Department of Geography

RWTH AACHEN UNIVERSITY

Deutsche Gesellschaft für Geomorphologie e.V.

DGGM

DGGM Meeting 2023

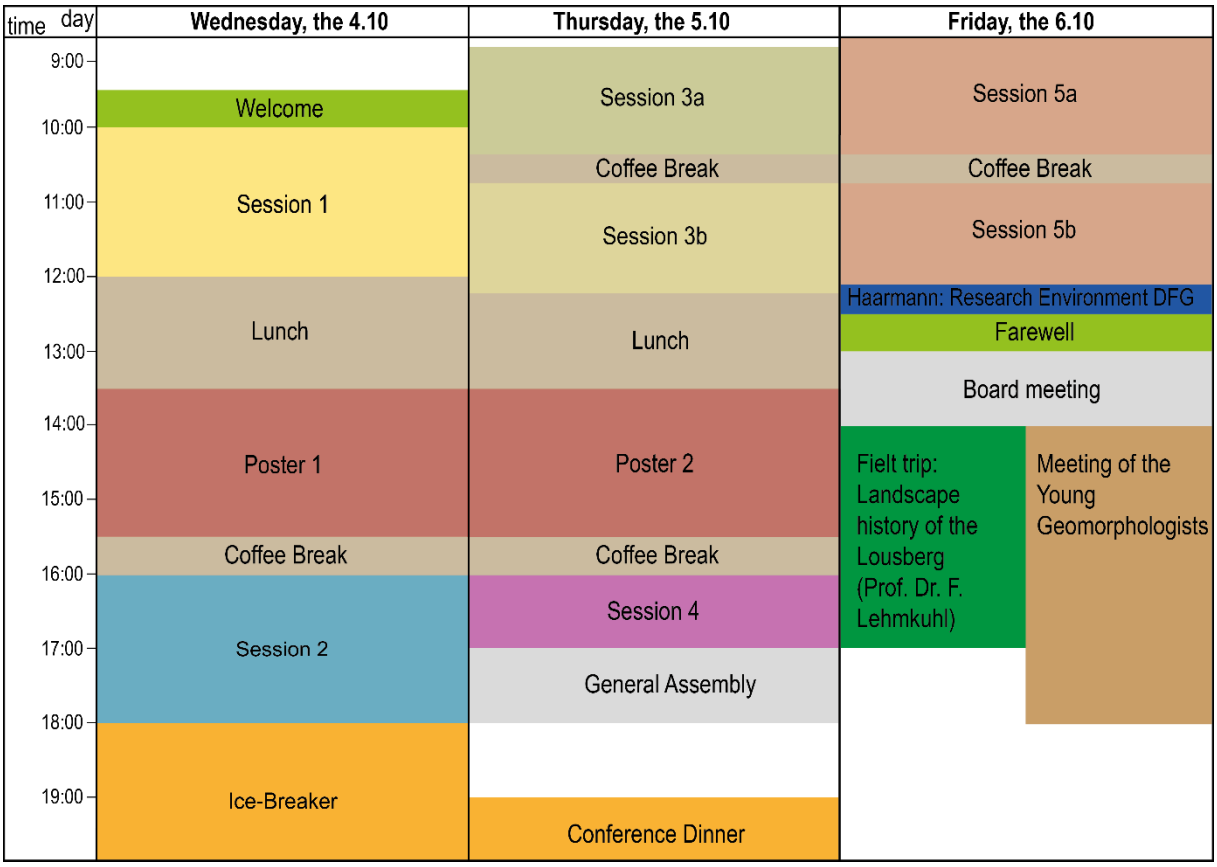
Conference proceedings

04. – 06.10.2023

DGGM 2023 Aachen

OUTLINE

Timetable



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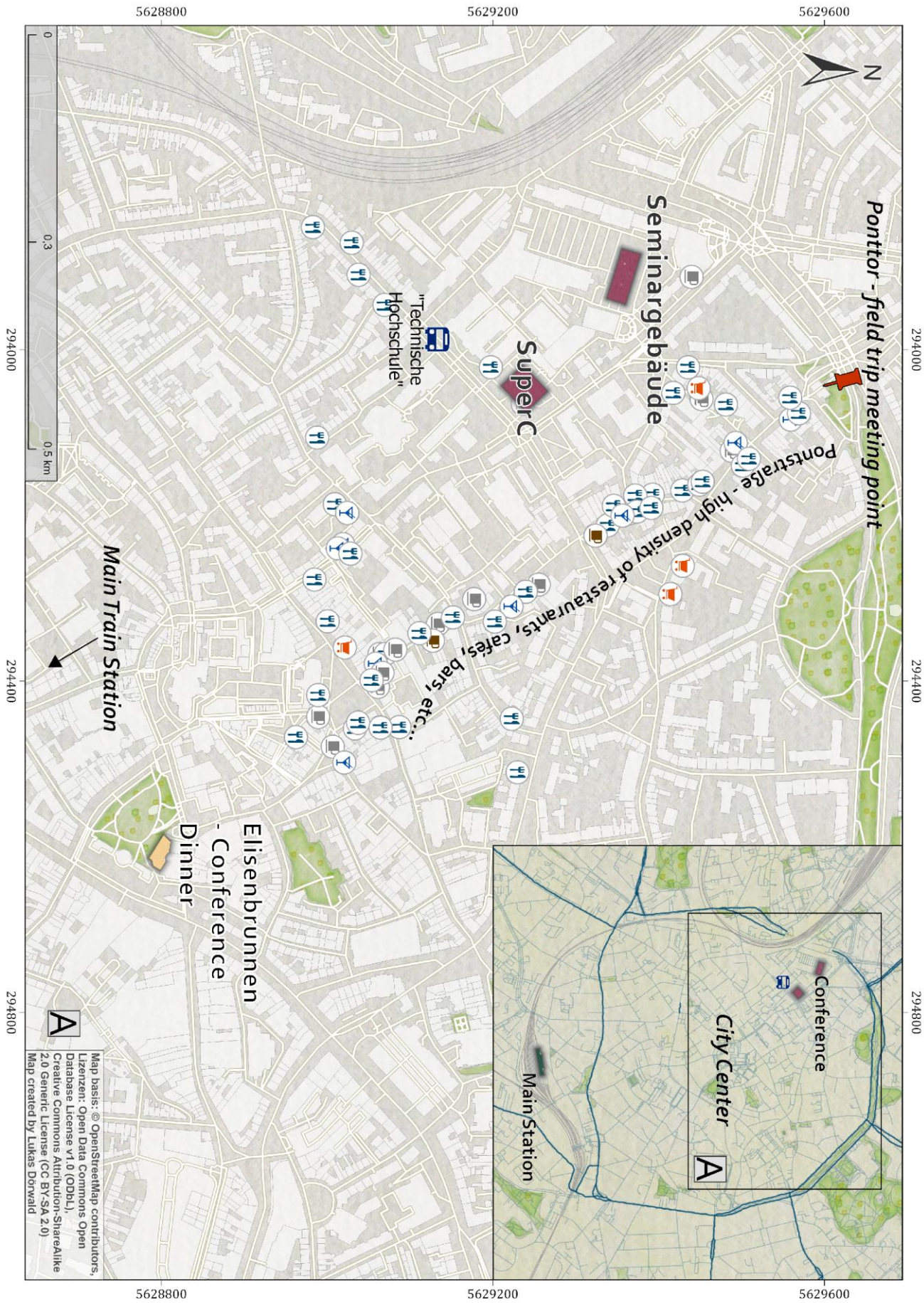
DGGM 2023 Aachen



1 CONFERENCE SCHEDULE

1.1 DAY 1 (04.10.2023)

9:30: Welcome

Session 1

10:00	Bebermeier, Wiebke	Is there an impact of ancient reservoirs on sediment routing in a meso-scale catchment in north central Sri Lanka?
10:20	Meister, Julia	Ancient Andean Agricultural Terrace Systems: An Integrative Approach to Study Pre-Columbian Land Use Dynamics in Southern Peru
10:40	Henselowsky, Felix	The anthropogenic relief of the Rhenish lignite mining district
11:00	Zielhofer, Christoph	The DFG-Priority Programme 2361 "On the Way to the Fluvial Anthroposphere"—Current Challenges and Perspectives of Multidisciplinary Research
11:20	Raab, Thomas	Small anthropogenic landforms from past land use – what have we (already) learned and what do we (still) want to know
11:40	Kessels, Johannes	The Anthropogenic Riverscape Transition in the Eastern Harz Mountains – How did settlement structures interact with the riverine landscape evolution since the middle ages? A conceptual framework

Poster 1

Appel, Elena	Man-environment interactions in the fluvial landscape of the Hessische Ried (Germany)
Betz, Florian	Connectivity of the river network in the Aral Sea Basin: From static connectivity indices towards understanding the impact of river fragmentation on the complex interaction of hydrologic, geomorphic and ecologic processes
Betz, Florian	Fluvial Biogeomorphology across Multiple Scales: Introducing the FluBig Project
Beylich, Achim A.	Environmental drivers, spatiotemporal variability and future trends of chemical and mechanical denudation in the mountain environment of the upper Driva drainage basin in central Norway
Bösmeier, Annette	Estimating sediment storage in Black Forest valleys from morphometric parameters and borehole information
Dietze, Michael	Seismic forensics of 2023 Italy flood crisis questions theoretical frameworks
Fischer, Peter	Multi-methodological investigation of lake sediments from Corfu (Ionian Islands, Greece) to decipher human-environmental interactions, seismotectonic impacts and climate oscillations in the Central Mediterranean
Grimm, Bastian	The fluvial landscape of the Wiesent River (Northern Franconian Alb, Bavaria, Germany) in Early Middle Ages to Early Modern times – change from a nature- to a human-dominated floodplain system?

Hadler, Hanna	Exploitation of a medieval coastal landscape - extensive peat extraction around Hallig Hooge, Wadden Sea of North Frisia (Germany) PART 2
Jouaux, Jens	River on the move – Tracing course changes of the Weser River in the ‘Rintelner Becken’, Lower Saxony
Köhler, Anne	The Lower Havel River and Greater Donaumoos Regions: 'Failed' or 'successful' reclamation of floodplains and peatlands? – A comparative analysis
Profe, Jörn	The fluvial landscape of the Wiesent River (Northern Franconian Alb, Bavaria, Germany) – taking advantage of the third dimension: reconstructions from point clouds
Raab, Alexandra	Geomorphology of the Schwarze Elster Valley (Southwest Brandenburg, Germany) at the Bronze Age barrow cemetery Schweinert – Findings from the 2023 research campaign
Reiß, Antonia	Exploitation of a medieval coastal landscape - extensive peat extraction around Hallig Hooge, Wadden Sea of North Frisia (Germany) PART 1
Ringleb, Bastian	Modelling the catchment response of the Weismain river catchment to land use change.
Sass, Oliver	Suspended sediment transport in a small headwater catchment in Upper Franconia
Schmidt, Johannes	Leipzig, city in a state of flux. Urban-fluvial symbiosis in a long-term perspective
Schmidt, Johannes	Erosion Modelling Indicates a Decrease in Erosion Susceptibility of Historic Ridge and Furrow Fields near Albershausen, Southern Germany
Schulte, Philipp	Interplay of anthropogenic landscape shaping and fluvial dynamics
Slabon, Lena	Evidence of a mid- to late Holocene lake environment in the vicinity of ancient Olympia (western Peloponnese, Greece)
Stolz, Christian	Celtic fields – vorgeschichtliche Flurrelikte im Norddeutschen Tiefland und im Mittelgebirge
Völkel, Jörg	Anthropogeomorphology, Soils and Subsurface Processes in the Otterbach and Perlenbach Catchments (TUM-CZO), Bavarian Forest
Wahlen, Hannah	Possible sedimentological traces of the 1st Grote Mandrenke 1362 AD at the coast of East Frisia near Dornum (North Sea coast, Germany)
Winkler, Markus	Changing river dynamics in the Eger/Röslau catchment since the late Middle Ages – investigations using three human induced metals as tracers (Hg, Fe, Sn)

Session 2

16:00	Slabon, Aron	Spatiotemporal variability of suspended sediment transport
16:20	Płaczkowska, Eliza	Changes in Solute Fluxes in a Headwater Catchment: Impacts of Forest Disturbances and Road Salting
16:40	Rixhon, Gilles	Deeper underground: Cosmogenic burial dating of cave-deposited alluvium to reconstruct long-term fluvial landscape evolution
17:00	Kolb, Thomas	Luminescence dating and diachronism of river terrace formation
17:20	Kögler, Laura	Fluvial landscape evolution in the Granada UNESCO Geopark: Application of a challenging dating approach

1.2 DAY 2 (05.10.2023)

Session 3

08:40	Marzen, Miriam	Aeolian dynamics on arable land in northeastern Kazakhstan
09:00	Bitzan, Simon	Identifying spatio-temporal patterns of dust deposition in the eastern Mediterranean and their impact on soil formation in Crete, Greece
09:20	Pötter, Stephan	Landscape dynamics of the Lower Rhine Embayment – an interplay of relief and environment
09:40	Kirsten, Fabian	Age, composition and genesis of sandy loess deposits (Sandlöss) in the Hoher Fläming (south-west Brandenburg, Germany)
10:00	Zeeden, Christian	Loess-Palaeosol-Sequences in Kashmir - an important and yet mostly unknown link between the Westerlies and the Indian Monsoon
10:20	**Coffee Break**	
10:50	Georg, Tina	The 365 AD and 1303 AD tsunamis hit the Korission Lagoon on Corfu Island (Greece): Geomorphological evidence and numerical simulation
11:10	Oehler, Salome	A story of two dunes – dating the formation and reactivation of dune fields in Arctic Sweden
11:30	Dörwald, Lukas	Dune movement and climatic changes on the north-eastern Tibetan Plateau – Gonghe basin and neighboring regions
11:50	Herzog, Manuel	Star dunes as topographical barriers – active surface forms in a complex system

Poster 2

Bellanova, Piero	Small-scaled variations in the 1755 CE tsunami deposits – observations from El Palmar de Vejer, Spain
Bartz, Melanie	Dates and rates of the Quaternary evolution of the Middle Rhine inferred from electron spin resonance dating
Blöthe, Jan	Rock glacier kinematics in the Desert Andes of Argentina derived from multi-temporal aerial and satellite imagery
Frimberger, Theresa	Anticipating multihazards in future decades from a comprehensive inventory from 5 Alpine countries
Feist, Lisa	Shelf geomorphology and hydroacoustic expression of offshore tsunami deposits (Algarve, Portugal)
Götz, Joachim	Mapping sediment dynamics based on multi-temporal orthophotos and a deep learning approach (Wimbach Valley, Berchtesgaden National Park)
Götz, Joachim	Extent and sedimentation history of a landslide-dammed lake (Hintersee, Berchtesgaden National Park)
Grigusova, Paulina	Mammalian bioturbation amplifies rates of both, hillslope sediment erosion and accumulation
Jemec-Auflič, Mateja	Anticipating future seismic Alpine rock slope failures: a general formula derived from the 1998 & 2004 Julian Alps Earthquakes (Slovenia)

Koehler, Tamara	Geomorphological mapping and distribution modeling of potentially ice-rich block- and talus slopes in the Dry Andes (Agua Negra, Argentina)
Krautblatter, Michael	Challenging the predictability of climate-induced impacts on alpine hazards
May, Simon Matthias	New insights into patterned ground formation in the hyperarid Atacama Desert (N Chile)
Mitchell, Andrew	Rock moisture: where it goes and what it does.
Mohren, Joel	Quantification of plutonium isotopes in environmental samples at the University of Cologne, Germany: progress update
Ortiz, Diana Agostina	Andean permafrost in taluses and block- slopes in the Agua Negra Basin, Argentina – Detection and Distribution
Pfluger, Felix	Measuring and modelling permafrost thaw and hydrostatic pressure pushing rock slopes towards instable conditions
Preuss, Johannes	Stand der Arbeiten zur Bestimmung der Alter der Terrassen im Mittelrheintal
Rehn, Lisa	Unveiling Alpine Permafrost Dynamics: Surface Kinematics of the Kaiserberg Rock Glacier on variying temporal scales
Rom, Jakob	Using lichenometric dating to establish a debris flow record since 1850 in the Horlachtal, Tyrol
Seeger, Manuel	Aggregatstabilität skelettreicher Weinbergsböden unter unterschiedlicher Bewirtschaftung – Quantifizierug mit unterschiedlichen Methoden
Seeger, Manuel	Microplastics ins steep sloping vineyard soils: Input, storage and output under different management practices
Sodnomdarjaa, Enkhjargal	Soil erosion using RUSLE in coal and copper-molybdenum mining in Mongolia
Stammler, Melanie	Pléiades and UAV imagery for rock glacier surface change detection (Agua Negra, Argentina)
Stauch, Georg	Smartphone-supported mapping of landforms - A new tool in teaching geomorphology
Steinritz, Vanessa	Neotectonic activity of the Rhine Graben Faults (Germany): results from paleoseismic studies
Torabi, Mehdi	Late Pleistocene-Holocene landscape evolution and paleoenvironments in Central Iran
Vött, Andreas	Possible traces of the Storegga slide tsunami around 8150 cal BP at the German North Sea coast
Walk, Janek	Spatial frequency analysis of hydrogeomorphic events in Northwest Namibia based on over two decades of satellite Earth observation
Wolf, Dennis	Morphological evidence of Quaternary lake-level fluctuations of the Khyargas Nuur, Western Mongolia

Session 4

16:00	Faust, Dominik	Zyklizitätsmuster quartärer Vegasedimente auf den Ostkanaren
16:20	Vinnepand, Mathias	What do dust sinks tell us about their sources and past environmental dynamics? Insights for oxygen isotope stages 3–2 in the Middle Rhine Valley, Germany
16:40	Dietze, Elizabeth	Teaching Geomorphology

1.3 DAY 3 (06.10.2023)

Session 5

08:50	Skowronek, Armin	„Die morphologische Analyse“ in Theorie, Experiment und Modell – Gedanken zum 100. Todestag des Leipziger Geologen Walther Penck (1888-1923)
09:10	Klinge, Michael	Welchen Beitrag können terrestrische Geoarchive zur Rekonstruktion von Klima, Vegetation und Landschaft im semiariden-kontinentalen Zentralasien liefern?
09:30	Larsen, Annegret	The role of beaver ecosystem engineering in river science
09:50	Hergarten, Stefan	Modeling of rock avalanches with a modified Voellmy rheology
10:10	**Coffee Break**	
10:40	Vinnepand, Mathias	Precipitation derived by geophysical properties of chernozems along a climate transect in the Middle Danube Basin – A direct comparison to meteorological data
11:00	Bell, Rainer	Ongoing response to the 2021 flood impact: the Müsch landslide (Ahr valley, Germany)
11:20	Weidt, Fabian	Analyse räumlicher Muster und Einflussfaktoren extremer geomorphologischer Veränderungen infolge des Hochwasserereignisses im Ahrtal im Juli 2021
11:40	Joel Mohren	Spatio-temporal patterns of alluvial deposition at the Skeleton Coast of Namibia

12:00	Haarmann, Tim	Fördermöglichkeiten der DFG in der Einzelförderung und den koordinierten Verfahren

2 ABSTRACTS

Man-environment interactions in the fluvial landscape of the Hessische Ried (Germany)

Elena Appel[1], Thomas Becker[2], Dennis Wilken[3], Peter Fischer[1], Timo Willershäuser[1], Olaf Bubenzer[4], Bertil Mächtle[4], Lea Obrocki[1], Andreas Vött[1]

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[2]Hessisches Landesamt für Denkmalpflege, hessenARCHÄOLOGIE, Field office Darmstadt, Germany
[3] Institute of Geosciences, Christian-Albrechts-Universität zu Kiel, Germany
[4] Institute of Geography, Universität Heidelberg, Germany

As early as in the 1st century AD, the Romans carried out early river regulation and water management in the Hessische Ried. Redirection of channels and construction of canals enabled cheap transportation of troops and wares, creating an extensive security infrastructure. The rivers Weschnitz, Lauter/Winkelbach, Modau, Darmbach and the Landgraben watercourse connect the Odenwald mountains with the River Rhine, partly using Palaeo-Neckar meanders that had formed until the early Holocene. During Roman times, fortlets, so called burgi, were locally built to protect these waterways. The fortlet at Trebur-Astheim facing the Schwarzbach/Landgraben watercourse represents such a Roman military site.

Multi-method geophysical, geomorphological and geoarchaeological studies were carried out at the burgus at Trebur-Astheim in order to reconstruct its relation with the Schwarzbach/Landgraben watercourse. Our results show that the burgus was constructed at the edge of the Lower Terrace and that the Schwarzbach/Landgraben that connected it with the River Rhine seems to have been built as an artificial canal. Sediments prove that the burgus itself must have been open towards the fluvial system. Based on stratigraphic data, the Lower Terrace section in between the wing walls was modelled as ramp into the burgus basin to pull vessels on the artificial riverbank. We found two different burgus-related sedimentary facies, namely a lower moderate to high-energy fluvial facies right on top of Lower Terrace sands and a subsequent fluvial facies reflecting a clearly reduced flow velocity. The final phase of use of the burgus that was constructed in AD 364/375 was dated to the time period 425–599 cal AD. It was thus in use for possibly more than two hundred years.

