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Abstract Booklet

Talk Session 1

Tuesday 3rd September 13.00-14.15

New insights into aeolian sediment flux and transport dynamics.

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How the behaviour of saltating grains determines sediment flux over different aeolian dominated surfaces is a fundamental but elusive question in coastal and desert environments on Earth and other planetary bodies. Here we show how bulk transport rates over moist, gravel and dry sand surfaces vary with changing boundary conditions and explore the spatial and temporal intricacies of sediment transport distributions (both horizontally and vertically) in relation to turbulent structures. While transport fluxes increase with shear velocity on all surfaces, both the bulk flux and the maximum vertical extent of the saltation cloud increase at a greater rate over moist and gravel surfaces. Further, we find two differing behaviours in sediment flux when measuring windspeed and sediment flux at higher time and space frequencies in the field. These are characterised by a consistent and continuous sediment transport component close to the surface which is overlain by eddy-driven saltation pulses evident at height, particularly at higher shear velocities. By accounting for these twin behaviours we improve the correlation between field measured wind speed and sediment flux and elucidate fundamental commonalities between disparate field, modelling and wind tunnel findings reported in the literature.

Keywords: sediment transport; saltation; aeolian; terrestrial laser scanner (TLS); desert; coast

Surface geochemistry and hydrological controls on 'hot-spots' of dust emission at Etosha Pan, Namibia.

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Dust emissions from ephemeral playas are characterized by considerable spatiotemporal variability. It has proven extremely difficult to resolve the complex dynamics between climatic conditions and surface crust characteristics that control aeolian dust emissivity. In this study we used multitemporal satellite remote sensing and model reanalysis data to determine the climatic environments, surface sediment mineralogy, and hydrological context associated with the formation of 'hot-spots' of dust emission at Etosha Pan, Namibia. A twenty-year record (2000–2022) of dust source locations was established from MSG-SEVIRI and MODIS data, which enabled the identification of clusters of dust sources ('hot-spots'). Using a time-series of Landsat 8-9 data we identified the surface mineralogical characteristics associated with the development of these 'hot-spots' of dust emission. These analyses were validated using reflectance spectroscopy and XRD analyses of sediment samples collected from the field. Linear spectral unmixing was applied to map the relative proportions of identified evaporite and clay mineral spectral endmembers from pixel spectra of Landsat image time-series. Results show that the development of emissive 'hot-spot' dust sources are associated with the formation of evaporite mineral crusts through the process of salt efflorescence initiated by wet season flooding events. Field experimentation using a portable wind tunnel combined with remote sensing analysis demonstrates that high winds in the dry season can break down this mineral crust exposing large quantities of fine and highly emissive sediments that are extremely susceptible to aeolian entrainment. Surface crust geochemistry, influenced by flooding history, therefore offers a first-order control on the development of 'hot-spots' of dust emission. The approach described here could be used at other ephemeral playas that are significant dust sources to elucidate hydrological and mineralogical controls on aeolian dust emission and to enhance regional-scale dust emissions modelling.

Keywords: Ephemeral lakes; dust; geochemistry; hydrology

Development of a dryland river terminus: The Luni River in the Indian Thar Desert.

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The ephemeral Luni River is located in the arid eastern margin of the Thar Desert, western India. The geomorphology, sedimentology and late Quaternary history of the upper-middle reaches have been investigated previously, but the Holocene development of the lower reaches and river terminus (the 'floodout zone') is poorly understood. This study integrates remote sensing, GIS-based analysis, and palaeoenvironmental reconstructions to provide a comprehensive picture of the Luni River's floodout zone (LRFZ) development. The LRFZ is characterised by a complex network of active, partially active, and abandoned channels that collectively form a distributive fluvial system (DFS). Twenty samples for optically stimulated luminescence (OSL) dating have been collected from riverbeds and banks across the LRFZ and the results will provide information regarding the timing of initial channel formation and floodplain aggradation rates, and when the sampled channels were last active. The hypothesis is that fluvial activity has declined in the mid-late Holocene, similar to many other rivers in the Thar Desert and other drylands worldwide, with a continuous through-going river having transformed to a multi-channel DFS. A recent field visit and remote sensing analyses have revealed how this fluvial landscape is now being transformed by the supply of irrigation water from canal networks, which is leading to increased soil salinization and land degradation. The near future of this riverscape will be driven by a complex interplay of climatic, anthropogenic, and possibly tectonic factors. The findings will contribute to growing knowledge regarding dryland riverscape resilience in the face of environmental changes.

Keywords: dryland river, floodout, Holocene evolution, palaeoenvironmental reconstruction, Luni River, Thar Desert

Improving understanding of geomorphological damage and geodiversity loss in armed conflicts.

Robert A. Watson[1], Eoghan Darbyshire[1], Anna McKean[1], Iryna Babanina[1], Jay Lindle[1], Jonathan Walsh[1], Linas Svolkinas[1], Leon Moorland[1], Philipp Barthelme[2], Doug Weir[1]

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Armed conflicts are becoming the defining global feature of the decade, with immediate and long-lasting consequences for humanity and the environment. While monitoring of certain aspects of environmental harm arising from armed conflict (e.g. ecosystem loss and surface water pollution) have gained increasing academic attention, loss of geodiversity and geomorphological damage have so far been largely neglected consequences of recent armed conflicts that demand further consideration (Kiernan, 2020).

