTM-3 DEM; (iii) map of landform fragmentation created on the basis of TPI; (iv) map of slopes on the basis of DEM; (v) map of contemporary geomorphological processes; (vi) map of soil cover, and (vii) maps with different attractive types of landform like caves, lakes, rivers, waterfalls, and sources. Map algebra and overlay operation were used for mentioned input maps. This algorithm of multi-criteria evaluation (MCE) produces final output map, i.e. a map of landform geodiversity as an effect of geoinformation analysis. Because of large class comminuting of landform geodiversity received map was reclassified up to 5 classes similarly to qualitative description for input maps. On the final stage of elaboration were indicated areas with great morphological advantages and concurrently attractive from the geomorphological point of view. Detailed parts of landform geodiversity map are presented for selected areas. Presented method of geodiversity determination is useful in geoconservation of unique and rare landscapes in anthropogenetically changed natural environment.

Geodiversity maps for the western coast of Admiralty Bay, King George island, Maritime Antarctica

Zwoliński Z.

Institute of Geoecology and Geoinformation, Adam Mickiewicz University, Dziegielowa 27, 61-680 Poznań, Poland (zbzw@amu.edu.pl)

The problems in determining the actual state and in predicting impacts of global warming on Antarctic ice masses result from the lack of accurate information on surface mass balance terms. Therefore I undertook these questions by resolving some aspects of Antarctic geodiversity of natural environment in the light of ice-free areas' geomorphology, sedimentology of cover deposits as well as hydrochemistry of melting surface waters from ice caps and permafrost. The South Shetland archipelago lies in a geologically active zone of the South Shetland Microplate and the Bransfield Rift whose development is limited by the age of the bedrock (Late Cretaceous) and the processes of relief formation taking place on it. A 1100-km belt of Drake Passage separates the islands from the continent of South America. And 120-km belt of Bransfield Strait separates the islands from the continent of Antarctica. King George Island is the largest and north-easternmost island of the South Shetland archipelago. Island is crescent-shaped, arching northwards, and is located between 61º53' and 62º15' S and between 57º30' and 59º00' W. Its northern coastline is fairly smooth and formed largely by an ice cliff going to the sea straight from the ice cap covering the interior of the island. The southern coast is more diversified, forming several inlets with their own fiords and coves. The fragment of the coast which this study deals with is located in the central part of the King George Island's southern coast. The Admiralty Bay region covers an area bounded by the southern coast of Ezcurra Inlet, the eastern coast of Admiralty Bay, and a section of Bransfield Strait up to the edge of the Polar Club Glacier. A large part of it has been delineated as the Antarctic Specially Protected Areas (ASPA) No. 128, because the area supports an exceptional assemblage of Antarctic birds and mammals, and specific features of the landscape can be protected here. Geologically, the study area adjoins the largest tectonic unit of the island, viz. the Ezcurra Fiord Fault, which separates Mesozoic structures in the north from Tertiary ones in the south. Between Bransfield Strait and the fault line, Birkenmajer (1980) places the rocks of the King George Island Supergroup, which consists of a complex of stratified basaltic and andesitic lavas with sedimentary intercalations of probably Middle Eocene-Miocene age, and the intrusive Admiralty Bay Group in the form of dykes and basaltic plugs. After a Tertiary period of volcanism that had shaped the foundations of the relief, several glaciations occurred in the Pleistocene and Holocene which were accompanied by changes in sea-level registered as terraces lifted up to 250 m above the contemporary level. After a period of severe climatic conditions and its associated stages in the development of the ice cover, the South Shetlands have found themselves in the zone of an ultra-oceanic sub-Antarctic climate involving very rapid changes in the weather. Its characteristic is widely different extreme values of meteorological elements, with a relatively frequent occurrence of disastrous events. They have affected the formation of most of the features of the geographical environment of the Admiralty Bay region, including the contemporary morphogenetic processes and relief found in the particular environments. This morphological environment is covered by different types of deposits, mosses, lichens as well as multiyear snow covers and ice sheets. Thawing glaciers and melting snow covers produce a lot of surface freshwaters. Mentioned combination of different environmental components creates geodiversity of the ASPA No. 128. The poster presents geomorphological, sedimentological and hydrochemical maps of the study area as an exponent of geodiversity of this spectacular and rare subpolar geoecosystem.

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