Moreover, we carried out geomorphological studies in an abandoned section of the Palaeo-Neckar channel near Alsbach-Hähnlein as well as near Gernsheim in order to unravel the development of the regional fluvial system and detect possible man-made influences such as river diversions.

Dates and rates of the Quaternary evolution of the Middle Rhine inferred from electron spin resonance dating

Melanie Bartz[1], Mathieu Duval[2], María Jesús Alonso Escarza[2], Gilles Rixhon[3,4]

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[2]*Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain*
[3]*Laboratoire Image Ville Environnement (LIVE), Université de Strasbourg-CNRS UMR 7362, Strasbourg, France*
[4]*National School for Water and Environmental Engineering, Strasbourg, France*

The Rhine River is one of the largest river systems in Europe connecting the two major, formerly glaciated areas at the continental scale, i.e., Alpine glaciers and the Scandinavian ice sheet. Thus, it is a key setting for studying Earth's surface processes under a changing climate during the entire Quaternary. The Middle Rhine Valley (MRV) exhibits a well-preserved terrace flight, one of the most complete fluvial archive in Europe. However, the long-term evolution of this important fluvial setting is only poorly known due to the difficulties of dating sedimentary features over 10^4-10^6 years timescales.

For the first time, we use electron spin resonance (ESR) to date quartz grains from six key geomorphological levels in the MRV. Based on these new ESR data derived from the Multiple Centre (Al & Ti centres) approach, we aim at reconstructing the aggradation and incision history in the MRV. We will not only be able to unravel the main drivers of river adjustments but also to discuss potential implications as far as early human occupations in the region.

First Al and Ti ESR ages from the three older terrace levels are consistent, suggesting complete bleaching (=signal reset) prior to deposition. The main terrace complex yields age estimates of ~1.3 Ma (older main terrace) and ~1.15 Ma (younger main terrace). In comparison, the Kieseloolithe terrace deposits show a much older age estimate of at least ~1.8 Ma, which is consistent with the existing geomorphological framework, although perhaps somewhat younger than the expected Pliocene chronology. Preliminary age constraints of the Middle Rhine terraces suggest low incision rates of <0.5 mm/yr for the period from the onset of the Quaternary. Finally, our results also indirectly provide additional chronological constraint to the well-known Kärlich archaeological site, considered as one of the earliest evidence of human presence in Germany.

Is there an impact of ancient reservoirs on sediment routing in a meso-scale catchment in north central Sri Lanka?

W. Bebermeier[1], B. Schütt[1], H. A, Dharmagundawardana[2], A. Pitawala[2], Tony Reimann[3]

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[2]*Institute of Geology, University of Peradeniya*
[3]*Geographical Institute, Geomorphology & Geochronology, Univerisät Köln*

In the dry zone of South Asia human-made reservoirs locally called tanks (in Sri Lanka) and eris (in south India) have served for the collection, storage and distribution of rainfall and runoff and provided irrigation water for the cultivation of paddy for 2400 years. Today, 30,000 small village tanks are in use in the dry zone of Sri Lanka, impacting the water and sediment balance of this region. Although many scholars highlight their retention capacity to buffer climatic extreme events like floods and droughts, little is known on their impact on sediment fluxes. However, as a result of human utilization (such as extraction of fines for brick production), disturbances by wave motion and post-sedimentary alterations, tank sediments have proven to be unsuitable as an archive for paleo-environmental reconstruction.

Therefore, we tested the suitability of floodplain records from the catchment of the Aruvi Aru River located in north central Sri Lanka as sediment archive for the derivation of proxy data. We described and sampled altogether 28 sediment sequences from the floodplain and derived for five sequences a robust geochronology by combining OSL and radiocarbon datings. The results indicate, that the alluvial deposits date to the late Holocene and accelerated accumulation started at c. 2.40±0.15 ka and 1.48±0.08 ka, respectively. Deposits, dating to the Pleistocene correspond to a fluvial terrace of the Aruvi Aru River, which was accumulated at the end of the Pleistocene (c. 20-30 ka). Late Glacial to early Holocene ages were obtained for a buried paleo-valley floor of an Aruvi Aru River tributary (9.2-10.6 ka). Overall our results point to a change in driving forces of sediment routing, chronologically corresponding to the regional introduction of the tank systems and corresponding intensification of agriculture and urbanization. In our presentation we will discuss these evidences in light of paleoclimate records.

Ongoing response to the 2021 flood impact: the Müsch landslide (Ahr valley, Germany)

Rainer Bell[1], Michael Dietze[2], Till Wenzel[3], Leon Chrysostomides[1], Fabian Flöck[1], Anna Schoch[1], Lothar Schrott[1]

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[3]*Department of Geography and Regional Research, University of Vienna, Vienna, Austria*

In July 2021 extensive rainfalls triggered an extreme flood event in the Ahr valley, causing 134 fatalities, enormous damage and geomorphological changes. The Müsch landslide (100m wide, 200m long) is located at a narrow stretch of the Ahr in the upper Ahr valley. At this section of the river the flood had a peak discharge of about 550 m/s and eroded approx. 7000m³ of the landslide toe. A complete failure of the slope might have the potential to dam the river causing a lake which could lead to inundation of buildings. Thus, the aim of this study is to better understand landslide behavior and assess hazard and risk potential.

We applied a multi method approach including field surveys, mapping, analysis of pre- and post-event airborne laser scanning (ALS), UAV monitoring, electrical resistivity tomography (ERT), seismic refraction tomography (SRT) and passive seismic monitoring.

The landslide is exposed to the NNW while the strata is dipping 30° to the West. According to ERT and SRT the depth of the landslide might be about 25 m at the western boundary. From July 2021 until May 2023 only the frontal part showed different levels of visible reactivations. However, passive seismic monitoring has indicated from the beginning that the whole slope has started to react to fluvial undercutting. In May 2023 cracks opened on forest roads in the middle and upper part of the landslide. Furthermore, a trunk of a spruce is split from the bottom upwards in the main scar area. All of these new signs confirm the results of the seismic monitoring.

Given the current results, monitoring needs to be continued and further methods included like deep drillings and installation of inclinometers to better evaluate hazard and risk potential of this landslide.

Small-scaled variations in the 1755 CE tsunami deposits – observations from El Palmar de Vejer, Spain

Piero Bellanova[1], Lisa Feist[1], Margret Mathes-Schmidt[1], Jan Schwarzbauer[2], Klaus Reicherter[1]

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Tsunami deposits originating from the 1755 CE Lisbon tsunami are known from the Spanish Gulf of Cádiz. The coastal areas around Conil de la Frontera were severely affected by the tsunami, with the destruction of the Conilete village, damages to the medieval Torre de Castilnovo, and inundation of low-lying areas of Conil de la Frontera (e.g., the old tuna factory La Chança). A tsunami wave train of at least three waves with inundation heights of up to 8 m has been reported in historical eyewitness documentation. Already, few studies have documented sedimentary remnants in the form of sandy units, and their inland extends in Conil de la Frontera and the adjacent alluvial plains of El Palmar de Vejer. Few studies along the coastal areas of the tsunami-affected Iberian Peninsula excavated trenches and pits for sampling. Yet, no study has investigated the 1755 CE tsunami deposits and their small-scaled sedimentological features in a high resolution along the cross-section of a sedimentological trench.

This research presents a combined sedimentological, micropaleontological, and biogeochemical analysis of a coastline-perpendicular cross-section in a large-scale hand-dug trench (4.5 x 4.5 x 1 m) from the coastal alluvial plain of El Palmar de Vejer. By means of sediment-stratigraphic analysis, grain size and micropaleontological analyses, organic biogeochemistry, and photogrammetry the 1755 CE tsunami layer has been distinctly identified from its surrounding strata, and sedimentary structures resulting from small-scaled tsunami processes have been analyzed.

Connectivity of the river network in the Aral Sea Basin: From static connectivity indices towards understanding the impact of river fragmentation on the complex interaction of hydrologic, geomorphic and ecologic processes

Florian Betz[1,2], Tobias Heckmann[1], Magdalena Lauermann[1], Rafael Schmitt[2], Akylbek Chymyrov[3]

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[2]*Stanford University, Natural Capital Project and Stanford Woods Institute for the Environment*
[3]*Kyrgyz State Technical University named after I. Razzakov*

Connectivity is crucial for the development of riverine landscapes as it determines the natural flow and sediment regime. Today, the connectivity of most large rivers is affected by anthropogenic infrastructure such as dams and reservoirs. This is also true for the Aral Sea Basin in Central Asia. The importance of freshwater resources lead to the construction of a large number of dams and reservoirs and thus a fragmentation of the river network. Despite its relevance for the functioning of the river corridors, connectivity in the Aral Sea Basin remains unexplored. This is partly due to the fact, that modeling connectivity in such large, data scarce regions is challenging. Against this background, we present a first assessment of the structural connectivity of the river network in the Aral Sea Basin on the basin and sub-basin level using the dendritic connectivity index. To move from the static view delivered by this index, we present an outline and preliminary results of process based modeling of the relationship between sediment connectivity and the complex interaction of geomorphological and ecological processes shaping riverine landscapes. For this purpose, we combine a recent dynamic version of the catchment sediment connectivity and delivery (CASCADE) model with satellite time series derived information on the interaction of vegetation and hydro-morphology. The results of the structural connectivity analysis show that rivers in the Aral Sea Basin are highly fragmented – even though large free flowing river sections remain. The dendritic connectivity index is able to show the spatial pattern of river network connectivity. However, to explain and predict the impact of river fragmentation on complex riverine processes, static indices are insufficient. To overcome this issue, the suggested coupling of CASCADE with satellite approaches might offer a solution which is applicable to large, data scarce catchments such as the Aral Sea Basin.

Fluvial Biogeomorphology across Multiple Scales: Introducing the FluBig Project

Florian Betz[1,2], Gregory Egger[3], Tobias Heckmann[1], Magdalena Lauermann[1]

[1]*Catholic University Eichstätt-Ingolstadt, Faculty of Mathematics and Geography*
[2]*Stanford University, Natural Capital Project and Stanford Woods Institute for the Environment*
[3]*Karlsruhe Institute of Technology, Institute of Geography and Geoecology*

Riverine landscapes are shaped by the feedbacks between hydrological, geomorphological and ecological processes. These feedbacks are happening across multiple scales, from the scale of single plants modifying the hydraulic forces around it to the formation of landforms like islands which in turn leads to the emergence of specific river types such as braided or anastomising. Over the past years, the field of biogeomorphology has improved the understanding of the interaction of vegetation and (hydro-) morphological processes. Despite recent scientific progress, research gaps remain. In particular, the functioning of the interactions across multiple scales is still poorly understood. Within the FluBig project introduced by this poster, we aim to fill this gap taking the Naryn River, a large free flowing river in Kyrgyzstan, as case study. We focus on the question, how small scale feedbacks on the scales of single plants influence the structures and processes on the scales of geomorphological units, reaches or even the entire river corridor, and vice versa. We base upon the concept of paparchy and investigate the adaptive cycles and their linkages on the different scales. To achieve our objectives, we combine field methods for mapping vegetation traits and geomorphic characteristics with UAV surveys and up-to-date satellite remote sensing to quantify adaptive cycles on different scales. Afterwards, panarchies are constructed for different river types occurring along the Naryn River. With this project, we quantify for the first time biogeomorphological feedbacks in river corridors across multiple scales. This advances the understanding of the emergence of riverine landscapes and contributes to the development of nature based solutions in river management.

Environmental drivers, spatiotemporal variability and future trends of chemical and mechanical denudation in the mountain environment of the upper Driva drainage basin in central Norway

Achim A. Beylich and Katja Laute

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The upper Driva drainage basin system in central Norway (Hjerkinn-Oppdal) is situated in a cold-climate and mountainous environment and ranges with a drainage basin area of 1630 km^2 from 220 to 2286 m a.s.l. The lithology is dominated by metamorphic rocks. This GFL research includes (i) field- and remotely sensed geomorphological mapping and computing of morphometric catchment parameters, (ii) statistical analyses of high-resolution meteorological and ground-temperature data, and (iii) the continuous observation and year-round monitoring of sediment transfers, runoff and fluvial solute and sediment transport. A range of different techniques is applied. Specific focus is on six tributary valleys of the upper Driva drainage basin system. Stationary hydrological stations are monitoring year-round runoff, fluvial solute and suspended sediment transport. The analysis of fluvial bedload transport includes the application of different tracer techniques together with underwater video-filming and Helley Smith and impact-sensor measurements. Discharge in the upper Driva drainage basin occurs year-round with a nival runoff regime and a mean annual runoff of 576 mm. The temporal variability of sediment transfers, runoff and fluvial transport are largely controlled by thermally and/or pluvially determined events. The selected tributary systems display varying solute and sediment yields which is explained by different lithologies, valley morphometries and sediment availabilities. The activation of sediment sources is strongly determined by thermally and/or pluvially induced events. The highest share of annual sediment transport occurs during the snowmelt period in spring. Altogether, chemical denudation dominates over mechanical fluvial denudation. It is expected that global warming and the connected shifts in the ratio of snow and rain, the increased frequency of extreme rainfall events, and the continued thawing of permafrost will have complex effects on denudation, with an increasing importance of pluvially-induced denudational events as compared to snowmelt-induced denudation processes, and an increasing dominance of chemical denudation over mechanical denudation.

Identifying spatio-temporal patterns of dust deposition in the eastern Mediterranean and their impact on soil formation in Crete, Greece

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The Sahara is the Earth's largest dust source and its dust plumes impact the whole planet. The mineralogical composition of dust particles depends in particular on the source area. Where deposited, dust particles' mineralogical composition can play a decisive role in soil formation processes. Although of importance for local ecological conditions, this impact has not been extensively studied in the eastern Mediterranean. Thus, further investigation of dust deposition fluxes, transport trajectories linking source to deposition areas, and elemental and mineralogical composition is required.

In order to get a holistic view on the prevailing processes from transport to deposition and the impact of dust on soil formation in the deposition areas, this project combines meteorological and physical-geographical methods. Based on satellite and reanalysis data, seasonal and event-specific source and deposition areas will be identified. Additionally, a network consisting of eight monitoring sites is installed around the Lefka Ori Mountains in western Crete reflecting the expected spatial variability in dust concentration and deposition. The sites are equipped with a marble-sampler, a MWAC-sampler, and an optical-particle-counter. Additional sedimentological and geochemical analyses of samples allow for attribution of dust source areas via the geochemical signature of dust particles.

Ultimately, this setting enables examining the impact of Saharan dust deposition on recent soil formation processes in Crete. The results will provide additional insights into sedimentation dynamics and their impact on soil formation across the eastern Mediterranean basin, which will lead to a better understanding of past and future landscape dynamics.

Rock glacier kinematics in the Desert Andes of Argentina derived from multi-temporal aerial and satellite imagery

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In semiarid mountain ranges, rock glaciers constitute an important part of the periglacial environment that is under threat in a changing climate. However, quantitative data on the state of rock glacier activity remain scarce, especially in the southern hemisphere. Here, we derive kinematic information on rock glaciers located in the Valles Calchaquíes district in the Desert Andes of Argentina from optical feature tracking in aerial photographs and satellite imagery. Using rock glacier outlines from the National Glacier Inventory of Argentina, we quantify surface movement of 35 landforms for three epochs between 1968 and 2022, and of 140 landforms for two epochs between 2009/2010 and 2022. To overcome matching difficulties resulting from varying image quality and lighting conditions associated with the use of multiple sensor platforms, we apply directional filters to enhance feature-tracking performance. Our analysis reveals mean surface velocities exceeding the limit of detection between 0.59 and 0.92 m yr^{-1} for all three epochs. Classifying all surface displacement values into kinematic categories reveals that between 62 and 87% of moving areas have velocities between 0.03 and 0.3 m yr^{-1}. In either case, the rock glacier velocities found for the Valles Calchaquíes are significantly lower than previously reported from other Andean environments. This might be related to the absence of glacier-connected rock glaciers, as well as the smaller size of periglacial landforms in the region. Analysing data from more than five decades, we do not find a coherent picture of permafrost degradation in the region, but rather a coexistence of rock glaciers characterized by accelerating, decelerating, and constant velocities in close vicinity. Our study provides the first quantitative information on rock glacier kinematics for multiple landforms in the Desert Andes of Argentina, contributing important information to assess the impacts of climate warming on this remote periglacial environment.

Estimating sediment storage in Black Forest valleys from morphometric parameters and borehole information

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Valley fills, such as floodplains, terraces and fan surfaces, buffer adjacent hillslopes from channel processes, protect underlying bedrock from erosion, nourish or attenuate sediment fluxes, serve as archives for paleoenvironmental reconstruction, and provide levelled grounds for human settlements. A thorough quantification of sedimentary volumes in mountain valleys can therefore contribute to a better understanding of landscape evolution and furthermore contains relevant information on hydrogeological characteristics. In contrast to the Upper Rhine Graben, where detailed information on sedimentary sequences is available, there is surprisingly little coherent information on the subsurface structure of Black Forest valleys. While in the upper reaches, the valley draining the Black Forest are narrow with limited space for sediment storage, the larger trunk valleys are characterized by broad alluviated valley floors. Here we set out to estimate the thickness of alluvial material filling the wide valleys of the south-western Black Forest by semi-automated geomorphometric and statistical analyses. For this, we make use of an extensive database (> 7100 boreholes) of the State office for geology, resources and mining (LGRB) Baden-Württemberg to derive local sediment depth and thickness above bedrock. We combine this information with the extent of valley fills delineated from high-resolution digital topography as well as information from geological maps. We then perform a spatial quantification of valley fill sediments using quantile regression models of sediment depth (as a function of the distance to the valley floor boundary), including stratified sampling to reduce a spatial correlation bias. Our preliminary results suggest that v-shaped valley geometries dominate the headwater tributaries. In the main valleys, however, wide and rather shallow valley fills prevail, pointing to a dominance of lateral channel migration. Approaching the Upper Rhine Graben, sediment thickness increases to 70-100 m, reflecting the influence of the Graben structure on the lower reaches of the Black Forest tributaries.

Teaching Geomorphology

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Climate and land cover change, increasing hazards from floods, mass movements and soil erosion, glacier and biodiversity loss call for increased understanding of ongoing and past Earth surface dynamics in all fields of society. In University education, we are training the next generation of land managers (in the widest sense: working in administration, in the field and in policy) as well as school teachers, which is a great responsibility. What basic geomorphological knowledge and which skills do we need to convey in our Geography and Geoscience study programmes at Bachelor, Master and PhD level? How can we ensure that the next generation of graduates (of whom only very few percent will realise a scientific career) is readily prepared for the large challenges ahead? Which knowledge should already be taught in schools (also to those that decide for different career paths after school) and which geomorphological understanding is already been taught in Geography classes in schools on which we can base our university knowledge transfer on?

Here we present our experiences from teaching Geomorphology in university, discussions with students, teachers and practitioners and present a basic inventory of geomorphological contents in current school curricula considering several federal states. We aim to stimulate a discussion within our discipline, for example, on dedicated foci in Geomorphology classes we are teaching, depending on the natural setting of the landscape in our respective geographical regions, and on the target knowledge for certain professional fields.

Seismic forensics of 2023 Italy flood crisis questions theoretical frameworks

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Rain fed river floods increasing impact densely populated landscapes across a warming globe. Their devastating potential is exacerbated by insufficient conceptual, predictive and now-casting capabilities, and lacking measurement capabilities. Here, I use 18 seismic stations and rain radar data covering 12000 km² of the Emilia-Romagna Province, Italy, that was hit by an exceptional rain storm on 16 July 2023. Despite largely varying upstream areas, the floods emerged virtually synchronous, arguing for a yet unconsidered runoff mechanism. Seismometers were able to sense the approaching waters with more than 30 min untapped warning lead time. Seismic flood anatomy in steep, valley confined river sections gives way to estimates of foreland water storing volumes by ground tilt signal analysis. The seismometer-based timings of numerous extra-local landslides questions existing predictors of rain driven mass wasting events. Hence, one spatially extensive, simple and yet comparably cheap and now-casting-ready geophysical approach is able to shed light onto several critical flood-related dynamics.