Since 2022, we have created and maintained databases of remotely assessed discrete incidents of environmental harm associated with armed conflict in Ukraine and Sudan. We have also worked with others to assess landscape-scale impacts and processes associated with armed conflict, such as mapping bomb craters in Vietnam from declassified satellite imagery (Barthelme et al., 2024) and a briefing on biodiversity and geodiversity loss resulting from the 2022 Russian invasion of Ukraine (CEOBS, 2024a). The latter includes widespread destruction and contamination of soil profiles by explosive weapons, landform destruction and accelerated erosion due to military fortification and earthworks, and significant alteration of watercourses and fluvial geomorphology by fighting and deliberate flooding. Specific examples of damage to fluvial systems include the Bilohorivka river crossing (CEOBS, 2024b) and the Irpin and Kakhovka dam destructions (CEOBS, 2024c, 2024d).

Our contribution here aims to raise awareness of the damage sustained to landforms and geological features due to armed conflict, and to encourage further study of the impacts of armed conflict on geodiversity and geoheritage by introducing a recent initiative - the Conflict and Environment Academic Network.

Keywords: armed conflict, geomorphological damage, geodiversity loss, remote sensing, earth observation

Talk Session 2

Tuesday 3rd September 14.45-16.15

Mind the gap! Trapped-charge dating to the rescue!

Georgina E. King

University of Lausanne

Understanding the timing and rates of geomorphological processes is critical for understanding landscape evolution. Luminescence and Electron Spin Resonance (ESR) dating are trapped-charge methods that can be applied to quartz and feldspar minerals over timescales of decades-105 years and 103 -106 years respectively. Trapped-charge dating methods are remarkably versatile, and our group specialises in exploiting novel applications of trapped-charge dating to address outstanding geomorphological questions. I will present two case studies of our recent work, first, the application of ESR dating of quartz minerals to understand the impact of Quaternary climatic changes, specifically glaciation, on exhumation rates of the Rhône valley in Switzerland. Although this region has been extensively studied previously, existing thermochronometric methods generally lack resolution over timescales <1 Ma, a temporal gap that ESR dating can fill, because of its low closure temperature of ~30 °C. The second case study explores the application of luminescence rock surface dating of glacially entrained cobbles for understanding ice dynamics. Englacial transport rates are extremely difficult to constrain, because of the challenge of observing these processes directly. Luminescence signals are reset rapidly upon exposure to sunlight, and thus the age of a rock surface should reflect the period of burial within the ice. Results from the Miage glacier (Italy) and Mer de Glace (France), Mont Blanc Massif will be presented.

Keywords: Trapped-charge dating, luminescence, ESR, glacial

Global diversity and significance of animals shaping the Earth's surface.

Gemma L. Harvey[1], Zareena Khan[1], Lindsey K. Albertson[2] Martin Coombes[3], Matthew F. Johnson[4], Stephen P. Rice[5], Heather A. Viles[3]

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Biodiversity influences landform development and landscape evolution because many species create or modify habitat in ways that both enhance their own survival and provide habitat for other species. These 'ecosystem engineers' include animals acting as zoogeomorphic agents, modifying soil and sediment dynamics, landforms and landscapes in diverse and important ways. Yet there has been no comprehensive global assessment of the diversity, abundance and geomorphic significance of zoogeomorphic agents. Empirical studies overwhelmingly focus on a single species within a specific environment, but recent exponential growth in biogeomorphological research creates a unique opportunity to bring together evidence across species and ecosystems. Here, we present a new global data set of zoogeomorphic species and their effects, focusing on wild animals in terrestrial and freshwater ecosystems. We uncovered over 600 species, genera or family groups with reported geomorphic effects. Most animals were studied in their native range and over one quarter are exposed to current or future threats. Terrestrial environments were richer in zoogeomorphic species in absolute terms, but freshwaters contained a higher proportion of reported zoogeomorphic species per unit area and measured effect magnitudes tended to be higher in freshwater habitats. Freshwater zoogeomorphic species were also collectively more globally abundant. We estimate that the combined energy available for zoogeomorphic work in terrestrial and freshwater environments exceeds the energy expended by major geophysical disturbances such as extreme floods and monsoons, by orders of magnitude. Zoogeomorphic species therefore represent a significant and overlooked driver of geomorphic change at the global level.

Keywords: biogeomorphology, zoogeomorphology, ecosystem engineer

Modeling the transport and deposition of sediment-microplastics fluxes in a braided river, using the software Delft3D.

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Plastic-polluted rivers have become sites where mixtures of microplastics-sediment particles are transport by the river flow and deposit-storage in the riverbed. A hydro-morphodynamic numerical model using the software Delft3D' was created to simulate the sedimentation, erosion, resuspension, and transportation of microplastics together with sediment particles, introducing an innovative model with an active riverbed. The model was used to understand the distribution patterns, morphology changes, and load balances of plastic debris in a river.

The study case is an artificial braided river with a non-buoyant suspended microplastic load. The results simulated a sediment bed that acts as a source of storage of microplastic near the release point, limiting the availability to be resuspended and transported downstream. The high deposition of microplastic increases the capacity of the river flow to erode the bars and banks channels, resulting in deeper channels and increased river bars. The highest amounts of microplastics were deposited in the inner curve of the main channel in the banks, and the highly suspended microplastic load is transported in the thalweg of the main channel. The results demonstrated that the method can be used as a more precise tool to model the dynamics of microplastic fluxes in rivers.

Keywords: Microplastics in the environment, Delft3D, particle dynamic in rivers

Sedimentological Insights into Anthropogenic Materials: A Comprehensive Framework for Improving Contemporary Environmental Assessment.