Dune movement and climatic changes on the north-eastern Tibetan Plateau – Gonghe Basin and neighboring regions

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The movement of active dunes is tightly linked to climatic conditions (e.g. wind regime, temperature, and precipitation) as well as human influence (e.g. grazing, dune fixation, infrastructure, and greening activities). Dune migration rates can be studied to draw conclusions of changing wind conditions over time. The intramontane Gonghe Basin, the source region of the Yellow River (Huang He), as well as other neighbouring regions upon the northern Tibetan Plateau are all influenced by two major wind regimes: the mid-latitude Westerlies and the Asian summer monsoon. To investigate environmental changes, we combined optical remote sensing techniques with climatic datasets. High resolution satellite images of the last six decades, such as Corona KH-4B, are used to map dunes and calculate their respective migration rates and allow a remote sensing approach as far back as 1968. Climatic changes from the ERA-5 reanalysis dataset and NDVI values were processed alongside, using Google Earth Engine. Relating the dunes' surface processes to climate model data shows an accordance between slowing migration, expanding vegetation and a decrease in Sand Drift Potential, calculated from ERA-5 data, recently updated to the 1950s. Within the Gonghe Basin, 76 dunes are studied over multiple time sections; in the source region of the yellow river, more than 400 were mapped for comparison. The study areas differ in topography, vegetation, agricultural use, infrastructure, and fluvial influences. This offers a good testing ground for the aforementioned assumptions.

DGGM 2023 Aachen

Zyklizitätsmuster quartärer Vegasedimente auf den Ostkanaren

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Im Rahmen eines DFG-Projektes (FA 239/26-1) zur Sedimentationsgeschichte auf den Ostkanaren konzentrieren wir uns auf zwei Sedimentarchive. Einerseits sind dies die bereits bearbeiteten karbonatsandigen Dünensequenzen auf Fuerteventura, (Roettig et al. 2017, 2019) und andererseits die von Suchodoletz et al. (2009, 2010) beschriebenen Vegasedimente auf Lanzarote. Letztere zeichnen sich durch das Fehlen von schelfbürtigen Karbonatsanden aus, und bestehen aus umgelagerten Böden, vulkanischen Aschen und Staubablagerungen, die aus unterschiedlichen Sedimentquellen des afrikanischen Festlands stammen. Die Vegas auf Lanzarote haben unterschiedlich große Einzugsgebiete. Im Vortrag stellen wir die Vega von Teguise mit geringem Einzugsgebiet (F_E = 150 ha) vor, um in größere zeitliche Tiefen vorzustoßen. In dieser Vega lassen sich gut differenzierbare Sedimentlagen erkennen, wobei sich die Abfolge von rötlichen kalkfreien zu hellen kalkhaltigen Sedimenten fortwährend wiederholt. Bei kleinen Einzugsgebieten der Vegas lassen sich in den Sedimenten Zyklizitätsmuster am deutlichsten erkennen. Auf einen eventhaften Eintrag schluffdominierter Stäube mit Feinsandanteilen folgt eine Aufkalkungsphase der in die Vega eingetragenen Sedimente. Im Einzugsgebiet beginnt gleichzeitig eine Bodenbildungsphase bei feuchter werdenden Bedingungen. Mit einsetzender Aridisierung kommt es zur Erosion tonreicher (> 80%) Böden vom Hang bei gleichzeitig zunehmender Staubaktivität, die in einem den Zyklus abschließenden eventhaften feinsandig-schluffigen Staubeintrag gipfeln. Innerhalb der hellen Kalkschicht lässt sich über Korngrößenunterschiede und graduell sich verändernden Quarzanteilen eine innere Differenzierung vornehmen. Der Übergang von der Kalkschicht zu rötlich-tonreichen Kolluvien ist durch ein Quarzminimum charakterisiert. Innerhalb der rötlichen Bodenumlagerungsschicht nimmt der Quarzanteil fortwährend zu (zunehmender Staubeintrag!) und gipfelt während des feinsandhaltigen Staub-Event. Die Feinsande stammen nicht aus den Dünenfeldern, sondern vom Afrikanischen Kontinent. Wir erkennen in dieser Abfolge Hinweise auf klimagesteuerte Sedimentzyklen, die im Vortrag zur Diskussion gestellt werden. Das Projekt wird nach umfangreichen Datierungen an den Vegasedimenten die Vergleichbarkeit der bereits datierten Dünensequenzen Fuerteventuras mit den Vegasequenzen Lanzarotes beinhalten.

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Shelf geomorphology and hydroacoustic expression of offshore tsunami deposits (Algarve, Portugal)

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The 1755 CE Lisbon tsunami destroyed Portuguese, Spanish, and Moroccan coastlines, with the Portuguese onshore record extensively studied. Offshore impacts, on the other hand, remain under-researched. To address this, the RV METEOR cruise M152 aimed to investigate offshore imprints of the 1755 CE Lisbon tsunami and possible preceding events on the southwestern Algarve continental shelf, southern Portugal. The team identified tsunami deposits from 1755 CE and an earlier event dated to around 3600 years BP in sediment core samples.

Our research offers an analysis of the sub-bottom and seismic profiles gathered during M152 and a supplemental cruise that explored shallower waters. The supplemental cruise used a parametric echo-sounder and 2D single-channel seismics, while M152 used an Atlas Parasound echo-sounder. We focus on the Late Quaternary sedimentary record on the Algarve shelf, which is predominantly comprised of rough, erosional seafloor with minimal sedimentary cover. Specific depositional geomorphological features were identified in some areas on the shelf in different water depths. The features of deeper areas are associated with past periods of lower sea levels. In some areas, one or more strong reflectors were recorded and, where possible, correlated to the stratigraphy of the sediment cores. Mapping the strong reflector related to the 3600 years BP event revealed its lateral distribution on the shelf.

Our research showcases the utility of hydroacoustic profiling in analyzing the Algarve shelf's Late Quaternary sediment cover. This provides a deeper understanding of sedimentary dynamics and the lateral distribution of offshore tsunami deposits.

Multi-methodological investigation of lake sediments from Corfu (Ionian Islands, Greece) to decipher human-environmental interactions, seismotectonic impacts and climate oscillations in the Central Mediterranean

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The Mediterranean has been identified as particularly vulnerable to rapid climate changes (RCCs) during the Holocene. RCCs are assumed to be one of the main environmental factors causing distinct cultural and socio-economic changes. So far, available proxies are often discontinuous or cover in detail only distinct Holcene time intervals leading to incomplete and partly diverging interpretations. In combination with chronological uncertainties, our understanding of the impact of RCCs on coastal and landscape evolution and their fingerprints within natural terrestrial archives requires further research.

We present a new sedimentary record from a palaeo lake in the Giannades polje on Corfu Island, Greece. Following geophysical prospection and in situ Direct Push electrical conductivity measurements, we retrieved a 16 m long sediment core partly containing finely laminated sediments composed of grey-clastic, dark-organic and yellowish-brown carbonaceous laminae. Our studies include high-resolution X-ray fluorescence (XRF) core scanning, grain size and magnetic susceptibility measurements, smear slide and microfaunal analysis as well as determination of total carbon and nitrogen contents. The age model is based on radiocarbon dates yielding consistent ages from ca. 7500 BC until 1700 AD, overall indicating an average sedimentation rate of 1.4 mm/a.

Observed changes in proxy data will be associated with environmental changes related to climate (RCCs) and human-impacts. In addition, we expect the Giannades polje geoarchive to comprise signals of local and regional seismo-tectonic events, as they have been evidenced by geoarchaeological investigations of regional coastal sites. Our studies are embedded in the joint research program SCaLES combining dendro- and sclerochronological and speleological studies on a larger spatial and temporal scale to increase the understanding of these environmental influences. This approach will allow detailed correlations with other regional to interregional archives of climate and environmental change.

Anticipating multihazards in future decades from a comprehensive inventory from 5 Alpine countries

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In recent years, the Alpine region has been affected by unprecedented weather extremes such as heavy rainfall, storms and heatwaves with severe impacts on the environment, humans and the economy. While there is recent scientific evidence of climate change attribution to the increasing intensity and frequency of such events, knowledge of future event magnitudes, cascading impacts and risks are still insufficient.

We developed a modular approach, which allows to categorize different types of natural hazards and harmonize Alpine-wide data on past hazardous/extreme events from Austria, Slovenia, Italy, France and Germany. For each hazard category and event, we can quantify meteorological promoting and triggering factors, hazard magnitudes and

reported damages. Different hazard modules can be combined, such that we are able to quantify compound hazards including their potentially cross-triggering effects. This approach allows to generate an inventory of > 100 past events across the Alpine region. By analyzing the comprehensive catalogue on past events and using regional climate simulations for the next decades, we anticipate process-specific future hazards and magnitudes.

This work is part of the X-RISK-CC project, funded by the Interreg Alpine Space Program 2021-27.

The 365 AD and 1303 AD tsunamis hit the Korission Lagoon on Corfu Island (Greece): Geomorphological evidence and numerical simulation

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The AD 365 and the AD 1303 tsunami events are well known extreme wave phenomena in the eastern Mediterranean Sea. Originating from earthquakes in the Hellenic Arc near Crete Island, both events caused severe damages and fatalities along the adjacent coastlines and left distinct traces in different geoarchives. This study focuses on the Korission Lagoon in southwestern Corfu Island, Greece. With a steep and narrow continental shelf and directly exposed towards the open Ionian Sea, the lagoon offers little protection against extreme wave events. Washover fans at the seaward lagoonal shore are a typical geomorphological feature for extreme wave impact. Geoscientific data focused on the stratigraphic sequences of the washover fans as well as on the landward shore of the lagoon where both the sedimentological and the microfaunal record document tsunami inundations. We present radiocarbon dating results pointing to the AD 365 and the AD 1303 tsunami events. Our study is complemented by numerical simulations of tsunami impact.

Along with the radiocarbon ages, our modelling results illustrate the inundation of the lagoon and confirm its vulnerability to high-energy impacts from a western and southern direction. Comparable events under present-day conditions, which are likely to occur in the highly active seismo-tectonic setting of the eastern Mediterranean Sea, are assumed to have great impact on today's society and emphasize the importance of adequate risk assessment.

Extent and sedimentation history of a landslide-dammed lake (Hintersee, Berchtesgaden National Park)

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Rockslides and their impact on sediment (re)distribution and connectivity are a major agent of alpine landscape evolution, e.g., in the case of landslide-dammed lakes. Such a situation can be observed in the Klausbachtal catchment in the Northern Calcareous Alps (National Park Berchtesgaden), where catchment lithology controls frequency and magnitude of geomorphic processes. The western valley flank is built up by limestone with dominating low-frequency/high-magnitude events. From here, the Zauberwald Rockslide (12-16*10^6 m^3) was released 3520 ± 85 years BP (von Poschinger and Thom 1995), damming a lake whose remains still exist (Hintersee, Ramsau). In contrast, the majority of backfill sediments is supposed to originate from the western side of the valley, where highly weathered dolomite yields huge amounts of debris by high-frequency/low-magnitude events via several steep torrents.

In this study, we aim a) to delimit the initial (maximum) lake extent, b) to analyse backfill sedimentation and determine (potentially changing) sediment source areas, c) to comparatively discuss our results with former studies (von Poschinger and Thom 1995, Bader 1981), and d) to validate (scenario-based) models on lake extents and trapped sediment volumes (Argentin et al. 2022).

To investigate the architecture of the valley fill, we acquired 1.5 km of electrical resistivity tomography (ERT) in June 2023. Interpretation of these data is supported by existing borehole data as well as previous geophysical profiles (Bader 1981). Multitemporal terrestrial and airborne laser scanning data (TLS, ALS) are used to analyse the (sub-)recent backfill sedimentation from the main source areas. Additional topographic data (evaluation of historical aerial photographs) are to be included.

First ERT results (ongoing work) suggest that the initial lake extent was overestimated by former studies and that the lake extended approx. 1.6 km up valley from the recent shoreline. Multi-temporal topographic data indicates a high present-day activity of two torrents originating from the western valley flank (Mühlsturzgräben).

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Mapping sediment dynamics based on multi-temporal orthophotos and a deep learning approach (Wimbach Valley, Berchtesgaden National Park)

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Alpine sediment transport from rockslopes to rivers usually occurs in cascades, with several intermediate deposits, from where the material is remobilized by different geomorphological processes of varying frequency and magnitude. When erosion rates are high and the transport capacity of the fluvial system is low, most of the sediment is trapped.

Characterized by a highly active sediment cascade, the Wimbach Valley in the Berchtesgaden National Park is a textbook test site for studying alpine sediment dynamics in such a transport limited system. Frequent rockfall from the strongly fractured, dolomitic rock faces supply huge amounts of sediments transported via debris flows and avalanches through numerous steep gullies towards the valley bottom. Subsequent fluvial sediment transport only takes place when heavy precipitation events trigger short-term surface runoff. This results in an up to 300 m thick valley fill (Bader 1981) that is still frequently reshaped by a high process activity and diversity and led to a unique scenery with a complex pattern of (semi-)active “Schuttströme” between vegetated areas of multiple successional stages. In the context of climate change, frequency and magnitude of rainfall events are predicted to increase, leading to more frequent surface runoff with massive effects in the Wimbach Valley.

Against this background, we aim at assessing the (sub-) recent sediment dynamics based on manual, multi-temporal orthophoto mapping (2003-2020) and an automated segmentation approach using the deep learning model U-Net (Ronneberger et al. 2015).

In line with previous research (Schlesinger 1974), preliminary results show a strong increase in geomorphologic activity between 2003 and 2012, a quiescent period 2012-2015, and a further slight increase between 2015 and 2020. From a methodological perspective, the deep learning approach is highly promising and in cases even superior to manual mapping, particularly if training data is maximised and high resolution multispectral aerial imagery is used.

This contribution presents ongoing work, which will be extended further back in time (orthophotos derived from historical aerial images) and complemented by a biogeomorphologic component, dedicated to the potential of succession analyses for the reconstruction of frequency and magnitude of geomorphological processes.

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Mammalian bioturbation amplifies rates of both, hillslope sediment erosion and accumulation

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Animals that interact with the soil are found all over the world and are crucial in the formation and preservation of productive soils and balanced ecosystems. However, numerous such species are endangered or have become locally extinct due to factors like habitat destruction, predation by invasive species, or illegal hunting and poisoning. Several reintroduction and rewilding initiatives have been put in place with the primary goal of boosting these animal populations and restoring the natural processes that were disrupted by their disappearance (Eldridge & Soliveres, 2023). However, very little is known about the effects burrowing animals have on soil re-distribution.

Animal burrowing activity affects soil texture, bulk density, soil water content and redistribution of nutrients. All of these parameters in turn influence sediment redistribution, which shapes the earth surface. Hence it is important to include bioturbation into hillslope sediment transport models. However, the inclusion of burrowing animals into hillslope-wide models has thus far been limited, and largely omitted vertebrate bioturbators, which can be major agents of bioturbation, especially in drier areas.

Here, we included vertebrate bioturbator burrows into a soil erosion model to allow a general approach to for assessing the impacts of bioturbation on sediment redistribution within four sites along the Chilean climate gradient. Our model was based on a combination of detailed field-, laboratory, and remote sensing datasets. Including bioturbation greatly increased model performance and demonstrates the overall importance of vertebrate bioturbators in enhancing both sediment erosion and accumulation along hillslopes. We also found that bioturbation had contrasting effects on sediment redistribution in arid than in semi-arid and Mediterranean, as well as in humid climate zone, while bioturbating animals seem to play only a negligible role in the humid zone (Grigusova et al., 2023).

The fluvial landscape of the Wiesent River (Northern Franconian Alb, Bavaria, Germany) in Early Middle Ages to Early Modern times – change from a nature- to a human-dominated floodplain system?

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Riverine landscapes and their floodplains are dynamic systems by nature and are characterized by socio-environmental changes throughout history especially since the Early Middle Ages. These landscapes have been subject to direct (e. g. water mills, bridges, use as meadows, transportation pathways) and indirect (e. g. catchment wide agriculture and soil erosion) transformation processes, that changed the floodplains' morphology. In consequence natural dominated floodplains and ecosystems transformed to human-dominated floodplain systems.

The Wiesent River and its tributaries in the Northern Franconian Alb, northern Bavaria, perfectly illustrates this transformation, because hydrotechnical installations such as watermills were increasingly built with the beginning of the Middle Ages. Soil erosion within the catchment due to increased agricultural activities in combination with increased hydrotechnical constructions could lead to the thick overbank deposits and increased sedimentation rates during the Middle Ages as reported for some northern Franconian valley floors.

We aim to investigate the floodplain transformation of the Wiesent River including its tributaries for the time period from the Middle Ages to Early Modern times and to unravel boundary conditions responsible for the morphological change. Based on DEM analyses we classified subcatchments (that we assumed to be homogenous) and delineate the floodplains to find optimal locations for percussion drilling and trenching. This enables us to establish a (chrono)stratigraphy by OSL dating and sedimentological and stratigraphical analyses. Results likely help to relate sediment dynamics to settlement dynamics and to identify consequences of the socio-economic settings on the fluvial landscape as part of the human-environment system. Furthermore, taking paleoenvironmental proxies (such as phytoliths, biomarkers, ostracoda, ...) into account facilitates attribution of flood plain ecology alterations to e. g. changes in land use.

Exploitation of a medieval coastal landscape - extensive peat extraction around Hallig Hooge, Wadden Sea of North Frisia (Germany) PART 2

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The unique coastal landscape of the North Frisian Wadden Sea – today protected as National Park and part of the UNESCO World Heritage 'Wadden Sea' – has a changeful past characterised by intense human-environment interactions. It is especially in medieval times that Frisian settlers cultivated and at the same time exploited the low-lying marshes and fenlands. Around the Halligen islands Langeness, Gröde and Hooge, peat extraction for salt production on an industrial-like scale significantly lowered the ground surface and turned large areas into wasteland.

Using a combined geoarchaeological, geophysical and archaeological approach, we investigated peat extraction sites in the tidal flats around Hallig Hooge to evaluate the impact of the large-scale peat extraction on the landscape development and coastal vulnerability, especially regarding the impact of storm surges.

Our results show that traces of peat extraction still visible in the surrounding tidal flats extend over far more than 20 hectares, not including those remains hidden underneath recent sediments, and give a good first estimate about the spatial extent of anthropogenic landscape changes. Peat extraction not only lowered the ground surface into the range of mean high water, thus significantly changing the local geomorphology. It literally turned the site's stratigraphy upside down. Our study therefore aims at understanding the hiatus between initial peat formation and medieval man-made landscape changes to estimate the extent and consequences of these large-scale geomorphological changes.

The anthropogenic relief of the Rhenish lignite mining district

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Open-pit mining results in a massive change of the land surface, where the example of lignite mining in the Rhenish mining district (western Germany) is unique and extraordinary due to its long history and spatial dimensions. The area directly and indirectly affected by mining extends up to 2,500 km². We reconstruct the complex development of a complete anthropogenic relief with the help of old maps and derived digital elevation models for the pre-mining landscape. This highlights the scale of absolute relief changes to the post-mining and present-day relief. Relief changes occur at the scale of -400 m to +200 m between the pre- and post-mining landscape and form new positive and negative landforms at the scale of the mesorelief. Furthermore, the anthropogenic relief is characterized by higher slope angles Even though the emergence time as anthropogenic relief is biased, the existence time for these mesorelief landforms will last for (ten-)thousands of years (without any strong further human made changes). Both, mining possibilities and subsequent landuse are massively influenced by the geomorphological-geological natural conditions.

The very high ratio of overburden to lignite in the Rhenish lignite district from 6:1 is one important reason, why the anthropogenic relief changes are so massive. The spatial and temporal differences are influenced by the respective technical progress for mining, starting from first small scale near surface excavations in the 19th century to the very deep pits with large scale bucket-wheel excavators. The same applies to the historical varying subsequent use of the post-mining landscape, from initially irregular and unplanned use to regulated extensive measures. Next to the general regional perspective for the anthropogenic relief in the triangle of Mönchengladbach, Aachen and Cologne, the study contributes also to the relevance of geomorphology in the Anthropocene and geomorphology for society.

Modeling of rock avalanches with a modified Voellmy rheology

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Rock avalanches reach considerably greater runout lengths than predicted by Coulomb friction. While it has been known for a long time that runout length increases with volume, explaining the increase qualitatively is still a challenge. Recently, a modification of the widely used Voellmy rheology was presented, which turned out to explain the increase in runout length with volume reasonably well for point-like masses. In this presentation, numerical simulations with the modified rheology are shown and compared to the conventional version of Voellmy's rheology. Beyond being able to explain the long runout of rock avalanches, the modified rheology also seems to be more realistic concerning the initial phase of movement and promises a large potential for further research on hummocky deposit morphologies and longitudinal striations.

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Star dunes as topographical barriers – active surface forms in a complex system

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Complex star dunes are, in contrast to most other smaller scaled dune forms, one of the most understudied aeolian bedform on Earth. Due to their unstable nature in time, overall size as well as morphometric and stratigraphic complexity they cover significant research challenges. They were often regarded as inert dune forms formed under past climatic conditions. However recent progress in capturing theses complex forms on surface and subsurface levels alike and a close combination with the environmental context showed that they can be described, at least in most parts, as active dune forms under current climatic conditions.

We combined high-resolution multitemporal surface changes reflecting actual aeolian dynamics with subsurface stratigraphical records describing older accumulation patterns in Erg Chebbi, Morocco. The results showed, on a short-term, a so far hardly observed shielding effect, pointing to a form of self-sustained dune growth. The observed star dune acts as topographical barrier inducing sediment accumulation on windward dune slopes. On long-term trajectories the overall morphology is governed by a multidirectional wind system. However, even secondary winds and directions seem to play a significant role. This leads to the assumption that star dunes are more sensitive to even small changes of controlling factors than previous assumed. In sum, sediment transport on these dune forms is highly dependent on the relation between slope exposition and the local wind regime. The resulting interdune sand transport determines overall crest distribution of the star dune.

The results can be transferred to other mega dune forms characterized by larger and steep dune slopes. The same transferability applies for the methodological approach, which can be used on all dune forms ranging from barchans to large star dunes. In the future, the past genesis and development of star dunes since the Pleistocene should be recorded via drilling and luminescence dating.

Anticipating future seismic Alpine rock slope failures: a general formula derived from the 1998 & 2004 Julian Alps Earthquakes (Slovenia)

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In this paper, we use rock slope failure inventories from the Julian Alps as the closest analogue to potential seismically induced landslide events in the Northern Limestone Alps. This is because (i) both have similar, very steep, highly dissected rock face structures that are highly susceptible to seismic shaking, and (ii) both have only moderate exposure to moderate magnitude earthquakes, unlike mountains in seismically highly active areas. We applied the Arias intensity to the severity of shaking by measuring the ground acceleration of seismic waves and introduced a power regression model to define a formula for calculating the rock slopes failure density in the alpine environment.

River on the move – Tracing course changes of the Weser River in the 'Rintelner Becken', Lower Saxony

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Riverine floodplains have always been spaces with high natural dynamics, resulting in a repeatedly changing pattern of fluvial landforms and shifts of river courses. Nevertheless, floodplains belong to the traditional settlement areas and are subject to a wide variety of human interests, as they function for instance as transport axes and provide natural resources. Accordingly, societies had to adopt to these dynamic environs, leading to multifaceted human – environmental interrelations, which are currently investigate in a pilot-project for a section of the Weser River in Lower Saxony.

The study area of this presentation is situated near the town of Rinteln, which was founded in the 12th century and received town charter in 13th century CE. It is a typical example of the numerous early and high medieval settlements and monastery foundations at the margin of the Weser floodplain and its adjoining terraces: documenting the process of Medieval Land Acquisition of Northern Germany and the cultural and historical importance of this region.

Based on geomorphological field mapping, digital terrain models (DEM1 and DEM5) and their derivates, satellite images and historical maps we observed numerous paleochannels in the vicinity of the village of Engern, which is located east of Rinteln. Written sources give evidence, that the former main course of the Weser River ran north of the village in Medieval times, while today the Weser River is situated south of the village.

In order to address these assumptions and to obtain a deeper understanding for the development of the Weser floodplain around Engern, we will present data on near-surface sediment architecture derived by ERT measurements and sedimentological data from percussion drillings.

The Anthropogenic Riverscape Transition in the Eastern Harz Mountains – How did settlement structures interact with the riverine landscape evolution since the middle ages? A conceptual framework.

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Fluvial systems have been experienced fundamentally changes due to anthropogenic activities since the Neolithic. Land use and landcover changes caused morphodynamic changes of fluvial systems as well as changes of runoff characteristics. As a result, all river systems in Central Europe today are anthropogenically influenced, their course often straightened, and rarely left in a natural state. Despite massive anthropogenic influences, natural factors such as runoff following heavy rainfall affect the rivers and their floodplains today as in the past. Fluvial systems are fundamentally shaped by their surrounding landscapes. This also means that changes in the natural environment bordering the river course impact the river's dominant morphodynamic processes and discharge characteristics, in turn determining sedimentation dynamics and the dispersion of sediment-bound pollutants. Key assumption is that overbank deposits and the floodplain architecture still contains the information about medieval sediment dynamics. Heavy metal concentrations can be used as a tracer.

The study area is the upper and middle catchment of the Selke River located in the eastern Harz Mountains tributary to the Bode River. The main area of interest has a size of 180 km². The Selke River is a typical river in the transition zone between the uplands of the mountain range and the loess dominated lowlands. The study area was an active mining region confirmed since the 9th century. While the mining history in the western Harz Mountains has long been focus of scientific research. Less is known about the (prehistoric, medieval) settlement and mining history of the Eastern Harz Mountains. Only few historical studies are available.

"Old Maps", written records, archaeological artefacts as well as LiDAR based terrain prospecting were used to prepare a detailed overview on the history of settlement, mining and smelting. In the region of the Selke catchment four main periods can be defined based on the beginning of the colonization and characteristic of the mining and smelting activities. Further divisions related to our research questions can be made within phase two and three.

In connection with the morphological and hydrological setting locations for the field work are highlighted.

Age, composition and genesis of sandy loess deposits (Sandlöss) in the Hoher Fläming (south-west Brandenburg, Germany)

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The so-called Fläming ridge stretches from the north-west to the south-east within the south-western part of the state of Brandenburg (Germany). The ridge was mainly formed during the Warthe stage of the Saalian period (MIS 7 to MIS 5e) as a terminal moraine complex comprising different glacial oscillations and respective push moraines (Stackebrandt 2020). Under periglacial conditions during the Weichselian period (MIS 5d to MIS2), the glacial landscape was transformed into its late Pleistocene/Holocene morphology and aeolian sediments with sandy to silty composition were deposited.

These sandy loess deposits, traditionally referred to as “Flottsand” and isolated from the main loess areas, are represented in current maps of loess distributions in Central Europe (Bertran et al. 2021; Lehmkuhl et al. 2021). However, these deposits have never been studied in detail regarding distribution pattern, provenance, composition and age.

Here, we present two soil-sediment-sections near Rabenstein. They comprise glaciofluvial sands of Saalian age (MIS6), stone lines including ventifacts, sandy loess of late Weichselian age (MIS2) that has only partially been decalcified, and approximately 50 cm of coversand at the top, which also dates to the late MIS2. The grain size distribution of the sandy loess is very similar to the that of loess deposits in the Harz foreland studied by Kraus et al. (2016), with a main mode in the coarse silt fraction and a minor mode in the medium sand fraction.

Furthermore, we present new data on the distribution and spatial extent of the (sandy) loess deposits in the Fläming area based on a reassessment of the original geological survey by Keilhack & Von Linstow as well as the “Lithofazieskarte Quartär” (LKQ50) of Brandenburg.

Based on these results and previous studies on late Pleistocene sandy loess deposits in Lower Saxony by Gehrt and Vierhuf, we propose a geomorphological model for the genesis of isolated (sandy) loess deposits in north-eastern Germany.

Welchen Beitrag können terrestrische Geoarchive zur Rekonstruktion von Klima, Vegetation und Landschaft im semiariden-kontinentalen Zentralasien liefern?

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Das hochkontinentale Trockenklima im nördlichen Zentralasien ist der dominierende Steuerungsfaktor für die Vegetation und die landschaftsprägenden geomorphologischen und pedogenetischen Prozesse. Im Westen und Süden von Gebirgen eingerahmt, liegt der zentralasiatische Trockengürtel zwischen zwei niederschlagsprägenden Klimazonen. Im Norden wird Feuchtigkeit mit der Westwindzirkulation herangeführt und die sibirische Hochdruckzelle führt zu winterlicher Trockenheit. Der südostasiatische Monsun greift nach Nordwesten bis in die Ausläufer der Gobi aus. Wechselnde Intensitäten der atmosphärischen Zirkulation prägen ein variables Niederschlagsregime. Globale Klimaveränderungen führten zur räumlichen Verlagerung der Vegetationszonen Wald, Steppe, und Wüste. Die klimatische Wasserbilanz als Differenz aus Niederschlag und Verdunstung beeinflusst die Ausbreitung der Gletscher im Hochgebirge und der Endseen in den Beckenlagen, während lokale Niederschlags-verhältnisse die Erosionsbedingungen und die Abflussdynamik in den Tälern bestimmen.

Die Seesedimente in den Beckenlagen eignen sich hervorragend als Archive für die Umweltanalyse, da sie verschiedenste Paläoproxies mit oft kontinuierlicher und zeitlich weit zurückreichender Auflösung liefern. Auch sind Moore und Gletschereis, die äolische Einträge wie Pollen, Staub und Asche in chrono-stratigraphischer Abfolge speichern, gute Archive für die Umweltrekonstruktion. Beim Aufbau von terrestrischen Sedimentkörpern verschneiden sich äolische, periglaziale, kolluviale, alluviale und fluviale Ablagerungen oft mit fossilen Bodenbildungen, die geoanalytische Rückschlüsse auf die Paläoumweltbedingungen aus diesen Geoarchiven erlauben.

Aufgrund der naturräumlichen Differenzierungen sind spezifische Geoarchive räumlich ungleich verteilt. Unterschiedliche Einzugsgebiete und Sedimentationsraten des aus den Geoarchiven gewonnenen Probenmaterials führen zu unterschiedlicher räumlicher und zeitlicher Repräsentanz der abgeleiteten Proxidaten. Zudem gibt es oft abweichende Interpretationsansätze für die paläoökologischen Befunde. Bei radiometrischen Altersbestimmungen treten methodenspezifische Probleme in Hinsicht auf die Sedimentationsbedingungen und das datierbare Material auf.

Im Rahmen des Vortrags werden die Potentiale und Grenzen von terrestrischen Geoarchiven und daraus gewinnbaren Proxidaten beispielhaft für das Gebiet der Mongolei vorgestellt und deren Relevanz für Paläoumweltrekonstruktionen kritisch bewertet. Dabei stehen Fragen der holozänen Klimaentwicklung und der potentielle Einfluss des Menschen auf die Vegetation und Landschaft im Vordergrund.

The Lower Havel River and Greater Donaumoos Regions: 'Failed' or 'successful' reclamation of floodplains and peatlands? – A comparative analysis

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The historical reconstruction of reclamation, colonisation and hydro-engineering in floodplains and peatlands is a key objective for improving our knowledge about human forcing on natural fluvial landscapes and environments (Werther et al. 2021).

The major aim of the new interdisciplinary project is a comparative assessment of these human interventions and corresponding ecological transitions towards two Fluvial Anthropospheres located in Central Europe. These are the Lower Havel River Region and the Greater Donaumoos Region. For the first time, we will reconstruct socio-ecological processes with a multi-methods approach from historical archaeology, geoscience and plant ecology. In addition, we will create through further data categorisations, transferable models and joint interpretations at intra- and interregional scales. We want to i) reconstruct human interventions on floodplains and peatlands during the medieval and pre-industrial modern periods, ii) reconstruct potential ‘great transitions’ and iii) validate the vulnerability of human intervention towards multidecadal climatic variability.

The presentation shows a first compilation of hydrological changes based on old map records within both study regions and indicates fundamental changes of both natural river landscapes towards the development of Fluvial Anthropospheres.

Werther, L.; Mehler, N.; Schenk, G. J.; Zielhofer, C. (2021): On the Way to the Fluvial Anthroposphere - Current Limitations and Perspectives of Multidisciplinary Research. Water 13 (16), 2188, doi:10.3390/w13162188.

Geomorphological mapping and distribution modeling of potentially ice-rich block- and talus slopes in the Dry Andes (Agua Negra, Argentina)

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Within the extensive periglacial belt of the dry Andean high mountain range (17°30'S to 35°S), the most visible expression of creeping mountain permafrost is the occurrence of rock glaciers, which have been studied systematically in the last decades (e.g. Schrott, 1996; Brenning & Azócar, 2010; Halla et al., 2021). Active, inactive and relict rock glaciers are included in regional and national inventories, whereas block- and talus slope formations have received far less attention. Thus, there is a lack of explanatory approaches and analytical data on their spatial distribution, ice content and formative controls, despite these landforms being widespread and characteristic elements of the extensive periglacial belt. Therefore, the existing "Inventario Nacional de Glaciares" published by IANIGLA-CONICET (2018) is expanded by block- and talus slope distribution based on a remote-sensing and field-based geomorphological mapping approach in the Agua Negra catchment. Mapping of the upper catchment reveals a spatial distribution of the target landforms of almost 82%, while rock glaciers cover only 1.5% of the areal surface. In combination with a set of independent predictor variables (based on 12 m resolution TanDEM-X and 1 m Pléiades DEMs) and published data, the mapping results are used for training and testing geostatistical models, aiming to explain their spatial heterogeneity and formation controls. Each model output is evaluated by spatial and non-spatial statistical validation and geomorphological plausibility. Preliminary predictive model runs based on logistic regression in the upper catchment show high model performances with AUROC values of 0.92 for talus slopes and 0.90 for blockslopes, respectively, with even better predictive results being expected when using more advanced statistical models. In combination with geophysical prospection and hydrogeochemical analyses, this study will provide the basis for a refined assessment of the hydrological significance of cryogenic landforms in the Dry Andes of Argentina.

Brenning, A., Azócar, G.F. (2010): Statistical analysis of topographic and climatic controls and multispectral signatures of rock glaciers in the dry Andes, Chile (27–33 S). Permafrost and Periglacial Processes, 21(1), 54-66.

Halla, C., Blöthe, J. H., Tapia Baldis, C., Trombotto, D., Hilbich, C., Hauck, C., Schrott, L. (2021): Ice content and interannual water storage changes of an active rock glacier in the dry Andes of Argentina. The Cryosphere, 15(2), 1187-1213.

IANIGLA-CONICET, Ministerio de Ambiente y Desarrollo Sustentable de la Nación (2018): IANIGLA-Inventario Nacional de Glaciares. Informe de la subcuenca del río Blanco. Cuenca del río San Juan, Pp. 62.

Schrott, L. (1996): Some geomorphological-hydrological aspects of rock glaciers in the Andes (San Juan, Argentina). Zeitung für Geomorphologie, Supplementband 104, 161-173.

Luminescence dating and diachronism of river terrace formation

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River terraces are regarded as valuable paleo-environmental and archeological archives and their particular importance is well documented by a huge number of studies spanning a wide range of temporal and regional settings. However, the information gained from fluvial terraces and their significance for paleo-environmental and present-day fluvial research strongly depend on an accurate and precise dating of the terrace formation. Numerical ages are essential for assessing the impact of various driving forces and for providing insights into the mechanisms and dynamics of river adjustments over variable temporal scales.

In this context, the concept of asynchronous evolution of fluvial systems, formalized among others by S.A. Schumm, is a long accepted paradigm of fluvial morphodynamics. However, in the practice of fluvial-geomorphological research it has so far led a rather shadowy existence. In this contribution, we present luminescence ages of fluvial deposits originating from various locations throughout the longitudinal course of an Upper Pleistocene river terrace located in the headwater of the Main River, Germany. The luminescence ages reveal a distinct diachronic alignment becoming progressively younger upstream although all samples originate from the very same morphological unit.

This diachronism of luminescence ages might reflect a process-immanent diachronism of river terrace formation, which is the result of an asynchronous and complex fluvial morphodynamics along the longitudinal river profile. Our findings are in accordance with results derived from laboratory based experiments and numerical modelling approaches indicating a complex behaviour of fluvial systems with respect to river terrace formation. If they are confirmed in other fluvial systems and are not merely the result of specific local conditions, they will be of great relevance for geomorphological research in fluvial landscapes, with state-of-the-art luminescence techniques offering the possibility to identify response times in fluvial systems and to assess the velocity of upstream knickpoint migration.

Fluvial landscape evolution in the Granada UNESCO Geopark: Application of a challenging dating approach

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The formation of river terraces is a common geomorphological phenomenon worldwide. The complex interplay of erosion and accumulation processes and the environmental conditions controlling the dynamics and timing of river terrace formation is just one of the many questions related to fluvial landscape evolution that have not yet been adequately answered.
The Baza/Guadix Basin in Andalusia, which is part of the Granada UNESCO Geopark, provides ideal conditions for investigating the dynamics of fluvial landscape evolution and river terrace formation. From the Pliocene to the Middle/Late Pleistocene, the intra-montane basin was a broad, undrained depression that was continuously filled with sediments of all grain sizes from the surrounding mountains. At some as yet unknown time in the Middle to Late Pleistocene, a source river of the Rio Guadalquivir entered this endorheic basin, and a new river system formed, which cut the sediments of the original basin, leaving several generations of river terraces in deeply eroded valleys. In several places, the river terraces are associated with calcareous sinter formations.
The goal of the DFG-funded project presented here is to study the evolution of this newly formed fluvial network. Luminescence dating of river terrace sediments and U/Th dating of calcareous sinter formations will be used to provide a regional chronostratigraphic framework that demonstrates the dynamics of the fluvial landscape evolution ever since the capturing event. Due to the difficult conditions to determine the correct ages of the terrace sediments, different methods of luminescence dating are applied. Particular challenges arise from the high expected ages of approximately 200-600 ka. We anticipate that our results will provide a rough estimate of backward erosion rates and determine typical incision rates for local rivers.
The talk will outline the project's goals, provide information on the methods used, and present the first geochronological results based on luminescence measurements.

Challenging the predictability of climate-induced impacts on alpine hazards

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Increased frequencies and magnitudes of climate-related alpine hazards in the last three decades significantly threaten alpine communities, infrastructure, and economies. Rock falls, slope failures, debris flows, and other mass movements show increasing response to melting glaciers, degrading permafrost and more frequent heavy rainfall events. In the foreseeable future, alpine hazards beyond our historic recognition will occur and scientific understanding is the only anticipative tool to prepare for the related risks. Therefore, we need dedicated research in risk anticipation, clever early warning strategies and purposive measures. Until now, a systematic analysis of the predictive power of a multi-method approach for climate-induced natural hazards is missing.

In a 3-year project funded by the Bavarian STMUV (AlpSenseRely) we aim at anticipating climate induced natural hazards comprehensively at an early stage for Bavaria and the European alpine region. AlpSenseRely quantifies the climate forcing and provides all relevant information for preparation of future events. The project systematically explores the capacity of space-borne, air-borne, and terrestrial high-resolution observation and monitoring in a changing climate. For this, we have chosen six representative test sites mostly in the critical 2000-3000+ m a.s.l. range of the eastern Alps, where the effects of climate change are most evident and cause frequent landslides and permafrost- or glacier-degradation related hazards in the vicinity of a dense tourist infrastructure. The test sites all (i) undergo massive environmental change, (ii) cause frequent natural hazards, (iii) have well-established and relatively dense tourist infrastructure and (iv) provide unique long-term observation and monitoring histories often dating back to the 19th century.

Here, we present the setup and preliminary results of the AlpSenseRely project: (i) monitoring at the test sites, (ii) integration of stakeholders, (iii) identification of hazard hotspots, (iv) modelling of hazardous objects, (v) near real-time monitoring and early warning strategies and (vi) 3D visualization.

The role of beaver ecosystem engineering in river science

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Biota has long been shown to influence surface processes, described already by e.g. Darwin (1899), and Rudemann and Schoonmaker (1938), but it has not been since recently that geoscience has taken a serious interest in understanding abiotic-biotic feedbacks. This is especially true for the influence of animals, also because humans have modified and limited animal distribution and density since thousands of years. Recent decades have seen an effort to re-introduce animals long-lost to ecosystems, with sometimes unforeseen consequences, an approach that is gaining fast traction within the context of 'rewilding'. In this presentation, I take a closer look at animal ecosystem engineering, and make a case how we can use their ecosystem engineering capabilities to improve the apparent negative effects of our own (human) engineering legacy. I zoom into research on Beavers, which are one of the most influential mammalian ecosystem engineer, heavily modifying river corridor hydrology, geomorphology, nutrient cycling, and ecosystems, mainly through the construction of dams, which impounds flow and increases the extent of open water, from which most other ecosystem feedbacks follow.

Darwin, C., 1899. Die Bildung der Ackererde durch die Thätigkeit der Würmer mit Beobachtung über deren Lebensweise, Charles Darwin's gesammelte Werke; aus dem Englischen übersetzt von J. Victor Carus Schweizerbart, Stuttgart, pp. 184.
Rudemann, R. and Schoonmaker, W., 1938. Beaver-dams as geologic agents. Science, 88(2292): 523-525.

Aeolian dynamics on arable land in northeastern Kazakhstan

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The semi-arid steppe regions of Kazakhstan were in the past subject to extreme wind erosion caused by the destruction of the natural steppe vegetation. Approximately 23 million hectares of native grassland were converted into arable land during the Virgin Lands Campaign from 1954 to 1963. The test regions Aqmola and Pavlodar in the southernmost region of the Western Siberian Plain are representative sites for still or again agriculturally managed converted land. While the loess soils may be extremely prone to aeolian processes, field-based data are scarce and wind erosion and dust emissions have not been quantified yet.