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Since 1950, approximately 9.2 billion tons of plastic have been produced, with about 5.3 billion tons discarded and potentially mismanaged. Indeed, human-made materials have become so pervasive in both terrestrial and marine environments that they now exceed Earth's total biomass. Therefore, earth scientists must account for these materials in their analyses of depositional environments. However, the variability in classifying these materials hinders our ability to predict plastic routing, degradation, and accumulation worldwide, highlighting a critical need for clear, universally applicable methods of assessment to effectively manage plastic distribution, pathways, and environmental impacts. By relying on established sedimentological principles, this proposed solution for plastic classification comes in two parts: 1) Treat plastics as sediment by applying sedimentological principles to develop a classification scheme based on size, shape, density, and material properties; and 2) Implement a plastic facies classification, which focuses on objective observation and recognition of spatial and temporal changes, providing an adaptable and flexible framework. The scheme enhances assessments of plastic source-to-sink routing, supports environmental monitoring and management strategies, facilitates data comparability through standardized nomenclature, and benefits stakeholders by enabling detailed predictions of material behaviour and environmental impacts. These enhanced capabilities have significant implications for recycling, reuse, and management strategies. Additionally, the approach supports interdisciplinary applications overlapping with archaeology, environmental monitoring, and engineering, aids in understanding and managing Earth's changing landscapes, and assists in developing strategies for future geological records in the Anthropocene.

Keywords: Sedimentology; Anthropogenic Materials; Environmental Assessment; Plastic Accumulation; Sediment Analysis

Talk Session 3

Wednesday 4th September 09.00-10.15

Chorley Medal: Discharge variability controls alluvial fan morphology and hazards

Anya S. Leenman[1], Brett C. Eaton[2], Lucy G. MacKenzie[3]

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Floods are the agents of change on alluvial fans. However, many experiments employ constant flows to simulate fans and their channel dynamics. To explore the effects of this simplification, I present a series of alluvial fan experiments with different amplitudes of flow variability: (a) constant flow, (b) alternating high and low flows, (c) moderate floods that decayed slowly, and (d) large floods that decayed rapidly. Repeating these different hydrographs generated fans with different slopes, even though all experiments had the same mean flow and sediment supply. Higher peak flows also increased lateral migration rates and erosion and deposition volumes. These results challenge the notion that a single representative flow can be used to approximate the geomorphic effects of a range of flows in a natural stream, and suggest that hydrograph shape can govern the geomorphic impact of a flood event. Alterations to basin hydrology (for instance, through land cover change) may therefore influence rates of geomorphic change and natural hazards on alluvial fans.

Keywords: Alluvial fan, discharge variability, flood, experiment

Quantifying river channel (in)stability.

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Changes in river channel morphology are of intrinsic interest for process fluvial geomorphology, and of fundamental importance for managing human-caused channel instability. Because continuous monitoring of river channel evolution is rare, field assessment has often used rapid assessment protocols using a set of proscribed field observations. Such assessments typically require interpretative understanding by an experienced field surveyor, and thus they risk significant inter-surveyor bias. Further, the multiple modes of possible channel adjustment preclude the simple scoring of observations from low-to-high, such as when quantifying the diversity or “naturalness” of physical habitat. In response, we have developed an approach to codify and combine field observations to identify the various modes of channel adjustment, in order to best discriminate impacted channel instability from the equilibrium 'dynamic stability' of an active, natural channel, together with the relative intensity of such processes. Our methodology has been tested in two highly contrasting environments: largely undisturbed channels of the High Sierras of California and heavily-impacted lowland channels of Ireland. The results, interpreted from a ‘heat map’ reflecting the intensity of 14 indices of channel activity include summary outcomes for the sensitivity, dynamic stability and prevailing instability in each river reach. Post-processing of field observations ‘internalises’ the scheme’s incorporation of expert judgment, providing transparency and allowing future modifications without reducing the integrity of the original field observations. This also should minimize inter-surveyor bias. The surveys can be periodically repeated to judge relative channel stability over time to provide input in planning sustainable river management and restoration.

Keywords: river channel stability, fluvial geomorphology, river management

‘Pebble Pushing’: Untangling Variabilities in Gravel Bed Stability using In-Situ Resistance Force Tests.

David Whitfield

Loughborough University

Gravel bed stability is an important concept when predicting sediment transport fluxes through catchments, and their implications on channel stability and form. Despite this, the spatial and temporal variabilities of grain mobility are poorly understood in the field. We use novel in-situ bed resistance force tests, alongside grain force balance models, to explore the distributions and uncertainties associated with sediment mobility thresholds, for 45 upland gravel bedded channels across England and Wales. We untangle the complex relationships between grain properties and bed resistance by measuring clast shape and size directly in the field, and grain arrangement (including imbrication, alignment, grain protrusion, and surface roughness) were quantified from 3D SfM channel bed models. We investigate the role that channel hydrology and flood history play on setting bed material arrangement and stability, by identifying and contrasting example channels with notably flashy and steady hydrologies. From this, we acknowledge the potential influence of flood sequencing and conditioning on bed de- and re-stabilisation cycles, and introduce opportunities for further long-term, targeted bed adjustment monitoring. Understanding spatial and temporal controls in bed stability is important for upland river management; improving the ability to map and model bed stability and sediment transfer through catchments, particularly under a changing climate.

Keywords: Sediment Transport, Mobility Thresholds, Channel Stability

Sediment budgets in the River Derwent: modelling and monitoring.