To investigate the recent potential for soil erosion and relocation by wind and emissions of mineral and organic dust, we conducted wind tunnel tests with a steady wind of a mean velocity of 15 m s^{-1} on two sites with differing texture and surface conditions in June 2023. The plots comprised surfaces typical for the agricultural landscapes of both sites: freshly tilled seedbed, crusted seedbed, ridge-furrow with young crops, traffic lane and dirt road. Wind erosion was quantified from all tested plots with the highest rates from dirt roads and seedbeds.

Results from the experiments are in line with on-site observations of forms and processes and indicate great potential for wind erosion and dust emissions with effects on the local to regional scale. In this vulnerable environment, increased land-use pressure may be the crucial trigger severely aggravating wind erosion and dust emissions in the medium term.

New insights into patterned ground formation in the hyperarid Atacama Desert (N Chile)

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In the central Atacama Desert (N Chile), a number of vegetation-independent patterned ground structures characterize the typically dust-coated hillslope surfaces. Although these structures only obtain a geomorphologic significance at or below the hillslope-scale, they represent characteristic landscape elements in this extremely hyperarid environment. Among these patterned ground structures are terracette-type forms, linear slope-parallel stripes on dust-covered surfaces, and quasi-slope perpendicular zebra (stone) stripes, all of which are associated with particular sorting patterns and a distinct – though sometimes subtle – geomorphology. Against the general impression of a stable landscape and stagnant geomorphodynamics under the virtual absence of water in this driest part of the Earth, these structures seem to represent a considerable geomorphologic activity that is shaping hillslopes in the Atacama at present. Yet, key drivers for their formation, related geomorphologic process rates and time scales, and their significance for sediment transport remain to be poorly understood, although their specific characteristics and enigmatic/unique nature demand for a particular importance in understanding geomorphologic process dynamics under extreme and long-term hyperaridity in general. Here we present an overview of these patterned ground structures by showing examples of terracettes, linear slope-parallel stripes in dust surfaces, and zebra (stone) stripes from the central Atacama Desert. Based on sedimentological, geomorphological and preliminary luminescence-based geochronological investigations, UAV-derived aerial photos and soil moisture monitoring techniques, we present geomorphological, chrono-stratigraphical and soil hydrological characteristics of the patterned ground structures and discuss potential drivers of their formation. Our observations suggest a combination of wind and fog-related moisture supply, particularly during several day-long periods of sustained high relative humidity and fog occurrence, as the key driver for terracette formation, adding to the various processes of terracette formation discussed in previous studies. For the dust-dominated slope-parallel linear structures, geomorphological and stratigraphical characteristics seem to be determined by subsurface gypsum dynamics, potentially controlled by fluctuations of soil moisture that are in turn modulated by fluctuations of relative humidity and/or fog occurrence. First OSL datings of the dust-dominated sediments from terracette platforms and the linear slope structures suggest the formation of and/or (halo)turbation activity within these structures on late Pleistocene to Holocene time scales. While these results illustrate the importance of fog-driven hillslope dynamics under present hyperaridity, our data point to frost- and nivation-related processes as the key driver for zebra stripe formation: time-lapse camera monitoring documents stripe clast activity (overturning) during a recent snow and frost period. In addition, OSL rock surface dating techniques give evidence of a Holocene activity of the zebra stripes. Older degraded stripes, in contrast, are assumed to be inactive and to represent paleo-forms that may have developed under different climatic conditions in the past, when frequent frost and nivation processes occurred at lower elevations.

Ancient Andean Agricultural Terrace Systems: An Integrative Approach to Study Pre-Columbian Land Use Dynamics in Southern Peru

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An impressive relic of the scale of human-environment interaction and land modification in pre-Columbian South America are agricultural terraces, covering slopes across the Andes and of which only a fraction is still in use nowadays. This paper presents the methodological approach and preliminary outcomes of a new interdisciplinary research initiative to explore these terrace systems in a study area between 1,300 and 3,800 m asl on the western Andean flank in southern Peru. To reconstruct the land use history in the wider region over the last four millennia we integrate methods from physical geography and archaeology, including archaeological, geomorphological and drone surveys, GIS and remote sensing, architectural documentation and excavations, soil testing, radiocarbon dating, and phytolith analysis. Our first results hint at intensive and diverse agricultural strategies and changing climatic conditions affecting terrace cultivation.

Rock moisture: where it goes and what it does.

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An aim of the CLIMROCK project is to further understand the effect of rock moisture content and the fluctuation of it on rock weathering in alpine environments. Be that as the main driver of weathering processes, as in wetting/drying, or the influence on the effectiveness of other processes such as frost weathering.

To simulate the outer 40cm of a rockwall, two blocks (40x20x20cm) of low-porosity limestone (Wettersteinkalk) of 100% and 50% saturation were subjected to diurnal (24 h) freeze-thaw cycles followed by longer 72hr cycles in a climate chamber. We installed nine Electrical Resistance (ER) sensors to track moisture fluctuation and four Acoustic Emissions (AE) sensors to observe the subcritical propagation of fractures and so weathering effect of these cycles depending on rock moisture content.

During diurnal cycles the 50% saturated samples show more AE Hits than the saturated ones, mostly occuring in the upper 4cm after re-freezing events. However, during the 72hr cycles the 100% saturation blocks show more AE Hits, with evidence of a slower rock moisture phase change shown clearly in the ER data. Furthermore, increased cracking is detected at greater depth from AE events, following the freezing front over time. AE parameter analysis shows a move to mixed mode dominated cracking during thawing phases, switching from tensile mode dominated cracking seen during freezing phases.

We hypothesise that having rock moisture present does increase the amount of rockwall weathering during freezing cycles, though the length of the freezing cycle affects the magnitude. The samples with lower rock moisture actually show a greater number of cracking events, while the average energy released is 20.1% greater in more saturated samples. In diurnal cycles, the permeability of the rockwall and where the rock moisture is in that porosity appears more important than water content. In longer cycles, the increased volumetric expansion stress in the more saturated samples causes greater weathering effect.

Spatio-temporal patterns of alluvial deposition at the Skeleton Coast of Namibia

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The timing and spatial extent of alluvial deposition and the processes causing post-depositional alterations of alluvial landforms are governed by a variety of environmental factors, which can be summarised in the domains of climate and tectonics. The significance and magnitude of the individual factors in shaping topography can depend on the spatial and/or temporal scales being considered, often blurring an interpretation of the sediment successions as climate archives. In contrast, landscapes situated in tectonically quiescent environments may host valuable climate archives, in particular in long-term (hyper-)arid settings. Such conditions can help to preserve alluvial landforms indicative for climate-controlled pulses of sediment aggradation. The (hyper-)arid Skeleton Coast of Namibia generally appears to provide such conditions, including the climate-controlled presence of a dune belt affecting oceanward sediment transport. Many alluvial deposits have been studied in detail in this region, but analyses largely focused on sedimentological and/or morphometric characteristics, while fewer attempts were made to date these landforms. Consequently, the region is still lacking a spatially extensive geochronological framework necessary to relate alluvial deposition dynamics to climatic fluctuations during the Quaternary. Here, we present first results of a combined approach investigating landform ages inferred from optically stimulated luminescence (OSL) and cosmogenic ^{10}Be data. In alluvial deposits located to the east of the dune belt, we find OSL ages to reflect Holocene sediment accumulation, while surfaces are dated to the Middle Pleistocene, as inferred from ^{10}Be concentrations. Middle Pleistocene (~100-500 ka) ^{10}Be ages are also obtained for other alluvial surfaces sampled in the vicinity of the erg, potentially reflecting the impact of orbital forcing on topography formation. An exception makes alluvial sediments sampled in the coastal Uniabmond area (~20.2°S). These sediments have OSL ages ranging ~20-40 ka and minimum ^{10}Be ages of ~20-30 ka, likely reflecting Last Glacial Maximum-related aggradation at the Skeleton Coast.

Quantification of plutonium isotopes in environmental samples at the University of Cologne, Germany: progress update

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Atmospheric nuclear weapon tests conducted in the 1950s and 1960s caused a global distribution of fallout radionuclides (FRNs), blanketing Earth's outermost skin and thus providing distinct geochronological markers. The released FRNs included large quantities of caesium and plutonium, which are playing a key role in investigating Anthropocene Earth (sub-)surface processes. Their application is well established, with ^{137}Cs ($t_{1/2}$ ~30 yr) still being the workhorse in most studies. However, the site-specific concentration of the plutonium isotopes ^{239}Pu and ^{240}Pu is less sensitive to decay ($t_{1/2}$ ^{239}Pu: ~24.1 kyr; ^{240}Pu: ~6.6 kyr). Furthermore, there is less soil inventory contamination arising from nuclear power plant accidents than reported for ^{137}Cs, and only a few grams of sample material can be sufficient for a measurement. Ultimately, the (separate) quantification of ^{239,240}Pu concentrations measured by Accelerator Mass Spectrometry (AMS) represents a further evolution step towards more precise measurements than achieved by other mass spectrometry or decay counting techniques.

The development of ^{239,240}Pu measurement capabilities at the Centre for Accelerator Mass Spectrometry (CologneAMS), University of Cologne (UoC), has given the go-ahead to exploit the wealth of possible $^{239+240}$Pu applications to decipher modern Earth (sub-)surface processes in different settings around the globe. Based on tailored sample processing protocols applied at the Institute of Geology and Mineralogy and the Division of Nuclear Chemistry, UoC, we present first results from a selection of ongoing projects. The sample processing workflow applied together with the AMS measurement precision achieved bears the potential to resolve concentrations below ~5 mBq kg^{-1}. Accordingly, a spatial focus is laid on study sites where ultra-high precision of measurements is required (e.g., the Atacama Desert in northern Chile).

A story of two dunes – dating the formation and reactivation of dune fields in Arctic Sweden

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After the last deglaciation, the abundance of loose glaciofluvial sediment, limited vegetation cover, and strong winds facilitated the formation of multiple parabolic sand dunes fields in Arctic Sweden. The dunes' stratigraphies with sequences of buried soils, charcoal layers, and redeposited sands now indicate repeated reworking of these dunes that occurred after their initial stabilization. Reworking events may have been driven by wider climate forcing, however, to date, no chronological framework exists for this activity in Sweden. To begin closing this knowledge gap we applied quartz optically stimulated luminescence (OSL) to two dunes at the sites of Vastakielinen and Jorggástat. A double-SAR protocol was chosen for equivalent dose determination and seems to be generally well suited to date aeolian reworking of the dune sediments. However, precise age assignment for initial dune movement and first stabilization is limited by low quartz luminescence sensitivity and feldspar contamination in samples recovered from stratified sands in the dune cores. Still, the dunes likely started forming immediately after deglaciation at 10-10.5 ka, ongoing to 7-8 ka. There is also evidence for repeated and long lasting aeolian activity throughout the Holocene especially around 4 ka and during recent decades, the chronology of which generally conforms to overall trends of aeolian activity in Fennoscandia and agrees with the independent age control provided by 14C ages for the sites. Together, our new ages and published ages from dunes in Arctic Fennoscandia may suggest a coupling to Holocene climate variability, however, additional extensive age investigation is required to properly test this.

Andean permafrost in taluses and block- slopes in the Agua Negra Basin, Argentina – Detection and Distribution

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The periglacial belt of the Dry Andes of Argentina (17°30'S to 35°S) is characterized by the development of several cryogenic landforms (Schrott, 1998; Trombotto et al., 1997), many of which have been so far underestimated -in terms of spatial distribution, internal structure and hydrological significance-. Rock glaciers are among the most studied landforms (Halla et al., 2021, Blöthe et al., 2021) even though they cover less than 2% of the surface in this sector of the Andes. Taluses and block-slopes are hardly studied, although they are widespread. Geomorphological mapping and statistical modeling of taluses and block-slopes are conducted for the very first time in the Agua Negra catchment (ca. 30°S and 69°W) and show a coverage of approximately 82% for the upper part of the catchment.

This work presents first insights on existence, distribution and internal structure of permafrost in taluses, protalus ramparts and block-slopes in the Agua Negra catchment using a geophysical approach. A combination of systematic two-dimensional measurements of Electrical Resistivity Tomography (ERT), Seismic Refraction Tomography (SRT) and Ground Penetrating Radar (GPR) were conducted. Results show a presence of permafrost within taluses and protalus ramparts, with differences in their distribution and ice-rich/ ice-poor permafrost bodies. The geophysical data will be used to estimate the volume of ice and water content using the Four Phase Modelling approach.

In combination with hydrogeochemical measurements and remote sensing analyses, the data-set aims to a get an overview on the hydrological significance of such landforms in this area of the Dry Andes.

Blöthe, J. H., Halla, C., Schwalbe, E., Bottegal, E., Trombotto Liaudat, D., Schrott, L. (2021): Surface velocity fields of active rock glaciers andice-debris complexes in the Central Andes of Argentina. Earth Surface Processes Landforms, 46, 504–522.

Halla, C., Blöthe, J. H., Tapia Baldis, C., Trombotto, D., Hilbich, C., Hauck, C., Schrott, L. (2021): Ice content and interannual water storage changes of an active rock glacier in the dry Andes of Argentina. The Cryosphere, 15(2), 1187-1213.

Schrott, L. (1998): The hydrological significance of high mountain permafrost and its relation to solar radiation, A case study in the high Andes of San Juan, Argentina: Bamberger Geographische Schriften, 15, 71–84.

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Measuring and modelling permafrost thaw and hydrostatic pressure pushing rock slopes towards instable conditions

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Permafrost degradation is a driving force for rock mass failure in high alpine landscapes worldwide. The timing of failure is yet difficult to predict. As classic rock mechanical models are not adequately describing the nature of rock mass failures in cryospheric environments we applied a rock-icemechanical model taking into account rock mass and joint properties depending on a changing thermal regimes. Using the rock-ice-mechanical model we show how permafrost features affect the stability in near-surface depths whereas for higher depths rock mechanics are prevailing. At shallow depths failure is controlled by shearing along given discontinuities. At higher depths brittle to ductile failure of previously intact rock becomes more important. The rock-ice-mechanical model is applied to a directly observed rockslide failure event (~1 Mio. m3) at the north face of Bliggspitze (Paragneiss host rock, Kaunertal valley, AT) in 2007. Taking into account the history of glaciation and presence of permafrost together with field observations, we try to decipher the combined processes that eventually lead to failure. As a majority of recent failures in permafrost rock faces occurred in structured rock walls with coincident presence of ice patches and water outflow, we evaluate the effect of (i) potentially transient water pressure in sealed fracture systems as well as the (ii) transition or loss of fracture ice as possible triggers for rock mass failure. Furthermore, we assume that thawing of metamorphic rocks critically influences slope stability especially if foliation runs parallel to rock slope. The generic rock-ice-mechanical model framework is found to be suitable to explain deep-seated rockslides and rock avalanches as a result of changing cryosphere.

Changes in Solute Fluxes in a Headwater Catchment: Impacts of Forest Disturbances and Road Salting

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Headwater areas in the Eifel Mountains currently face natural and anthropogenic disturbances, including a decrease in forest area due to spruce die-off and the use of de-icing salts on asphalt roads. The objective of this study was to determine changes in solute fluxes within a headwater catchment under these disturbances. The study focused on the Wüstebach experimental catchment, a part of the TERENO (Terrestrial Environmental Observatories) network. In 2013, the National Park cleared 22% of the catchment area to facilitate the regeneration of near-natural beech forests. To calculate solute fluxes in stream water, groundwater, and precipitation, we analyzed 13 years of environmental monitoring data (2009-2022) from the Wüstebach catchment. The average annual total dissolved solids in the Wüstebach catchment were found to be 84 t/km^2/a, with 15% originating from atmospheric sources. Within the first two years following deforestation, no significant differences in solute fluxes were observed between the periods before and after deforestation. This suggests that the chemical denudation had only a minor impact on the system, likely due to limited soil erosion. During logging activities, the soil was adequately protected by covering harvester lanes with branches. However, the solute fluxes in the headwater catchment were significantly affected by road salting. The substantial input of de-icing salts led to elevated concentrations of Na^+ and Cl^- throughout the study period, with slight seasonal variations. This finding demonstrates the accumulation of salt in the subsurface as a result of long-term salt application. On average, this increased the total dissolved solids by 62%. It indicates that the long-term and intensive road salting during winter has a more substantial impact on solute fluxes than the clear-cutting of 22% of the catchment area.

Stand der Arbeiten zur Bestimmung der Alter der Terrassen im Mittelrheintal

Johannes Preuß, Mainz

Mit fünf Stationen zeigt das Poster die sieben Schritte zum Terrassenmodell des Mittelrheintales. Der achte Schritt, die Datierung einer Auswahl von Rheinterrassen mit kosmogenen Nukliden, wurde kürzlich von der DFG genehmigt (Antragsteller: Prof. Dr. Ralf Hetzel, Münster, Dr. Benedikt Ritter, Köln).- Im Rahmen der Dissertationen von Lothar Görg (Marburg 1984) und Johannes Preuß (Marburg 1983) wurde das untere Nahetal geomorphologisch untersucht. Görg kartierte die Naheterrassen, Preuß kartierte ca. 70 km² der geomorphologischen Karte Blatt 6013 Bingen. Bei den zahlreichen Maschinen-Bohrungen wurde zusammengearbeitet. Ab 2006 bis 2013 lebte das Projekt im Rahmen von Lehrveranstaltungen und Examensarbeiten zwischen Bingen und Boppard wieder auf (Preuß et al. 2015, 2019; Preuß 2017. Vorträge und Poster beim Deutschen Geographentag und im Arbeitskreis für Geomorphologie (z.B. dieses Poster in 2018 in Gießen). Das Poster beginnt mit dem Downstream Correlation Diagram (DCD, s. Fig. 1), in dem 726 Bohrungen zusammengefasst wurden. Es zeigt, dass die Hypothese von der Horizontalkonstanz für das obere Mittelrheintal obsolet ist und es legt den Verdacht nahe, dass Teile des oberen Mittelrheintales in südliche Richtung abgesenkt worden sind. Bei Trechtingshausen wurde für Rheinkilometer 533 aus dem DCD eine Sammelsequenz der erfassten 28 fluviatilen Sedimentkörper erstellt. Die Weiterentwicklung zu einer Sammel-Chronosequenz (s. Fig. 2) erfolgte in drei Schritten. Zunächst wurden die 28 Terrassenbasisflächen in die von Zagwijn (1985, 1998) aus Pollen abgeleitete Temperaturkurve des Quartärs, in die kalten Abschnitte mit < 10°C Juli-Temperatur, eingefügt. Dann wurde diesen aus der Kurve der Marinen Isotopen Stadien (Cohen & Gibbard, 2011) die Zeitpunkte maximaler Abkühlung zugeordnet, die in einem dritten Schritt ihrem Alter entsprechend, in zwei paläomagnetisch datierte Bohrkerne aus Heidelberg (307 m Quartär) und Viernheim (221 m Quartär) übertragen wurden (Für die Kerne: Gabriel, Ellwanger, Hoselmann & Weidenfeller, 2008; Für die paläomagnetische Datierung: Scheidt, Hambach & Rolf, 2015). Im Liegenden und Hangenden der übertragenen Punkte wurden Unter- und Obergrenze der fluviatilen Sedimentkörper aufgesucht und die Alter der Grenzen mit den paläomagnetischen Tiefenfunktionen des jeweiligen Kerns berechnet und anschließend zu Mittelwerten der beiden Kerne zusammengefasst (rote Spalte in Fig. 2). In Fig. 3 wurde für die Sammel-Chronosequenz auf der x-Achse die Zeit, auf der y-Achse die Höhenlage der Terrassenbasisflächen abgetragen. Für die beiden relativ glatten Kurvenabschnitte wurden lineare Gleichungen berechnet, deren Steigungen 52 m/Ma (oben) und 66 m/Ma (unten) betragen. Der untere Kurvenabschnitt entspricht etwa der Hebungsrate (= Rate der Eintiefung) in den letzten 0,5 Ma. Im oberen Kurvenabschnitt wurde die Hebungsrate durch Absenkung vermindert. Der mittlere Senkungsbetrag liegt bei 14 m/Ma. Die Terrassenbasisfläche der tRh1.1 wäre folglich, ihrem angenommenen Alter entsprechend, von 311 m ü. NN um 37 m auf ihr heutiges Niveau von 274 m ü. NN abgesenkt worden. An die Ausgangshöhe von 311 m ü. NN wurde im Modell die heutige Tiefenlinie (Talweg) des Rheins als Polynom 3. Ordnung „montiert“ (s. Fig. 6: Terrace Model …). Für die Absenkung sprechen zwei Argumente: Schon das Downstream Correlation Diagram ließ den Verdacht auf Senkung des oberen Mittelrheintales aufkommen (s. Fig. 1, rote und grüne Linie). Die Untersuchung von Mälzer et al. (1983) weist für diesen Bereich eine leichte Senkungstendenz aus (s. Fig. 4), die im Bereich der Lahnmündung beginnt und in südliche Richtung bis zum Rheingraben verfolgt werden kann. Unter der Chronosequenz von Nahe und Rhein (s. Fig. 3) wurden parallel zur Zeitachse das „Pollenthermometer“ und die Marinen-Isotopen-Stadien abgebildet. Sie lassen erkennen, dass sich das Klima ab 1,04 Ma verändert hat, so dass für die starke Eintiefung des Rheintales nach der

Bildung der tRh6.5 zusätzliche Veränderungen des Paläoklimas als Ursache anzunehmen sind. Das Terrassenmodell wurde mit zwei unabhängigen Datensätzen aus dem unteren Mittelrheintal getestet (Bibus, 1980; Hoselmann, 1994) (s. Fig. 7). Ein abschließender Blick auf Fig. 5 zeigt die Täler von Rhein und Mosel auf einer Karte der Taleintiefung, die Schmanke (2007) aus dem SRTM-DGM erstellt hat. Dazu wurde die Tangentialfläche zu den Talböden (Sockelfläche) errechnet und vom SRTM-DGM abgezogen (Taltiefen von > 100 m in Rot, von > 50 m in Blau und dunkel Grün). Erkennbar sind Affinitäten zu den Höhenverhältnissen der Kruste-Mantel-Grenze (s. Franke et al. 1990), die so verstanden werden können, dass Flussterrassen und großtektonischen Prozessen ebenso zusammenhängen wie Flussterrassen und Klima (s. Fig. 3). Das Terrassenmodell ist komplex, die Alter der Terrassenbasisflächen sind hypothetisch und weichen von den zurzeit für richtig gehaltenen Werten ab. Daher besteht die Notwendigkeit einer Überprüfung mit physikalischen Datierungsmethoden. Geeignet ist die Methode der Datierung mit kosmogenen Nukliden (10Be- und 26Al-Konzentration). Im Jahr 2019 wurde Kontakt mit Kollegen T. Dunai in Köln (CologneAMS) aufgenommen und für August 2019 eine Exkursion ins Mittelrheintal vereinbart, zu der er die Kollegen R. Hetzel (Münster) und B. Ritter (Köln) einlud und ich die Kollegen C. Hoselmann (Wiesbaden) und M. Weidenfeller (Mainz). Im Verlauf der Exkursion wurde in Kasbach-Ohlenberg (unteres Mittelrheintal), 0,5 m über der Basis der tRh4.3 (s. Fig.7; GK-H 5606,5; 203,5 m ü. NN) eine Probe entnommen, von der sechs Klasten bearbeitet worden sind. Von diesen bildeten fünf ein Cluster, der sechste Schotter weicht sehr deutlich davon ab, so dass die Zugehörigkeit zur Grundgesamtheit (für mich) fraglich war. Die Datierung erfolgte nach der burial dating-Methode (Balco & Rovey, 2008). Ohne den Extremwert ergaben die ersten Berechnungen einen vorläufigen Zentralwert von 1,39 Ma. Das Modell sieht für die Terrassenbasisfläche der tRh4.3 ein Alter von 1,48 Ma vor, die darauf liegenden Sedimente können bis ca. 0,1 Ma jünger sein (in Fig. 2 ist die stratigraphische Lage von 1,39 Ma gut erkennbar). Unter Berücksichtigung des vollen Probenumfangs von sechs Klasten wurde von den Antragstellern ein Alter zwischen 0,85 Ma und 1,20 Ma errechnet. Schon die erste Probe zeigt also, dass die untersuchte Terrassenbasisfläche wahrscheinlich älter ist, als die Matuyama/Brunhes Magnetfeldumkehr. Die Höhenlage der Terrassenbasisfläche im Relief entspricht der Höhe der tRh4.3 nach dem Modell, auch bei Hoselmann (1994, Abb. 49, S. 129) gehört diese Höhe zum Niveau der älteren Hauptterrasse. Die vor 46 Jahren publizierte Annahme, dass die in der älteren Hauptterrasse (tR4, tRh4.1) nachgewiesene Magnetfeldumkehr für ein Terrassenalter von ca. 0,78 Ma spricht, ist wahrscheinlich nicht richtig. Das ist aber noch keine zufriedenstellende Aussage zu dem neuen Terrassenmodell.- Das Projekt bleibt spannend.

The fluvial landscape of the Wiesent River (Northern Franconian Alb, Bavaria, Germany) – taking advantage of the third dimension: reconstructions from point clouds

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The northern Franconian Alb reflects a unique landscape to track fluvial-morphological changes caused likely by long settlement history. In particular, hydrotechnical construction sites combined with deforestation and soil erosion during medieval times result in increased sediment dynamics and thus transformed floodplain systems. These human-influenced changes may formed hidden structures in the current landscape such as terraces or channel adjustments. Even freely available digital terrain models with a spatial resolution of 1 m are insufficient to investigate those structures. Therefore, using the 3D airborne laserscanning (ALS) point clouds instead of pre-processed digital terrain models, is expected to overcome the identified challenges.

Applying well-established methods in ALS point cloud processing such as breakline detection or seeded region growing enables identification of homogeneous point cloud segments that might be representative for different morphodynamical changes over time. Such segments could reflect snapshots of relative (in)stability that are optimal sites for further sedimentological and dating analyses to complete paleoenvironmental understanding of socio-environmental interactions.

Landscape dynamics of the Lower Rhine Embayment – an interplay of relief and environment

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Archaeological and geoscientific research in loess landscapes remain challenging due to erosional discordances and the relocation of sediments by fluvial erosion and slope wash. The interpretation of atypical loess sequences influenced by these processes is not straightforward, and they cannot be easily used for regional to continental correlations. Within the last few years, however, such sequences gained increased attention, as they are valuable archives for regional landscape dynamics. The Lower Rhine Embayment (LRE) can serve as a blueprint for archaeological and paleoenvironmental research in loess landscapes of Central Europe. The accumulation of wind-blown dust, palaeosols developed therein, and the archaeological artefacts preserved in loess-, colluvial or alluvial sediments are evidence of the Pleistocene and Holocene dynamics of the landscape and human occupation. Here, we show the complex and dense interplay of relief and environment, which strongly shaped this oceanic loess landscape. Besides a review of dominant surface processes during the Late Pleistocene and Holocene, we showcase the study site of Siersdorf, which shows that the LRE was more diverse than previously assumed, regarding not only its geomorphological settings and related processes but also its ecosystems and environments.

Geomorphology of the Schwarze Elster Valley (Southwest Brandenburg, Germany) at the Bronze Age barrow cemetery Schweinert – Findings from the 2023 research campaign

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Within the framework of the DFG project "Holocene Landscape History in the "Schweinert" Forest Area - a Geoarchaeological Study in Germany's Largest Bronze Age Barrow Field", interdisciplinary investigations are continued to expand the knowledge about this important necropolis in southwest Brandenburg. We present new results from the 2023 research campaign, focusing on (1) analysis of landforms in the Schweinert Forest and the surrounding Schwarze Elster Valley, (2) soil profile analyses and GPR survey on a dune on the western edge of the Schwarze Elster Valley, and (3) recording of soil stratigraphy in the central area of the burial site by Pürckhauer coring reaching a depth of two meters.

Ad (1) Mapping of high-resolution LiDAR-derived DEM data covering an area of circa 200 km^2 has yielded a preliminary landform classification. After field verification, the following main classes were defined: eolian, fluvial, and anthropogenic. In a next step we try to refine the classification in order to disentangle the complex geomorphology of the fluvial environment, which obviously includes a variety of meandering and braided fluvial landforms.

Ad (2) Podzols are reported on a dune nearby Züllsdorf about 12 kilometers northwest of the Schweinert. No paleosols were found on the dune crest to a depth of six meters. Preliminary evaluation of a GPR transect across the dune also provides no evidence of buried soil horizons within the eolian facies.

Ad (3) Eolian cover sands were identified within the burial mound area in several corings, some of them directly adjacent to burrows. They are rich in fine to medium sand, range in thickness from 50 to 150 cm, and overlay fluvial deposits with higher percentages of coarse sand and fine gravel.

Small anthropogenic landforms from past land use – what have we (already) learned and what do we (still) want to know

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Rapid advances in the generation of high-resolution Digital Elevation Models (DEMs) have changed our vison and understanding of Earth's surface over the past decade. Relief models, generated from DEMs, and accurate to a few centimeters, are available for a wide variety of landscapes (even remote, inaccessible, forested areas). Analysis of such high-resolution relief models reveals that, especially in woodlands, modern morphological structures (ditches, forestry tillage, etc.) can be found but also numerous small anthropogenic forms created in pre-industrial times. The origins of these relict features can vary widely, along with their morphology: settlement structures (e.g., stone walls, burial sites) or linear relief forms created by soil cultivation (e.g., field terraces, ridge and furrow systems). Relict Charcoal Hearths (RCHs), resulting from historic charcoal burning, are generally circular small platforms, surrounded by pits or ditches, but can nevertheless occupy significant proportions of the land. Relatively complex geomorphology is observed in historic mining areas, which may include various landform types, such as mining shafts and spoil heaps. We present the results of the investigation of several kinds of relict anthropogenic features (RAFs) and show their characteristics and differences relative to native, undisturbed soils. We present case studies on: (1) RCHs, which have been studied over the past 10 years in the northeastern USA and Germany; (2) Land use relicts in northeastern Bavaria with a focus on lynchets; (3) A historical mining landscape at the UNESCO World Heritage Site Tarnowsky Gory, Silesia (Poland); and (4) Ridge and furrow raised bed systems in Ireland.

Unveiling Alpine Permafrost Dynamics: Surface Kinematics of the Kaiserberg Rock Glacier on variying temporal scales

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Permafrost degradation profoundly affects water availability, runoff patterns, and slope stability in alpine regions. Quantifying degradation processes is crucial for local communities and society at large, deepening our understanding of the alpine cryosphere and predicting future trajectories. However, quantification and temporal differentiation of permafrost degradation are inherently challenging due to its subterranean nature. Active rock glaciers have become a primary research focus due to the changes in their kinematic behavior caused by internal permafrost degradation.

In this study, we investigate the surface kinematics of the Kaiserberg rock glacier in the Austrian Kaunertal for the past 20 years on different timescales. We utilize optical and LiDAR remote sensing data obtained through unmanned aerial vehicles (UAVs) and aircraft. Additionally, we deploy a time-lapse camera capturing daily images of the rock glacier throughout this summer, providing an enhanced temporal resolution of rock glacier movement. We analyze all datasets using a feature-tracking methodology implemented with the environmental motion tracking software (EMT).

Preliminary findings reveal varying velocity fields across the rock glacier's surface, with the southern lobe exhibiting higher movement rates compared to the larger northern lobe. The mean movement rate for the southern lobe from 2003 to 2022 is approximately 0.65 meters per year, reaching a maximum of 1.60 meters per year. In contrast, the mean movement rate for the northern lobe is only 0.14 meters per year, peaking at 0.62 meters per year. While the data confirms accelerated movement rates in late summer, it does not indicate a clear trend of interannual acceleration as expected for rock glaciers in the European Alps. Further analysis of the daily time-lapse imagery will provide insight into the extent of movement during the summer months and reveal variations in kinematics within a single season.

Exploitation of a medieval coastal landscape - extensive peat extraction around Hallig Hooge, Wadden Sea of North Frisia (Germany) PART 1

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The unique coastal landscape of the North Frisian Wadden Sea – today protected as National Park and part of the UNESCO World Heritage 'Wadden Sea' – has a changeful past characterised by intense human-environment interactions. It is especially in medieval times that Frisian settlers cultivated and at the same time exploited the low-lying marshes and fenlands. Around the Halligen islands Langeness, Gröde and Hooge, peat extraction for salt production on an industrial-like scale significantly lowered the ground surface and turned large areas into wasteland.

Using a combined geoarchaeological, geophysical and archaeological approach, we investigated a medieval salt production site on Hallig Hooge to evaluate the impact of the large-scale peat extraction on the landscape development and coastal vulnerability, especially regarding the impact of storm surges.

Our results show that the salt production site was set up on an artificial dwelling mound (so-called 'terp') built in an area that was subject to peat extraction before. In the direct vicinity of the production site, the ground surface was lowered by peat extraction into the range of the mean high tide at that time, thus significantly increasing the risk of storm surge-induced flooding. Although it remains unclear whether the production site was destroyed by the severe storm surge of 1362 AD or abandoned beforehand, human impact on the landscape's geomorphology strongly favoured the advance of the North Sea and the establishment of tidal flats.

Modelling the catchment response of the Weismain river catchment to land use change

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From the beginning of the Neolithic period (around 5500 BC), human activity became the driving force behind soil erosion and the transformation of natural landscapes into cultural landscapes. Agriculture, livestock farming and the clearing of large areas of woodland changed the landscape permanently.

The Weismain river basin (c. 125 km2) in the Northern Franconian Jura, Germany, bears witness to this cultural landscape with its colluvial and alluvial sedimentary archives. Several high-resolution archives suggest a dense settlement history, with dated overbank fines indicating the beginning of an increase in human activity. However, catchments and reaches may respond differently to land use change, which can have important implications for the interpretation of field data. It is therefore important to determine the sensitivity of catchments to changing environmental and climatic factors.

In this study, we are using a numerical modelling approach to test whether floodplain sediment deposition is directly related to an increase in human activity. Using the landscape evolution model CAESAR-Lisflood, we hope to gain a better understanding of the sediment dynamics and evolution of this catchment. The modelled sediment loads can then be tested against dated records of alluvial sediment loads from the Weismain river to identify driving factors influencing landscape evolution and to gain more insight into the settlement history of the catchment.

Deeper underground: Cosmogenic burial dating of cave-deposited alluvium to reconstruct long-term fluvial landscape evolution

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Cosmogenic burial dating based on measurements of the $^{26}Al/^{10}Be$ ratio is a well-established geochronological method that contributed to significant progress in several scientific disciplines, including fluvial geomorphology. Although it was originally developed to date buried alluvium in multi-level cave systems 25 years ago, merely ~30 research papers focusing on deep cave environments worldwide have been published since then. It is all the more surprising considering that buried alluvium in multi-level cave systems perhaps is the most advantageous material to apply the $^{26}Al/^{10}Be$ dating method.

In this contribution, we thus consider endokarstic fluvial sediments deposited in multi-levels cave systems or networks, which have formed in response to regional base-level changes over long periods of time (typically 10^5-10^6 years). More specifically, we aim at fostering the use of cosmogenic burial dating of cave-deposited clastic sediments to unravel the long-term evolution of fluvial landscapes. The formation of epigenic cave systems and their geomorphological relevance as a marker of long-term river incision is firstly discussed. After a brief presentation of cosmogenic burial dating, this contribution focuses on how/where to sample within multi-level cave systems and on selecting the sampling material. It afterwards highlights the main drawbacks (analytical and geomorphological uncertainties) associated to this method and presents some strategies to avoid them (if possible). The combination of cosmogenic burial dating with other geochronological tools in the underground realm is also tackled in that respect. Whilst the multi-purpose use of this approach to unravel evolution of fluvial landscapes is briefly reviewed, we focus on the reconstruction of long-term incision rates, including their variation through time, and the drivers of incision. We conclude by a number of useful recommendations to fully benefit from this approach.

Using lichenometric dating to establish a debris flow record since 1850 in the Horlachtal, Tyrol

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Debris flows are an important factor for the sediment balance and occur as natural hazards in in high mountain areas worldwide. Long and complete debris flow records are necessary in order to determine possible changes in debris flow dynamics due to climate change. However, especially for remote alpine catchments, such records are scarce. As remote sensing data sets (e.g. aerial images) for most parts of the Alps are only available since the second half of the 20th century, it is difficult to obtain information on debris flow activity prior to the 1950s.

In this study, we use lichenometric dating to date old debris flow depositions in the Horlachtal catchment in Tyrol, Austria. As the growth rate of the lichen individuals of the subgenus *Rhizocarpon* is highly dependent on local conditions, we established a local lichenometric reference curve by measuring the thalli diameters of lichens on surfaces of known age. However, these ages are often interval censored to the period between two consecutive aerial image acquisition campaigns. We developed a bootstrapping approach within the reference curve calculation process to account for the interval censored reference data.

Using the established reference curve, we are able to date old debris flow deposits by measuring the diameter of the lichen thalli at these locations. With the lichenometric method, we can provide evidence of debris flow activity in the Horlachtal since at least 1850. The lichenometric results indicate phases with high-magnitude debris flows at around 1850, around 1900 as well as between 1930 and 1942. Combined with the evaluation of remote sensing data since the second half of the 20th century, there is no clear evidence for a change in the frequency of high-magnitude debris flow events since 1850 in the Horlachtal.

Suspended sediment transport in a small headwater catchment in Upper Franconia

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Suspended matter transport is an important component of river ecology, river dynamics and sediment budget studies. It is highly variable in space and time and its unterstanding requires long-term monitoring data (Blöthe and Hoffmann, 2022). This is particularly lacking for small catchments near the headwaters. In the Truppach catchment (tributary of the Wiesent, river Main system), intermittent sediment transport during heavy precipitation events is responsible for a significant part of the sediment input into the Wiesent and causes problems for aquafauna and fishery. Local authorities attribute the problems to soil erosion from agricultural land.

We installed three turbidity probes at the outlet of the catchment (106 km²) and at the confluence of two sub-catchments (approx. 16 and 25 km², respectively). The data from the latter two is fragmentary due to frequent low flow and ensuing technical problems. Furthermore, we mapped the system of small-scale trenches and drainage pipes around arable land and carried out turbidity measurements with mobile sensors on several days with different water flow. Turbidity measurements were calibrated using slurried samples of different sediment concentrations from the catchment area.

First results show that over two years, the suspended sediment output from the catchment is around 130 t km^{-2} yr^{-1} which is one order of magnitude higher than the range of 5.9 to 28.7 t km^{-2} yr^{-1} published by Blöthe and Hoffmann (2022) for larger catchments. Dissolved sediment transport is roughly half as high (75 t km^{-2} yr^{-1}). The share of suspended sediment load transported during the ten largest events was 39.5% which is also way higher than for larger catchments. Spatial distribution of turbidity indicates that trenches and drainage pipes are highly important for sediment routing into the creeks near the watershed and are thus an important element of sediment connectivity.

Leipzig, city in a state of flux. Urban-fluvial symbiosis in a long-term perspective

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Leipzig, today a metropolis with 600.000 inhabitants, originated in the Middle Ages at the edge of the Pleiße and Weiße Elster floodplain. The place gave the city its name, which derives from Indo-European *Leibh-, meaning watery, slippery, loamy area. At least since the 12th century, Leipzig's inhabitants engaged in water engineering methods in order to secure water provisioning and allow for the use of water power and waterways. This led to an anthropogenic transformation of the existing waterbodies and related fluvial landscapes, which shaped the city for centuries. While the close connection between city and water tended to disappear in the 20th century, it is being rediscovered today through town planning, tourism and nature conservation. With its varied water history, Leipzig is a particularly well-suited case study for investigating the interdependencies between humans and water in the sense of a "fluvial anthroposphere". The city is characterised by a dense network of smaller water courses, a still-existing riparian forest, and a high density of archival sources, provided by both cultural and natural archives. The project takes a long-term perspective, investigating the period between 1000 and 1800, and combines historical, archaeological and geoscientific analyses. Its main objectives are (1) hydrological dynamics and city politics, (2) floods and droughts as social-natural events, (3) urban water pollution and (4) floodplain economies. The project stands for a decisive urban approach that provides the basis for drawing out the specifics of an urban-fluvial anthroposphere. Beside the conceptual idea, we will focus our presentation on the sedimentary reconstruction of Late Holocene fluvial and alluvial boundary conditions of the Weiße Elster, Pleiße and Parthe floodplains before and after passing Leipzig. Therefore, we will present a first drilling transect of the Parthe floodplain near the medieval city with focus on the Late Holocene hydrological dynamics.

Erosion Modelling Indicates a Decrease in Erosion Susceptibility of Historic Ridge and Furrow Fields near Albershausen, Southern Germany

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Ridge and furrow fields are land-use-related surface structures that are widespread in Europe and represent a geomorphological key signature of the Anthropocene. Previous research has identified various reasons for the intentional and unintentional formation of these structures, such as the use of a mouldboard plough, soil improvement and drainage. We used GIS-based quantitative erosion modelling according to the Universal Soil Loss Equation (USLE) to calculate the erosion susceptibility of a selected study area in Southern Germany. We compared the calculated erosion susceptibility for two scenarios: (1) the present topography with ridges and furrows and (2) the smoothed topography without ridges and furrows. The ridges and furrows for the studied site reduce the erosion susceptibility by more than 50% compared to the smoothed surface. Thus, for the first time, we were able to identify lower soil erosion susceptibility as one of the possible causes for the formation of ridge and furrow fields. Finally, our communication paper points to future perspectives of quantitative analyses of historical soil erosion.