Janet C. Richardson[1], Helena Brown[2], Gareth M. Keevil[2], Ben Aston[3], Alison Dunn[2], David M. Hodgson[2]

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[3]Yorkshire Water

The River Derwent, Yorkshire has a recognised fine grained sediment problem, impacting water treatment costs. Sediment budgets are a useful tool to understand where sediment in a river catchment is sourced, helping to optimise management. Within the River Derwent, 2 of the 4 operational catchments have a high occurrence of the invasive non-native species Signal Crayfish; however it is currently unknown how much sediment they contribute to the overall catchment sediment budget. This project monitored the River Derwent monthly from February to November 2022, assessing water quality changes (including grain size) and modelled the catchment to understand sediment sources. Results showed that the catchment is extremely complex – flow was the main forcing factor impacting sediment loads, however, locally important aspects such as soil erosion and agricultural runoff and Signal Crayfish were significant. Areas of high risk have been identified for future management. Currently, it has not been possible to attribute a proportion of the sediment budget to Signal Crayfish (and other sources), however modelled soil erosion from the River Derwent contributes 12% of the wider Ouse Catchment Area, with similar volumes from the Upper Rye and Upper Derwent sub-catchments. Future work could focus on monitoring the catchment using pump samplers or turbidity / flow sensors to be able to adequately track the pulse of sediment from Signal Crayfish. Research gaps relate to: how far downstream the pulse from Signal Crayfish activity extends and quantifying the impacts of Signal Crayfish beyond the reach scale. (243)

Keywords: Sediment budget, crayfish, soil erosion, modelling

Talk Session 4

Wednesday 4th September 11.00-12.15

Sweeting Award: Investigating the impacts of the 2009 Mt Redoubt eruption on the geomorphology and dynamics of Drift River, Cook Inlet, Alaska.

Athena Eftychiou

University College London (UCL)

Glaciofluvial systems close to active volcanoes are some of the most dynamic landscapes in the world, as even at times of volcanic dormancy, the significant fluctuations in their flow magnitude and frequency result in unique geomorphic settings. Using remote sensing data, this study investigates how the 2009 eruption of Mt Redoubt in Alaska has influenced the geomorphology of Drift River, a highly braided river system on the west side of Cook Inlet. The timing and duration of the event led to the generation of significant meltwater and extensive lahars, which inundated extensive areas of the Drift River valley and had a long-lasting legacy on the geomorphology of the area. Analysis of satellite products from 1995-2022 reveals a highly dynamic fluvial system, with the mid- and lower-sections of the valley experiencing the most significant impacts. Satellite data from before and after the eruption as well as NDVI analysis revealed a redirection of the active flow of Drift River into the neighbouring Rust Slough catchment immediately after the event, while supervised classification and NDWI cross-transect analysis provide evidence that the lower Drift River had not reached a stable-state by 2022. The alluvial fan created at the mouth of Drift River following the event resulted in an avulsion note 29km downstream, from where most of the major shifts in the position of the channel originated after 2009. The findings also highlight the role of climate in the geomorphic evolution of the landscape as years of higher-than-average temperature in the last decade coincided with the most significant shifts in the system. Overall, the analysis provides compelling evidence of the significant impacts that extreme events have on the extrinsic and intrinsic thresholds of a system, emphasizing the need to incorporate volcanic eruptions as essential components in landscape genesis.

Keywords: geomorphology, glaciofluvial, volcanoes, remote sensing

Detection of paraglacial sediment supply using detrital 10Be in postglacial landscapes of southwest British Columbia.

Lizzie Dingle[1], Erin Seagren[2], Aaron Steelquist[3], Julia Carr[2], Isaac Larsen[4], Jeremy Venditti[2]

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The legacy of glaciation persists for thousands of years in postglacial fluvial landscapes, where paraglacial sedimentation produces distinct patterns of downstream sediment yield that can mask signals of primary landscape denudation (i.e., bedrock incision). The timescales over which this legacy persists are difficult to quantify without detailed information on fluvial sediment load or landscape denudation rates. Here, we present 33 new 10Be-derived basin averaged denudation rates to explore spatial patterns and rates of landscape denudation in the lower Fraser River basin in western Canada. We combine this with automatically mapped paraglacial terrace distributions and present a sediment mixing model to assess the extent to which reworked paraglacial terrace sediment contributes to landscape denudation. We find that estimated denudation rates are largely invariable along a ~320 km reach of the lower Fraser River at ~0.22 mm yr-1 despite a near doubling in drainage area and extensive paraglacial terrace fill distribution. Basin-averaged denudation rates are weakly correlated with landscape morphometry (e.g., slope, channel steepness) and climate. To reproduce the observed changes in absolute 10Be concentrations along the ~320 km reach, paraglacial terrace sediment contributions to the modern Fraser River sediment load must be limited to a maximum of ~15%. We attribute the low paraglacial sediment input to limited connectivity between terrace fill and the main stem Fraser River channel which is now incised into bedrock. Our results indicate that basin-scale paraglacial effects should diminish once channels re-incise into bedrock and terrace fills become disconnected from lateral river channel erosion.

Keywords: Cosmogenic radionuclides, sedimentation, fluvial geomorphology

Discovery of lithospheric drip explains topographic rejuvenation of the Uinta Mountains, USA

Adam Smith

Adam G G Smith[1], Matthew Fox[1]; Scott R. Miller[2]; Leif S Anderson[2]; Matthew C Morriss[3];

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[3]Utah Geological Survey

Densification at the base of thickened crust drives lithospheric dripping or delamination. Mountain ranges form due to crustal thickening, and so represent locations where dripping and delamination are likely to occur. Recent studies have implicated dripping continental crust with a variety of different surface expressions, from driving surface uplift to initiating rifting, highlighting the uncertainty associated with our ability to predict the surface consequences of dripping continental crust. The Uinta Mountains in Utah formed during the Laramide orogeny, and despite this period of crustal shortening ending ~50 mya, the elevation of the range, and the form of the river networks draining the range suggest the range has undergone topographic rejuvenation. To investigate the cause of this rejuvenation, we extract map of recent surface uplift from the river networks of the Uintas, and use previously published seismic tomography to investigate the structure of the mantle beneath the range. We identify dripping lithospheric crust beneath the Uintas, and, using a simple isostatic model, are able to reconcile the observed surface uplift with a prediction of surface uplift based on isostatic compensation. The agreement between our observations and our predictions allow us to present a compelling case for delamination driven surface uplift of the Uintas, and show that simple isostatic compensation can explain the surface expressions of delaminated crust. Our observations therefore have important implications for the history of the Uinta Mountains and more generally for our understanding of the long-term evolution of the continents.