Interplay of anthropogenic landscape shaping and fluvial dynamics

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Humans have influenced fluvial systems with their activities and economies for centuries, so they have been negatively and profoundly affected. As a result, all river systems in Central Europe today are anthropogenically influenced and, in some cases, transport pathways for pollutants.

Rivers originating in the low mountain ranges and flowing into the lowlands were only used to a limited extent until the High Middle Ages, as they were hostile to human settlement. More intense human land use of the floodplains located in low mountain ranges only began in modern times.

Our study area is located in the Inde River catchment (North Rhine-Westphalia, Western Germany), a part of the international River Basin District Meuse. Due to the progress of the open-pit lignite mining, a 5 km long river course had to be relocated. To create a near-natural landscape and an appropriate development corridor for the river, a 12 km long river relocation was designed. The artificial river section "Neue Inde" is still geomorphologically "naive" and is characterized by temporary, highly energetic morphodynamic processes resulting in strong erosion processes in the river bed and the surrounding area. Our study investigated initial soil formation in a morphodynamically active artificial river valley constructed with a restoration substrate called “Forstkies”.

Land rehabilitation is a strategy for restoring near-natural landscape systems in anthropogenically influenced environments. Especially in post-mining landscapes after open-pit mining, land rehabilitation gives opportunities and potential for near-natural landscape modeling. The loss of natural soils, which results from long-term formation, is irreversible damage to the pedosphere. The natural soil functions must be re-established entirely. However, it is difficult to examine the success of such measures.

Aggregatstabilität skelettreicher Weinbergsböden unter unterschiedlicher Bewirtschaftung – Quantifizierug mit unterschiedlichen Methoden

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Die Diversifikation der Landwirtschaft, und die Implementierung neuer Anbaukonzepte, wird als ein vielversprechender Weg zur nachhaltigeren Landwirtschaft angesehen. Im Rahmen des EU-geförderten Projektes Diverfarming wurden im Weinbaugebiet Mosel die Effekte der Diversifizierung auf Böden, Biodiversität und Ertrag im Steillagenweinbau untersucht.

Im Steillagenweinbau an der Mosel werden die Fahrgassen zumeist begrünt gehalten, jedoch der Unterstockbereich entweder chemisch oder mechanisch vegetationsfrei gehalten. Dies soll den Einfall von (Pilz)Erkrankungen der Rebe ebenso reduzieren wie die Wasserkonkurrenz. Im hier untersuchten Versuchsaufbau wurden im Unterstockbereich der Reben eines biologisch bewirtschafteten Steillagenweinbergs (Weingut Dr. Fey, Jesuitenberg, Kanzem/Wawern) standortangepasste aromatische Kräuter (*Origanum vulgare* und *Thymus vulgaris*) mit dem Ziel angepflanzt, die Bodenbedeckung zu erhöhen, und gleichzeitig den Wuchs unerwünschter hochwachsender Beikräuter zu unterdrücken.

Neben zahlreichen anderen Bodenparametern wurde der Effekt der Diversifikation im Vergleich zur mechanischen Unterstockbearbeitung auf die Aggregatstabilität untersucht. Dabei sollte quantitativ erfasst werden, inwieweit die unterschiedlichen Managementmethoden einen Einfluss auf die Stabilität von Bodenaggregaten haben. Hierzu wurde auf die drei gängigen Methoden zur Messung der Aggregatstabilität zurückgegriffen:

- Nasssiebung, von lufttrockenen und vorbefeuchteten Aggregaten,
- Perkolationsmethode,
- Tropfenaufschlagmethode an lufttrockenen und befeuchteten Aggregaten.

Mit allen angewandten Methoden konnten Unterschiede der Aggregatstabilität festgestellt werden. Dabei zeigte sich, dass sie am höchsten mit Thymian bewertet werden konnte, und am niedrigsten mit mechanischer Unkrautbekämpfung. Die Ergebnisse waren mit allen Methoden gleich interpretierbar. Aus methodischer Sicht zeigte sich aber auch, dass keine klare, quantitativ darstellbare Korrelation zwischen den Ergebnissen der unterschiedlichen Methoden festzustellen war.

Es zeigt sich also, dass eine Diversifikation im Steillagenweinbau substanziell und schon nach kurzer Zeit zu einer Erhöhung der Stabilität der Böden gegenüber Aggregatzerfall (und damit zu einer Reduktion der Erodierbarkeit) führt. Es zeigt sich jedoch auch, dass eine quantitative Aussage in hohem Maße von der angewandten Methode abhängt, und diese somit sorgsam ausgewählt werden muss.

Microplastics ins steep sloping vineyard soils: Input, storage and output under different management practices

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Pollution with microplastics (MPs, 5000–1 µm) has become a global environmental issue. Despite the increasing research within the last years, for soil science microplastic research is still a new field and certain areas and soil systems are out of focus so far. Major studies on MPs in soils pointed at common agriculture and the related input pathways, but special cultures have been omitted. For closing this gap, we focus this research on studying MPs in steep sloping vineyard soils. Several vineyards in the Mosel Wine Region (Rhineland-Palatinate) have been sampled in a field campaign in February 2023. With this study serving as a very first investigation, the amount and composition of microplastics in vineyard soils of organic and conventional management practices will be assessed and compared. Our research also focuses on the spatial distribution of MPs along the vineyard hill slope at different slope positions, including erosive and depositional areas, as well as the distribution pattern in two different depths. In addition, a quantification and characterisation of MPs found on the soil's surface of the vineyards will add information on the recent input dynamics. On selected vineyards, samples of runoff and erosion will be also collected to identify the output off the system. Results will also be correlated with the measured soil parameters. Quantification of MPs and identification of their polymeric composition is done with µFTIR and ATR-FTIR, following an enhanced MP extraction protocol using NaBr solution (1.5 g cm^{-3}) for density separation and oxidation protocols for organic matter dissolution. Possible input pathways will be estimated and the provenance is investigated using random sampled macroplastic collected at the vineyards. We expect first results on MP quantification and further insights on the MP abundance within viticulture systems in summer 2023, which will be presented within our contribution.

„Die morphologische Analyse“ in Theorie, Experiment und Modell – Gedanken zum 100. Todestag des Leipziger Geologen Walther Penck (1888-1923)

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„Das Endziel der Erosion und Denudation“ ist nach Albrecht Penck (1858-1945) eine Rumpffläche. Bewertet man diesem Axiom die Erkenntnisse seines Sohnes Walther sowie die Ergebnisse nachfolgender Experimente und Modellierungen, so kann man Folgendes festhalten.

Walther Pencks Erkenntnis besteht im Kern darin, dass die Verebnung (Konkavität, Fußhang) ungleichförmig – aufwärts und basisgesteuert – durch das parallele Zurückweichen des steileren Hangteils geschehe, während bei Davis die Verebnung (Flachhang bis Talboden) gleichförmig abwärts und zeitabhängig – durch Tieferlegung erfolge. Bei Davis resultiert als finales Ergebnis die klassische – gewellte – Peneplain (Fastebene), bei Penck eine – ebenfalls gewellte – Rumpffläche als „Endrumpf“, die Gossmann wegen ihrer „Enstehung durch Hangrückzug mit Freigabe der Fußfläche“ auch „Pediplain“ nennt. Diese Formungsweise gilt ebenso für die treppenartig angeordneten „Piedmontflächen“ (Piedmonttreppe).

Anhand der Experimente zu Hangentwicklung, Einebnung und Piedmonttreppen konnte W. Pencks Heidelberger Ko-Doktorand Adolf Wurm (1886-1968) Mitte der 1930er Jahre zeigen, dass in geraden Hängen mit 23 bis 28° Neigung (als Ausgangsformen) durch rückschreitende Erosion bzw. durch Einschneidung von Fußflächen Konkavitäten ungefähr in Höhe der Erosionsbasis entstehen. Das Experiment mit einem ruckweise gehobenen – Kegel ergab zwei umlaufende „Einebnungsflächen“ oder Bergterrassen bzw. eine zweigliedrige „Piedmonttreppe“.

Der Büdel-Doktorand Hermann Goßmann (Jg. 1938) modellierte 1970 – wahrscheinlich zum ersten Mal im deutschsprachigen Raum – Hangentwicklungen, indem er Transportrate und Transportdifferential als mathematische Schlüsselgrößen einsetzte. Er kommt zu dem Ergebnis, dass die Hangentwicklung durch Abspülung (bei konstanter Abfluss- bzw. Denudationsbasis) im „Periglazialgebiet“, in „semiariden und ariden Gebieten“ und im Gebiet der „tropisch-semihumiden Rumppfläche“ immer Hangkonkavitäten erzeuge.

Die Schlussfolgerung kann lauten: Walther Penck hat Reliefeinebnung (Rumpfflächenbildung) mit der Ausbildung von Hangkonkavitäten theoretisch begründet, Adolf Wurm wies dabei die Notwendigkeit einer Hangversteilung experimentell nach, und Hermann Goßmann modellierte dies mathematisch.

Auch der heutigen Geomorphologie sollten diese fundamentalen Erkenntnisse bei der Interpretation des fluvialen Abtragungsreliefs bewusst sein.

Spatiotemporal variability of suspended sediment transport

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The majority of the sediment transported by rivers is moved in suspension. Therefore, processes related to the transport, deposition and resuspension of fine sediment are important for the stability and ecological integrity of river systems. Suspended sediment dynamics in river systems is controlled by complex interactions between tectonics, climate change and anthropogenic activity leading to strong spatial and temporal gradients of suspended sediment transport in river channels. Understanding these interactions is essential for sustainable sediment management, especially for navigable waterways.

Starting in the 1960s the Waterways and Shipping Administration (WSV) and the Federal Institute of Hydrology (BfG) started an extensive monitoring program to quantify suspended sediment transport. To cope with the large spatiotemporal variability of suspended sediment transport the WSV combines daily point sampling and infrequent multi-point measurements. Recently, manual point sampling is replaced by high-resolution turbidity measurements.

First, we present results concerning the temporal variability of suspended sediment transport from high-resolution point measurements from four river catchments (Rhine, Moselle, Ilz, Ammer) in Germany with differing catchment characteristics (e.g. in size, topography, discharge variability). Second, we investigate the representativity of single point measurements by analysing multi-point measurements with a focus on lateral and vertical variability of sediment transport.

Our results indicate lower accuracy and precision in sediment load estimates with higher temporal variability. Here, we were able to link temporal variability with a minimum required sampling interval and show that a higher sampling frequency is necessary with increasing temporal variability.

The evaluation of the multi-point measurements further shows that single point measurements generally underestimate the sediment load by up to 20 % on long-term averages, caused by lateral and vertical gradients in suspended sediment transport.

Evidence of a mid- to late Holocene lake environment in the vicinity of ancient Olympia (western Peloponnese, Greece)

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Ancient Olympia is located at the northern fringe of the Makrisia basin at the confluence of the Kladeos and Alpheios rivers. The entire area was affected by strong tectonic uplift of minimum 13 m to 30 m since the mid-Holocene. Our study presents evidence of a large lake environment near Olympia. The “Lake of Olympia” covered large parts of the Makrisia basin, with the ancient site of Olympia directly located at the northern shore. The Alpheios River, flowing through the lake, was naturally dammed at a narrow breakthrough valley across the hills of the nearby Drouva ridge.

Limnic sediments were retrieved at various locations in the Makrisia basin, i.e., at the western and southern fringes as well as in the immediate surroundings of ancient Olympia. These findings are supported by Direct Push sensing and geochemical data. Additionally, micropalaeontological studies reveal the existence of freshwater ostracods within these limnic sediments. Based on radiocarbon ages, the “Lake of Olympia” existed at least until the late Bronze Age and again during several periods in Antiquity. The fluctuating water level was primarily controlled by the natural bedrock sill of the Drouva ridge. Water level was influenced by tectonic processes, and anthropogenic control at the narrow breakthrough situation may be assumed.

We suppose that the “Lake of Olympia” was used to provide adequate water supply during summer months for the visitors of the ancient Olympic Games as well as the livestock needed as supply for food and sacrifices. Furthermore, shallow water conditions at the eastern fringe of the lake would easily allow to cross the large valley of the Makrisia basin.

Soil erosion using RUSLE in coal and copper-molybdenum mining in Mongolia

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Mining is one of the main supports of the national economy in Mongolia. However, soil degradation caused by mining activities is a severe environmental issue in the country. This case study addresses the long-term impacts of mining on soil degradation at two mining sites located in the semi-arid steppe zone of Mongolia: the open-lignite mine of Baganuur about 140 km east of Ulaanbaatar, and the open-pit copper-molybdenum mine of Erdenet about 240 km northwest of Ulaanbaatar, both of which started commercial extraction in the late 1970s. For the assessment of soil erosion, the RUSLE model was applied in different seasons for the long-term from 1986 to 2018 with three years apart, considering both climatic variation and the expansion of the mines based on maps and satellite imagery. Severely eroded areas were identified in the vicinity of the mining sites. The highest soil erosion rates were found in both areas in July 2018, reaching 7.88 t ha–1 month–1 in the Erdenet area and 9.46 t ha–1 month–1 in the Baganuur area. The spatial patterns of soil erosion showed higher soil loss rates were in the vicinity of the mines and adjoining industrial sites.

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Hyperconcentrated flows shape bedrock channels

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In this study, we show results of an unprecedented LiDAR dataset quantitatively determining the lateral bedrock erosion of a narrow limestone gorge during an extreme hyperconcentrated flow. With a M3C2 change detection analysis, were able to detect and quantify the massive breakout of particles up to 3.5 m^3 and areal abrasion along the full 900 m long channel. Turbulent flow indicators such as sinuosity, convergence and gradient were proven not to influence erosivity. Instead, magnitude-frequency relations of the eroded particles mimic subaerial rock wall retreat. The findings provide quantitative evidence for massive rock erosion processes in alpine gorges that could also control rock gorge formation and evolution over Holocene/Lateglacial time scales.

Pléiades and UAV imagery for rock glacier surface change detection (Agua Negra, Argentina)

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Glacial and periglacial landforms in the semi-arid Andes store essential waters and contribute to regional river runoff. While glaciers in the area are diminishing at high rates, periglacially stored waters gain in relative importance. Surface changes on rock glaciers provide local patterns and indicate permafrost thaw / degradation. Understanding such changing processes is important to assess their future input to the hydrological system. Limited accessibility of landforms, however, leads to a lack of catchment-scale analyses. We envision that investigating surface change through a combination of Pléiades and UAV imagery allows us to investigate change signals over larger spatial areas. This might provide new insight in our process-response understanding of the high Andean (peri)glacial landscape and its hydrological significance. We derive high-resolution digital elevation models (DEMs) based on tristéreo, panchromatic Pléiades data for the austral summers 2022 and 2023 and evaluate generated DEMs of difference (DoDs) against UAV based DoDs, exemplified for Dos Lenguastalus-derived rock glacier in the Agua Negra catchment, Argentina. The UAV flights were performed during the same time as the corresponding Pléiades datatake and are supported by DGPS measurements. We compare outputs of two software and recognize differences in DEM quality depending on the software used as well as shifts in the Pléiades based data. We improve co-registration using the DEMCOREG package (Shean et al., 2016). The UAV derived DoD for the time period 2022 to 2023 shows an overall net negative surface change of Dos Lenguas rock glacier. We are able to see similar surface change patterns in the Pléiades based DoD. For a thorough quantitative analysis of these patterns, however, a further improvement of the co-alignment of the Pléiades derived DEMs is necessary.

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Smartphone-supported mapping of landforms - A new tool in teaching geomorphology

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Understanding 3D properties of objects is an integral part of geomorphological teaching. This can best be achieved during field trips. However, there are numerous reasons why teaching outdoor might not be possible, either for a group of students or just individuals. 3D models of landforms, either static or interactive, are a great method to improve students learning success, e.g. in a blended learning environment. Preparation of 3D models of individual geomorphological landforms has been so far time-consuming. However, since 2020 LiDAR sensors have been integrated into some smartphones. These systems offer great potential for geomorphological teaching, as they enable simple and cost-effective recording of geomorphological landforms and objects in three dimensions. The smartphone LiDAR systems are suitable for the documentation and 3D reconstruction of objects in the range of several decimetres to metres. By means of three examples, the possible applications of smartphone-based LiDAR systems in the field of geomorphological teaching will be demonstrated. All in all, these smartphone LiDAR systems support the understanding of the three-dimensional structure of geomorphological landforms and objects in teaching in schools and universities and, thus, increase the success of teaching among pupils and students. Furthermore, 3D models make geomorphology more inclusive, e.g. for people not able to conduct field work. At the same time, in research, they offer new opportunities for scientific observation projects, e.g. through the continuous monitoring of geomorphological changes in the context of Citizen Science projects.

Stauch, G., 2022. Smartphone-supported mapping of landforms – A new tool in teaching geomorphology. Erdkunde 76, 227–234. https://doi.org/10.3112/erdkunde.2022.03.06

Neotectonic activity of the Rhine Graben Faults (Germany): results from paleoseismic studies

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The Rhine Grabens in Central Europe are one of the most seismically active intra-plate regions, historically experiencing damaging earthquakes below M 7. Research efforts have aimed to characterize the seismic hazard associated with the Rhine Grabens by exploring surface rupturing faults primarily focusing along the western margins of the grabens, unraveling Upper Pleistocene-Early Holocene surface rupturing faults. Our research aims to characterize seismogenic faults within the Rhine Grabens by studying their neotectonic imprint in the landscape and establishing a chronology of seismic events along each fault or fault segment. We present new Lower and Upper Rhine Grabens fault data, based on geomorphological, seismological, geophysical, and trenching investigations, proving the fault kinematics, depicting fault segmentation along the faults, and allowing us to define areas with varying tectonic activity. We trenched several sites for paleoseismological studies in the Upper and Lower Rhine Graben. In all study sites, we found surface rupturing events providing evidence of Late Pleistocene and Holocene tectonic activity with M >6. Holocene surface rupturing events are rare, and their recurrence intervals are large, at around 10^3-10^4 years. Associated slip rates are well below 0.5 mm/yr or ≤ 0.1 mm/yr, respectively. However, some faults show marked linear scarps and topographic steps, as revealed by high-resolution DEMs and field surveys. The preservation of tiny scarps in an agriculturally used area is enigmatic: how can c. 50 cm high, single event scarps been preserved for 10^3-10^4 years? Recurring paleo-earthquakes are recorded in surficial deposits, as shown in our trenches in the Upper Rhine Graben. In addition, some normal faults in the Lower Rhine Graben show evidence for the “Clustering and Quiescence” earthquake occurrence, which may explain the longevity of the scarps, and contrast the “One Shot” hypothesis sometimes stated for Stable Continental Regions (SCR) faults. Our studies contribute significantly to the completeness of the earthquake history.

Celtic fields – vorgeschichtliche Flurrelikte im Norddeutschen Tiefland und im Mittelgebirge

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Hochauflösende digitale Geländemodelle eröffnen den Blick auf eine Vielzahl kleinräumiger anthropogeomorphologischer Formen, die als Elemente (prä-) historischer Kulturlandschaften verstanden werden können. Neben den Relikten der Köhlerei und den in einigen Regionen verbreiteten Wölbäckern sind sogenannte *Celtic fields* vielerorts besonders häufig und flächendeckend anzutreffen. Dabei handelt es sich um zumeist vorgeschichtliche Flurrelikte, die sich vornehmlich im Wald erhalten haben (ARNOLD 2011). Eine Verbindung zu den „Kelten" besteht jedoch i.d.R. nicht. Der von den britischen Inseln stammende Begriff ist missverständlich, hat sich aber durchgesetzt. Nach der nahezu flächendeckenden Inventarisierung anhand hochauflösender DGM-Daten für weite Teile Mittel- und Nordeuropas steht fest, dass derartige Flurrelikte nahezu überall in Mittel- und Westeuropa weit verbreitet sind. In Schleswig-Holstein sind sie in fast allen alten Waldbeständen zu finden, häufig jedoch mit dem bloßen Auge vor Ort im Gelände nur schwerlich zu erkennen. Fast immer bestehen die früheren Fluren aus einem rechteckigen Parzellensystem, das sich aus flachen Wällen und dazwischenliegenden Senken zusammensetzt. Die Wälle erinnern ihrer Ausprägung nach an Ackerberge, an Hangstandorten im östlichen Hügelland Schleswig-Holsteins auch an terrassenartig angeordnete Raine. Häufig kommen Lesesteinhaufen vor. Bei bodengeographischen Untersuchungen werden regelmäßig stark veränderte, häufig stark kolluvial oder durch künstlichen Bodenauftrag verlängerte Profile festgestellt. Neuste Untersuchungen dazu fanden in den Altwäldern Elmholz und Gehege Außelbek (Kreis Schleswig-Flensburg) statt. Die entsprechenden Sedimente enthielten reichlich Keramik, geglühten Flint, Tierknochenfragmente, Holzkohlen und verkohlte Samenkörner (u.a. Gerste). Radiokarbondatierungen weisen in die vorrömische Eisenzeit. Die gute Erhaltung Wall- und Senkenstrukturen lassen auf eine durchgängige Bewaldung seit dem Wüstfallen der Flur schließen. Dazu passen auch die festgestellten Bodenbildungen in den Strukturen selbst. Untersuchungen im Hinblick auf Biomarker und ein Pollenprofil laufen derzeit.

Die Ergebnisse aus Schleswig-Holstein passen erstaunlich gut zu älteren Befunden aus den Mittelgebirgen (STOLZ et al. 2012), wo vergleichbare, terrassenartige Strukturen weit verbreitet sind, deren Alter jedoch von der vorrömischen Eisenzeit bis in die frühe Neuzeit variieren kann. Auch hier verblüfft die weite Verbreitung der Strukturen.

Für eine Übersicht sei auf die Internetseite von Volker Arnold verwiesen: http://www.celtic-fields.com/

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Late Pleistocene-Holocene landscape evolution and paleoenvironments in Central Iran

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Central Iran is a key region for a better understanding of landscape evolution in relation to past environmental and climatic conditions. Since little information has been available for the Late Pleistocene and Holocene, landforms and sedimentary archives from the semiarid Iranian Plateau are being studied to reconstruct landscape evolution, paleoenvironments, and climate. Landforms and incorporated sedimentary archives respond differently to climate and environmental changes. Therefore, the morphogenesis of individual landforms must be considered and the spatiotemporal representativeness of their geoarchive information has to be validated. In this sense, the detailed study of multiple late Pleistocene and Holocene landforms of similar development allows a comparative view of the formation processes of different geoarchives. This is a prerequisite for their correct interpretation and the resulting reconstruction of landscape evolution, paleoenvironment and climate.

The DFG-funded project objectives will be achieved through a detailed landform mapping program, followed by the study of paleoenvironmental proxies from various sedimentary archives such as alluvial fans, playas, and dunes, all located on the Central Iranian Plateau of the playas of Khoor Va Biabanak, Torud, Miani, Mehrejan, and Jandaq. The crucial establishment of a reliable chronostratigraphy of the various landforms and sediment archives will be accomplished by OSL sediment dating.

Precipitation derived by geophysical properties of chernozems along a climate transect in the Middle Danube Basin – A direct comparison to meteorological data

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Spatial precipitation patterns across Europe are likely to vary in response to changing temperature regimes. Yet, our knowledge about such relationships is limited, despite its importance for the direct living-environment of humans. One reason for this is the lack of reliable proxies, which can be determined in high spatial and temporal resolution along with a profound understanding about how these reflect temperature and precipitation. The magnetic susceptibility (χ) and its frequency dependence (χ_{fd}) as quickly and easy to determine geophysical tools are known to reflect the quantity and modification state of magnetic minerals including magnetite, which are dependent on the combined influence of temperature and precipitation. Recently, also the maghemite contribution to the high-temperature dependent susceptibility (χ_{td}) has been used to create climofunctions, which are mainly constrained to reconstruction of precipitation. Yet, such relationships have been reported from Asia, but these have not been tested in Europe so far. Here we test, if we can qualify and quantify precipitation and temperature by a multivariate statistical approach integrating room- and high-temperature rock magnetic and colorimetric data and geochemical information about provenance changes of recent chernozem topsoils into a Principal Component Analysis. All samples were taken along a narrow precipitation range between ~535 mm/a and 585 mm/a (data from multiple stations of the Hydro-meteorological service of Serbia) at the Bačka Loess Plateau (Middle Danube Basin). Our results show that we can best quantify precipitation by χ_{td}. On the contrary, the impact of temperature on all included proxies is not dominant but remains challenging to assess. Although we show the great potential of χ_{td} to derive precipitation in the regional context of Serbian loess, this method needs to be tested considering different environmental conditions in space (e.g., across Europe) and time (e.g., using Loess-Palaeosol-Sequences).

What do dust sinks tell us about their sources and past environmental dynamics? Insights for oxygen isotope stages 3–2 in the Middle Rhine Valley, Germany

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Loess-Palaeosol-Sequences (LPS) denote dust sinks that are directly linked to the atmospheric circulation and may be used to reconstruct shifts in dust provenance and flux relative to recorded climate changes. Yet, such studies are fragmentary for western Central Europe limiting our understanding of dust dynamics in varying environmental conditions. Here we combine sedimentological, rock magnetic, and geochemical data including $^{87}Sr/^{86}Sr$ and εNd values providing insights into the formation of LPS. We focus on the Schwalbenberg RP1 profile in the Middle Rhine Valley (Germany) for which a robust ^{14}C based age model has been established. A stratigraphic unconformity subdivides the profile into a lower section correlated to late OIS 3 (~40–30 ka) and an upper section correlated to the LGM (~24–22 ka). Proxies for wind dynamics and pedogenesis in the lower section indicate a synchronicity of recorded environmental changes and climatic oscillations in the Northern Hemisphere. The anisotropy of magnetic susceptibility (AMS) reveals a correlation between finer grain size and increasing AMS foliation within interstadials, possibly owing to continuous accumulation of dust during soil formation. Such a clear negative correlation has not been described for LPS on stadial-interstadial scales so far. Distinct shifts in proxy data including $^{87}Sr/^{86}Sr$ and εNd within the lower section indicate changes in provenance and decreasing weathering during a cooling and aridification trend after ~35 ka. Our data suggest enhanced wind activity with significant input of recycled coarse-grained material from local sources during increased landscape instability (after ~31.5 ka). In addition, AMS-based reconstructions of near-surface wind trends may indicate the influence of NE winds beside the overall dominance of westerlies during the LGM. Our integrative approach contributes to a more comprehensive understanding of LPS formation including changes in dust composition and associated atmospheric circulation patterns.

Anthropogeomorphology, Soils and Subsurface Processes in the Otterbach and Perlenbach Catchments (TUM-CZO), Bavarian Forest

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The Otter Creek watershed is part of a long-standing study area of the author according to the basic principles of Critical Zone research. At present we dedicate ourselves to questions of anthropogeomorphology in the course of centuries-old, small-scale mining (i.b. fluorite), early settlement since the turn of time and last but not least alluvial sedimentation connected with it. Extending previous studies in the floodplain, we analyzed and instrumented adjacent slopes for near-surface subsurface architecture. Using two catenas as examples, we show, among other things, the following: Sediment and soil genesis and their physicochemical as well as mineralogical properties are characterized by the common parameters. Using volume-based and undisturbed samples, we capture the water retention functions of varying layers. We permanently instrumented each catena with soil moisture probes, at 5 locations, at 4 depths per location. These are placed based on the position of particular layers like PSDs and saprolite, to highlight their differentiation and role in term of interflow and water storage. In addition, the profiles were fitted with suction cups at the same depths, to be able to also assess biogeochemical parameters. Finally, the tensiometers are utilized to assess the water transport mechanisms at the boundary between toe slope and floodplain, as well as between the floodplain and the stream. To characterize the seasonal wetting and drying of the shallow subsurface with different horizons, layers, saprolite in situ, and the granitic bedrock, we create a resistivity model using two-dimensional (2D) electrical resistivity tomography (ERT) along each catena. The geophysical prospection is added by Ground Penetrating Radar (GPR) and Shallow Seismic Refraction (SSR) in order to cross-check ERT measurements and identify hydrological boundaries.

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Possible traces of the Storegga slide tsunami around 8150 cal BP at the German North Sea coast

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The Storegga slide tsunami (SST) at ca. 8100 ± 100-250 cal BP is known to be the largest tsunami that affected the North Sea during the entire Holocene. Geological traces of tsunami landfall were discovered along the coasts of Norway, Scotland, England, Denmark, the Faroes and Shetland Islands. So far, the German North Sea coast has been considered as being well protected due to the wide continental shelf and predominant shallow water depths, both assumed to dissipate tsunami wave energy significantly, thus hindering SST propagation dynamics.

The objectives of our study were to clarify if the SST reached the German Bight and if corresponding sediment markers can be found. Our research was based on a 20 m long sediment core (GAR 1A) recovered from Eiderstedt Peninsula near Garding in North Frisia. High-resolution Direct Push sensing data and results of multi-proxy analyses of the sediment material were used to reconstruct palaeoenvironmental as well as palaeogeographical conditions.

We identified a high-energy event layer with sedimentological (e.g. erosional unconformity, rip-up clasts, fining upward), microfaunal (e.g. strongly mixed foraminiferal assemblage) and other features (e.g. upward increase of organic matter) typical of tsunami influence and identical in age with the SST. The event layer was deposited at or maximum ca. 1-1.5 m below the local contemporary relative sea level and minimum 40 km inland from the coastline within the palaeo-Eider estuarine system beyond the reach of storm surges. Tsunami facies and geochronological data correspond well with SST signatures identified on the nearby island of Rømø. SST deposits identified at Garding represent the southernmost proof of this event in the southern North Sea. They give evidence, for the first time, of high-energy tsunami landfall along the German North Sea coast and tsunami impact related to the Storegga slide.

Possible sedimentological traces of the 1st Grote Mandrenke 1362 AD at the coast of East Frisia near Dornum (North Sea coast, Germany)

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Since the end of the last Ice Age, the landscape history of East Frisia (Lower Saxony, Germany) has been shaped by a sharp rise in sea level and a resulting loss of land. Storm surges have repeatedly flooded populated areas, especially since the Middle Ages. Man tried to counteract this development by building dykes.

The data and results presented here originate from the marsh near Dornum in East Frisia, located inland of the Accumer Ee tidal inlet. Due to this location, the study area was particularly exposed to storm surges in the past. Between the barrier islands of Baltrum and Langeoog the water could flow towards the coast unhindered. A port near the present day Dornum was first mentioned in 1289 AD. During the 1st Grote Mandrenke (or St. Marcellus' flood) in 1362 AD, the dyke was breached and a bay between Dornum and Westeraccum was created. Several attempts to repair the dyke failed. Efforts to close the bay succeeded almost 100 years later, largely along the dyke line from before 1300 AD.

Geophysical investigations (ERT, DP-HPT, DP-CPT) and vibracoring were carried out with the aim to find evidence of past storm surges and to reconstruct the landscape history of the region. Sediment cores underwent geochemical and microfaunal analyses. Vibracores ACC 1A and ACC 3A as well as the results of geophysical investigations document several Holocene extreme events, most likely including the 1st Grote Mandrenke 1362 AD. Possible sedimentological traces of the associated ingression bay were detected in drill core ACC 3A.

Spatial frequency analysis of hydrogeomorphic events in Northwest Namibia based on over two decades of satellite Earth observation

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Rare but heavy precipitation events are the fundamental driver for geomorphic activity in arid regions. A quantification of the frequency and magnitude of episodic discharge is essential for a robust characterization of flood hazards and better understanding of the poorly studied hydromorphodynamics in deserts. However, observation data from both precipitation and stream gauges often are sparsely distributed and/or do not cover a sufficiently long seamless time series. This applies, for instance, to the remote Northwest Namibia, where more than a dozen ephemeral rivers drain the Kunene Highlands towards the Skeleton Coast, yet daily river flow data for a period of several decades is only available from the Hoanib. Therefore, we apply spatial frequency analyses on time series of (i) the IMERG (V06) precipitation product since 2000 (temporal resolution: 30 min; spatial resolution: 0.1°) and (ii) the Landsat multispectral satellite imagery archive since 1999 (temporal resolution: 16 d; spatial resolution: 30 m) in order to generate spatially resolved recurrence intervals for pluvial events and floods of different magnitudes, respectively. While pluvial events are analysed for the entire catchment areas in the Kunene Region, a refined spatial aggregation of stream and floodplain sections is used for the hydrogeomorphic frequency analysis. To cater for the limitations of the Landsat imagery related to the 16-day-revisit time, we calculate spectral indices allowing for the detection of both inundated areas during flooding (e.g., NDWI) and effects sustained after flood recession (e.g., NDVI). As a novel approach, we implement the hydrogeomorphic frequency analysis directly in the Google Earth Engine environment after attributing the spectral imprints of floods to their magnitudes. For this purpose, a statistical relationship is developed between the daily record of the gauging station at the Hoanib and the multispectral surface characteristics along the river course – before transferring this relationship to the other ephemeral streams.

Analyse räumlicher Muster und Einflussfaktoren extremer geomorphologischer Veränderungen infolge des Hochwasserereignisses im Ahrtal im Juli 2021

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Das extreme Hochwasserereignis vom 14./15. Juli 2021 führte entlang des Flusslaufes der Ahr zu massiven geomorphologischen Veränderungen. Zu den Prozessen gehören Massenbewegungen und Erosionen an Uferhängen, Flussbettverlagerungen und -verbreiterungen sowie die Deposition von Material in den Flussauen, die alle zu den extremen Schäden beitrugen. Mit dem Ziel eines umfassenderen Verständnisses der Steuerungsfaktoren dieser Prozesse wurden geomorphologische Veränderungen auf regionaler Skala hinsichtlich räumlicher Muster analysiert. Untersuchte Einflussfaktoren sind der Spitzenabfluss im Haupttal und der Nebenflüsse, die Breite des Talbodens sowie der Einfluss von zerstörten Brücken. Als Datengrundlage dient ein differentielles Geländemodell (DoD), errechnet aus vor- und nach dem Ereignis mittels flugzeuggestütztem Laserscanning (ALS) erhobenen digitalen Geländemodellen (DGM). Der Flussverlauf wurde in 120 m breite und 100 m lange Segmente unterteilt, für die jeweils die Summe der Erosion und Deposition errechnet wurde. Diese Datensätze wurden hinsichtlich der Verteilung von Extremwerten untersucht, die durch ein Überschreiten der n-fachen Standardabweichung charakterisiert sind. Zur Berücksichtigung von Autokorrelationen innerhalb der Datensätze wurden zusätzlich die Residuen zweier ARIMA Modelle auf Extrema untersucht.

Die Prozessmagnituden nehmen mit der Entfernung zur Quelle, d.h. mit zunehmendem Abfluss, zwar zu, es zeigen sich aber räumliche Schwerpunkte, die durch andere Einflussfaktoren gesteuert werden. Die Extremwertanalyse zeigt, dass die stärksten geomorphologischen Veränderungen mit hohen Spitzenabflüssen und einer kleinen Talbodenbreite einhergehen. In unmittelbarer Umgebung zerstörter Brücken sowie in den Abschnitten 100 m flussabwärts ist die Erosion erhöht. Dieses Muster zeigt sich ebenfalls in den Extremwerten der Residuen des ARIMA Modells der Erosionssummen.

Insbesondere der auf die Distanz limitierte Einfluss der Brücken auf zusätzlich erhöhte Erosion überrascht zunächst und muss mit anderen Ansätzen weiter untersucht werden. Wenn sich dies bestätigen sollte, würde dies Hinweise liefern auf die Dynamik der Ausbruchsflutwellen verklauster Brücken und den Ablauf des Extremereignisses generell.

Changing river dynamics in the Eger/Röslau catchment since the late Middle Ages – investigations using three human induced metals as tracers (Hg, Fe, Sn)

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River systems in the Middle-European uplands have undergone significant changes in their structure and dynamics due to different types of human impact. Our aim is to unravel the change of river dynamics of the upper Eger and its tributaries in the Fichtelgebirge uplands (Upper Franconia, Germany) driven by land-use and mining history. From 1788 until 1985, the chemical factory Marktredwitz contaminated the river system with mercury. Even earlier the region was rich with mining and metalworking, starting in the Middle Ages. The most important metals were tin (peaking 1300-1450) and iron (peaking 1400-1750), connected with hammer mills and hydropower. As a result, the floodplains have been severely modified and chemically imprinted.

We use these metals from three different time periods as tracers to determine the age and mixing of river and floodplain sediments as well as their overall dynamics through time. Based on an evaluation of historical maps, aerial- and ortho-photos and mapping of current erosion, we defined cross sections along the river course to perform sediment coring and geophysical surveys (geoelectrics/ERT, ground-penetrating radar/GPR). Sediment coring provides an overview of the sedimentary architecture, grain size distributions and provides the samples for chemical analysis (XRF, ICP). ERT and GPR extend drill core information on thickness, lateral extent and architecture of fluvial and floodplain deposits. Erosion mapping and chemical analyses will be compared to a study on mercury contamination conducted 2011, to reveal current dynamics.

First results show a great variability of the character of floodplain sediments, especially in their grain size distribution, implying spatial and temporal differences in erosion and sedimentation along the river. Variability close to the rivers (<1m) is significantly higher than further away (1-10m), indicating concentration of present-day river dynamics in the immediate vicinity of the rivers. Results of the chemical analyses will be presented on the poster.

Morphological evidence of Quaternary lake-level fluctuations of the Khyargas Nuur, Western Mongolia

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Situated in the rain shadow of the Altai Mountains, the Basin of the Great Lakes in Western Mongolia is among the most continental regions on Earth, exhibiting a high range of temperatures and low precipitation. Apart from the Khövsgöl, it hosts Mongolia's major lakes, namely Uvs-, Khar-Us-, Khar- and Khyargas Nuur. The study area is located within an endorheic basin, forming the ultimate sink of a sediment/water cascade from adjacent Altai and Khangai Mountains with intercalated lakes Khar Us and Khar, draining into the Khyargas Nuur. The three lakes formerly joined one paleolake, evidenced by a variability of elevated geomorphological paleo-shoreline features, indicating massive lake-level regression.

Lake expansions likely occurred during interglacials and interstadials, driven by melting glaciers of the adjacent mountains and thawing permafrost. Synchronously, specific lake level stages cause the formation of associated paleo-shoreline features such as beach bars, cliffs or spits, leaving geomorphological highwater marks that can be exploited for geochronological analyses, while lake-level lowering exposed sediments to subaerial processes. Thus, reconstructing lake-level dynamics is an essential part in understanding moisture availability and the state of the basins sedimentary system in terms of sediment supply and availability. Furthermore, reliable chronologies bear the potential to quantify the secondary modification of shoreline features by tectonics or (hydro-) isostatic deflection.

We aim to establish chronologies of littoral landforms using terrestrial cosmogenic nuclide (TCN; ^{10}Be) and optical stimulated luminescence (OSL) dating. Field surveys hint to clusters of different shoreline generations with frequent beach ridges up to +20m, a series of further degraded ridges up to +87m and a prominent double beach ridge of +117m to +130m, that is expressed in a (paleo-) cliff on the eastern shore. Specific (paleo-) lake volumes are calculated based on FABDEM v1-0 with 30 m resolution and the GLOBathy global bathymetric dataset.

Loess-Palaeosol-Sequences in Kashmir - an important and yet mostly unknown link between the Westerlies and the Indian Monsoon

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Loess-paleosol sequences have been demonstrated to be a key archive for understanding terrestrial palaeo-climate and palaeo-environmental dynamics spatially and through time. Loess-paleosol sequences have been comprehensively studied across Eurasia and N-America, whilst this is not the case for other areas including India. A better understanding of LPS across the Indian sub-continent will likely provide crucial information about interactions of the Westerlies and the Indian Monsoon systems over time, and their contributions to precipitation.

Here, we summarize available high resolution (2cm) data from a last interglacial loess-paleosol sequence at Khan Sahib in Kashmir/India. Our results demonstrate a considerable dust deposition during the last interglacial. Further, these suggest a relevant contribution of the Indian Monsoon to precipitation. Field observations and rock magnetic estimates for precipitation suggest that last interglacial precipitation was higher than it is recently. We use this finding in combination with available models to discuss future precipitation under ongoing global warming in Kashmir.

The DFG-Priority Programme 2361 "On the Way to the Fluvial Anthroposphere"—Current Challenges and Perspectives of Multidisciplinary Research

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The Priority Programme 2361 "On the Way to the Fluvial Anthroposphere" investigates the pre-industrial floodplains in Central Europe and the fluvial societies that operated there. Floodplains are global hotspots of sensitive socio-environmental changes, exceptionally dynamic landscapes, and key areas of cultural and natural heritage. Due to their high land-use capacity and the simultaneous necessity of land reclamation and risk minimisation, societies have radically restructured Central European floodplains. The Priority Programme aims to answer the questions of when and why humans became a significant controlling factor in floodplain formation and how humans in interaction with natural processes modified floodplains. The individual projects focus on the medieval and pre-industrial modern periods and are based upon the systematic overlay of historical, archaeological, and geoscientific data that entails the use of the methodological expertise of at least one discipline in the natural sciences and one in the humanities. In the first funding period (2022–2025), the focus is on individual and comparative case studies. By the second funding period (2025–2028) at the latest, additional benefit should be created through increasingly comparative analyses of case studies, categorisations, and transferable models at intra- and inter-basin scales. The presentation provides an overview about the initial stage of the first funding period and invites you to a variety of possibilities for scientific cooperation and networking.