Keywords: Tectonic Geomorphology, Inverse Modelling, Surface Uplift

Deplete and Retreat: constraining glacio-hydrological processes and systems across the Andes.

Bethan Davies[1], Owen King, Tom Gribbin, Jeremy Ely, Claudio Bravo, Wouter Buytaert, Jonathan Carrivick, Alejandro Dussaillant, Ines Dussaillant, Fabien Drenkhan, Juan-Luis García, Iñigo Irarrázaval, Tom Matthews, Nilton Montoya, Robert McNabb, Baker Perry

Newcastle University

The food and water security of 90 million people depends on the Andean Mountain water tower, which is at risk in several regions because climate change is depleting the stores of water held in high altitude wetlands, lakes, snow and glacier ice. These cryospheric changes are spatio-temporally complex; snowfall amounts are declining but are increasingly delivered in extreme events, and glacio-climatic feedbacks modulate glacier mass loss. Understanding the changing role of the cryosphere and wetlands (bofedales) in catchment hydrology is vital for long-term water resource management. However, there is a void of data over the Andes, especially at high altitudes and latitudes. The spatial and temporal coverage of observational data limits our ability to understand changes across the Andes. In “Deplete and Retreat: the future of the Andean Water Towers”, we are upskilling model ability by combining state-of-the-art regional climate, ice flow and hydrology models, evaluated against newly collated datasets including glaciology, climate, glacier mass balance and glacier landsystems. Here we present initial empirical findings gathered from catchments across the Andes.

Keywords: Andes, glaciers, water resources

Constraining the extent of the Greenland Ice Sheet during past warmer climates: insights from subglacial geomorphology.

Guy J. G. Paxman[1], Kirsty J. Tinto[2], Jacky Austermann[2], Stewart S. R. Jamieson[1], Aisling M. Dolan[3], Michael J. Bentley[1]

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The Greenland Ice Sheet is a key contributor to contemporary global sea-level rise, but its long-term history remains highly uncertain. The landscape covered by the ice sheet comprises ~79% of Greenland and is one of the most sparsely mapped regions on Earth. However, sub-ice geomorphology offers a unique record of environmental conditions prior to and during glaciation, and of the ice sheet's response to changing climate. Here we use ice-surface morphology and radio-echo sounding data to identify, and quantify the morphology of, valley networks beneath the Greenland Ice Sheet. Our mapping reveals intricate subglacial valley networks beneath the ice-sheet interior that appear to have a fluvial origin. By contrast, in the southern and eastern coastal highlands, valleys have been substantially modified by glacial erosion. We use geomorphometric analysis and simple ice-sheet model experiments to infer that these valleys were incised beneath erosive mountain valley glaciers during one or more phases of Greenland's glacial history when ice was restricted to the southern and eastern highlands. We infer that this valley incision primarily occurred prior to the growth of a continental-scale ice sheet, when Greenland's contribution to barystatic sea level was up to +7 metres relative to today. Our findings therefore provide new data-based constraints on early Greenland Ice Sheet extent and dynamics that can serve as valuable boundary conditions in models of regional and global palaeoclimate during past warm periods that are important analogues for climate change in the 21st century and beyond.

Keywords: glacial erosion; ice sheet; landscape evolution

Cuchlaine King Symposium

Wednesday 4th September

Himalayan sediment bombs: understanding catastrophic sediment transport events.

Kristen Cook

Université Grenoble Alpes

The Himalaya are subject to frequent geomorphic disasters, including landslides, debris flows, and extreme floods. These are often considered as separate processes, but extreme events can incorporate all of these processes and blur the boundaries between them. This can be demonstrated by several recent events in the Himalaya that have involved extreme discharges, flood-driven slope failures, and highly concentrated flows. These events are notable for catastrophic sediment mobilization and deposition, with the largest involving more than 200 million m3 of material. I will discuss two of these events, the 2021 Melamchi hazard cascade, and the 2023 Teesta River glacial lake outburst flood (GLOF), which had very different causes and triggers, but remarkably similar impacts and geomorphic and sedimentary signatures. The Melamchi event resulted from heavy rainfall in the headwaters, and appears to have initiated as a highly concentrated flow. In contrast, the Teesta River event originated as a major GLOF event, with the very rapid release of ~50 million m3 of water from a moraine dammed lake, followed by the downstream incorporation of sediment largely through lateral erosion and slope failures. Both of these events resulted in massive aggradation over 10s to 100+ km of channel downstream of the zone of erosion. These deposits are very distinctive, with both events producing extremely angular and poorly sorted deposits containing far-traveled clasts. The sedimentology and the volumes of transported material indicate that both of these events reached extremely high sediment concentrations and should not be considered as water floods. Our observations suggest that standard hydraulic and sediment transport modeling may be inadequate for understanding and anticipating such extreme events, and that the geomorphic processes that occur during flow propagation cannot be neglected in flood modeling and hazard assessment.

Warm storms drive sediment export from high-elevation Andes.

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Mountain regions are warming at twice the rate of the global average, exposing them to retreating glaciers, thawing permafrost, snowmelt and changing precipitation patterns. We present evidence from the Rio Teno, Chilean Andes for warm winter storms caused by atmospheric rivers, which generate extreme rainfall and rapid snowmelt at altitude, driving 1) coarse sediment export from high elevations over a single extreme event and 2) fine sediment export from high elevations over a 50-year time series.

To observe sediment mobilisation, we trace coarse sediment sources using the composition of each clast's secondary mineral assemblage, i.e. their type of hydrothermal and supergene alteration. Repeat sampling of gravel composition along the length of the Rio Teno, before and after an extreme flood event in June 2023, revealed mass transport of clasts rich in iron oxides sourced from high elevation, transported > 15 km downstream of the mountain front. Combining an analysis of suspended sediment trends over five decades with a catalogue of warm storm events and satellite datasets, we find sediment yield estimates strongly enhanced during warm storms and significantly elevated during warm storms that follow landslide events in deglaciated valleys. This suggests climate changes at high elevation are not only important for enhancing glacial retreat but also for mobilising sediment downstream catastrophically during extreme events, and subsequently driving rapid channel evolution downstream. As warm storms are forecast to become more frequent over the next century, there is an important and, as yet, unconstrained risk for downstream communities in the central Andes and likely other arid regions globally, with significant implications for potable water supplies, the operation of hydroelectric turbines, river health and bank erosion.

Keywords: Coarse sediment, Andes, Climate, Hazard

The origin and hazard of catastrophic debris flows.

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Extremely large (catastrophic) debris flows are amongst the most fatal landslides on Earth. Only a few hundred debris flows exceeding one million cubic metres in volume have been recorded historically. This rarity means that we lack a systematic understanding of how these extremely large debris flows originate and often fail to account for these events in hazard models.

In this talk, we seek to understand the origin and hazard of catastrophic debris flows using both a historical global distribution and a unique dataset of 37 catastrophic debris flows triggered following the 2008 Mw 7.9 Wenchuan earthquake. Globally, we find that catastrophic debris flows are distributed in high relief mountains, triggered by large volumes of water (or ice), in areas with excess sediment often generated by volcanic or earthquake activity. In Wenchuan, catastrophic debris flows originated in catchments with high volumes of earthquake-triggered landslide sediment at a higher frequency than expected. Using the 2D debris flow model Massflow, we demonstrate that the volume of sediment within a catchment limits the ability of flows to become extremely large. We therefore infer that the high volumes of coseismic sediment explain the high frequency of catastrophic debris flows observed in Wenchuan. Catastrophic debris flows remain a major cascading effect of large sediment generating events and thus pose significant hazards to recovering local communities.

Keywords: Catastrophic debris flows, landslides, hazard

UK Coastal HAzards, Multi-hazard Controls on Flooding and ERosion (CHAMFER).

Andres Payo

British Geological Survey

Land, rivers, oceans, the seabed, atmosphere, and humans all converge at the coast. While much research has focused on these elements individually, understanding their combined impact on coastal flooding and erosion remains a major challenge in environmental sciences. Climate change is expected to increase the occurrence, intensity, and impact of coastal flooding and erosion. However, future changes in sea level, storms, pluvial and fluvial inputs, coastal habitats, and their interactions create significant uncertainties with major socio-economic consequences. How will various terrestrial and marine factors interact to control future coastal flooding and erosion? Issues with traditional coastal defences have led to advocating "natural solutions" using coastal habitats. What will their future vulnerability and effectiveness be, especially on coasts already partially protected by engineered defences?

Andres, the Head of the Coasts & Estuaries geohazard area at the BGS, aims to integrate national outputs to better understand the effectiveness of Nature-Based Solutions for managing coastal flooding and erosion risks across Great Britain. This involves numerical simulations of local inundation, morphological change, and coastal erosion for diverse coastal typologies in GB. In this talk, Andres will present the challenges and preliminary results of this ongoing project.

More information: https://projects.noc.ac.uk/chamfer/

Talk Session 5

Thursday 5th September 09.00-10.15

Kirkby Award: Sediment controls on the morphology of steep channels, a journey from fractures to fans.

Alexander Neely[1], Roman A. DiBiase[2]

[1]University of Tübingen

[2]Pennsylvania State University

Forecasting when, where, and how much sediment leaves mountains requires relationships among hydrologic forcing, sediment supply, and sediment mobility in steep channels. Between 2016 and 2021, we mapped sediment grain sizes throughout 3 mountain ranges in southern California and calculated discharges needed to move sediment by in-channel mass-wasting or fluvial entrainment in steep, 3-40° channels. Sediment supply and grain size in catchments varies 1-2 orders of magnitude between adjacent tributaries and surrounding wildfires, demonstrating the complexity of sediment production and routing through steeplands. Still, with >38,000 individual clast size measurements, patterns relating steep channel morphology and sediment emerge.

In landscapes unaffected by recent wildfire, channel networks show downstream transitions from (1) steep, nearly-constant gradient headwater channels, where bed sediment cover coarsens downstream and is mobilized by in-channel mass-wasting processes that widen channels, and (2) gentler, longitudinally-concave channels, where bed sediment cover fines downstream and is preferentially mobilized by fluvial entrainment. Steep headwater channels reach maximum reliefs of ~1 km and lengthen with coarser hillslope sediment supply, independent from catchment averaged erosion rates. We interpret downslope coarsening in headwater channels to reflect hillslope sediment transport by non-local processes, such as rockfall or landslides, and suggest that headwater channel length is set by a grain size dependent fluvial entrainment threshold. In each landscape, the coarsest sediment was seen at the transition between mass-wasting and fluvial channels, reflecting a bottleneck in sediment rouging through steep watersheds that is emptied during the largest storm events or following landscape disturbances such as postfire debris flows.

Keywords: sediment, debris flow, river, hillslope, erosion

Transformations in Exposure to Debris Flows in Post-Earthquake Sichuan, China.

Isabelle E. Utley[1], Tristram C. Hales[2], Ekbal Hussain[3], XuanMei Fan[4]

[1]University of Bath

[2]Cardiff University

[3]British Geological Survey

[4]State Key laboratory of Geohazard Prevention, Chengdu University of Technology[4]

Post-earthquake debris flows can exceed 1x10^6 m³ and pose significant recovery challenges. These stochastic hazards occur when monsoonal rain remobilises coseismic landslide material, particularly threatening recovery areas situated downslope. We investigate the relationship between changing exposure and hazard of post-2008 debris flows in three gullies chosen based on the number of post-earthquake check dams: Cutou (2), Chediguan (2), and Xiaojia (0). Using high-resolution satellite images, we developed a multitemporal building inventory from 2005-to-2019 and compared it with the spatial distribution of past and modelled future debris flow events. Post-earthquake urban development increased exposure to a major debris flow in 2019, impacting 40% and 7% of structures in Cutou and Chediguan respectively. We simulated future debris flow runouts using LAHARZ for three volumes: 10^4 m³ (low), 10^5 m³ (high), and 10^6 m³ (extreme). Our simulations show that under the extreme scenario, 59% of buildings in Cutou would be inundated, followed by 22% in Chediguan and 33% in Xiaojia. Check dams were effective for low and high-volume flows but ineffective for extreme events. We verified our analyses with a statistical exposure model adapted from a social vulnerability equation. Cutou's exposure increased by 64% in 2019, Chediguan's by 52%, and Xiaojia's by 2% in 2011 highlighting that more extensive grey infrastructure correlates with higher exposure to extreme debris flows, but less so to smaller events. Our work suggests that in these catchments check dams increase the perception of exposure reduction downstream, ultimately producing a levee effect where exposure to large events increases.

Keywords: Debris Flows, Built Environment, Exposure, Check Dams, LAHARZ

Using analogue experiments to assess the impact of sediment supply and base-level fall rate on knickpoint morphology.

William J. Norriss[1], Edwin R. C. Baynes[1], John Hillier[2], Dimitri Lague[2], Phillipe Steer[2], Laure Guerit[2]

[1]Loughborough University

[2]Universite de Rennes

Knickpoints are prominent geomorphic features, and despite being localized (i.e. 10s of m) within longitudinal river profiles they profoundly influence landscape evolution. Thus, a thorough mechanistic understanding of knickpoint dynamics is imperative to understanding landscapes, yet the study of knickpoints remains limited. While previous research has focused on the transient channel dynamics governing knickpoint retreat rates, studies elucidating the determinants of knickpoint morphology have received comparatively less attention. The Bedrock River Experimental Incision Tank at the Universite de Rennes was used to perform 18 analogue experiments to provide a comprehensive dataset assessing the relative impact of sediment supply and base level fall rate on knickpoint morphology. Experiments were conducted with uniform and homogenous lithology, constant water discharge (1.5 l min-1), sediment supply ranging from 0 g l-1 to 20 g l-1, and base-level fall rates between 1.5cm hr-1 and 5cm hr-1. We find that knickpoint retreat exists between two end member states: knickpoint replacement and headward migration. It is illustrated that sediment supply impacts the channel's ability to diffuse the knickpoint lip, whilst protecting the base, and base-level fall rate impacts the time the channel has, to tend towards headward migration. Furthermore, we construct a phase diagram to illustrate the intricate interplay of sediment supply and base-level fall rate in shaping knickpoint morphology. This study provides a useful insight into key controls on knickpoint morphology and provides a starting point for accurately modelling how knickpoint morphology varies as it migrates through a channel system.

Keywords: Knickpoint morphology, analogue experiments, landscape evolution, sediment supply, base-level fall, fluvial geomorphology

Deciphering the morphology and formation processes of freshwater tufa barrages.

Luca Mao[1], Kristen Beck[1], Mario Borrelli[2], Edoardo Perri[2]

[1]University of Lincoln

[2]Università della Calabria

Tufa is a solid precipitation of calcium carbonate that in fluvial environments take the form of a calcareous concretion on sediments, wood and other surfaces in contact with water. The process of tufa deposition depends on specific physicochemical characteristics of water (high saturation to calcite), particular hydrodynamic conditions favouring oxygenation, and the role of the microbial biofilm in the induction of the mineral precipitation. Tufa deposition can profoundly determine the morphology of streams because can accumulate in very large barrages, and also creating stable staircaselike sequences of barrages similar to step-pools units in mountain streams, increasing the resistance to flow. From a geomorphological point of view, tufa deposition on surface sediments can stabilize the bed by cementing grains to each other, increasing considerably the shear stress needed for the entrainment of sediments. We surveyed the longitudinal profile of two streams, the Parmenta and Cisso streams in Calabria (Italy) and the Dunston Beck in Lincolnshire (UK), both featuring sequences of tufa barrages and associated pools. The geometry of each tufa barrage surveyed in the field (height, spacing, width, slope, depth and length of pool) allowed to derive parameters such as the steepness factor, relative submergence with respect to the complex bed irregularity, and spacing relative to bankfull width. The geometric relationships are close to those observed in streams with step-pools, even though grain size is not a relevant parameter since the grains are not movable given the fact that they are mostly cemented by tufa deposition. Preliminary analysis suggests that the stable configuration of tufa barrages may be determined by energy dissipation (form roughness) and flows higher than those able to move sediment, but rather flows competent to disrupt tufa barrages. These geometric relationships can be used to design leaky barriers generating the hydrodynamic conditions that would favor tufa deposition in streams with naturally occurring deposition of tufa.

Keywords: tufa, barrages, step-pool geometry, form resistance

Talk Session 6

Thursday 5th September 11.00-12.15

Terrestrial Laser Scanning for forest geomorphology.

Stuart W.D. Grieve[1], Harry J.F. Owen[2]; Paloma Ruiz-Benito[3]; Emily R. Lines[2]

[1]School of Geography, Queen Mary University of London

[2]Department of Geography, University of Cambridge

[3]Department of Life Sciences, University of Alcalá

Sediment transport in forested landscapes is governed in part by the feedbacks between biotic and abiotic processes. Trees shape landscape form gradually via root growth and tree throw and rapidly through landsliding and debris flows, where spatial variability in root properties modulates slope stability. Landscape morphology controls the availability of water, light and nutrients, driving significant variability in the structure and composition of forests across scales. A limitation of many studies exploring these feedbacks has been a lack of high resolution data of tree and landscape morphology, with many ecological studies simplifying landscape form, and many geomorphology studies simplifying forest properties.

Recent developments in Terrestrial Laser Scanning (TLS) have unlocked our ability to quantify landscape and forest structure at unprecedented spatial scales, resolving individual branching structure and fine scale microtopographic variability in tandem. We have applied this technology to a collection of forest plots across Europe, capturing data across a climate gradient, and representing a broad range of species distributions and landscape forms. Using these data we segment individual trees, and compute individual, species, and regional level metrics, coupling these with high resolution topographic data to explore the feedbacks between biotic and abiotic processes which modulate landscape morphology in forested ecosystems across Europe.

Keywords: Forest, hillslope, lidar, terrestrial laser scanning.

The Application of Webcams to Create High-Frequency Digital Elevation Models of the Intertidal Zone.

Owen C. James[1], Daniel Schilllereff[1], Stuart Grieve[2]

[1]King's College London

[2]Queen Mary University London

Beaches and shorelines are important economic and cultural assets and diverse and rich habitats for marine and terrestrial biota. Monitoring these regions is therefore of key importance to stakeholders throughout society. Intertidal beach morphology is dictated by numerous variables that include but are not limited to: wave height and direction, wave energy flux, tides, wind speed and direction and geology. These variables drive morphological changes across multiple spatio-temporal timescales, ranging from micro (seconds/minutes-mm/cm) to mega (decade/century-regional). To model large-scale changes across greater time periods, knowledge transfer between scales is necessary. This requires improved analysis of daily or event-driven coastal change and the effects that oceanographic variability throughout time may have. However, high-frequency morphological data is often unavailable due to expensive manpower and equipment costs associated with traditional methods such as RTK-GPS or Airborne LiDAR. Video imagery has regularly been used to analyse coastal processes using specialised Argus Stations with Aarninkhof et al. (2003) producing a method to map intertidal topologies across a tidal cycle, producing accuracies of ~30cm. Improvements in camera quality, 4G wireless internet speeds, machine learning tools and nearshore wave models offer opportunities to remotely create accurate high-frequency digital elevation models at limited cost with limited user input. This work aims to develop a methodology using novel equipment development and processing pipelines to create daily elevation models of the intertidal zone at Tenby North, Pembrokeshire, Wales. The data created from this methodology will be tested against topographic data collected using RTK-GPS across a series of survey dates.

Keywords: Beaches, Intertidal, Morphology, Elevation Models, Image Processing.

Using archival visual sources for reconstructing geomorphological changes across the mid Wales coastal uplands: challenges and opportunities.

Stephen Tooth[1], Courtney Goode[1], Hywel M. Griffiths[1], Tristram D. L. Irvine-Fynn[1], Dewi Roberts[2]

[1]Aberystwyth University

[2]Independent researcher and freelance educations advisor

Given rapid environmental changes worldwide, analysis of the processes, patterns, and rates of landscape change is an ever more urgent task. In geomorphology, and across the wider geosciences and ecology, increasingly sophisticated short-term change monitoring approaches (e.g. photogrammetry, LiDAR, drone imagery) can be complemented by archival visual sources that extend timelines back several hundred years. Here, we report on how maps, geological sketches, paintings and early photographs are helping to reconstruct geomorphological changes across mid Wales during the last 100-150 years. We focus on two contrasting contexts: i) bedrock rivers, where changes to waterfalls, gorges and potholes are negligible over this timescale; ii) bedrock coastal sections, where changes to clifflines and shore platforms are relatively rapid. At our coastal sites, a combination of archival sources has helped solve a local mystery regarding the location and date of disappearance of a prominent coastal stack (Tŵr Gweno/Egg Rock) that formed a Victorian tourist attraction, and also is providing new insights into late Quaternary shoreline development. Potential for wider use of archival visual sources exists but challenges include sourcing well-dated, high-quality visual images to enable establishment of robust timelines of change, and safely accessing potentially hazardous locations to enable re-photography. If these challenges are surmounted, opportunities include enhanced potential for: i) providing quantified landscape change case studies for inclusion in school/university geoscience syllabi; ii) demonstrating the relevance of geomorphology for local/regional natural and cultural heritage; and iii) enhancing public engagement with geomorphology (e.g. through citizen science projects or science-art collaborations).

Keywords: archival sources, education and outreach, geoheritage, geomorphological change, science communication

Influence of alluvial slope on avulsion in river deltas.

Octria A. Prasojo[1], Trevor B. Hoey[2], Amanda Owen[1], Richard D. Williams[1]

[1]University of Glasgow

[2]Brunel University

Changed hydrological regimes, sea-level rise, and accelerated subsidence are all putting river deltas at risk across the globe. One mechanism by which deltas may respond to these stressors is that of avulsion. Decades of delta avulsion studies have resulted in conflicting hypotheses that avulsion frequency and location are primarily controlled by upstream (water and sediment discharge) or downstream (backwater and sea-level rise) drivers. Here we use Delft3D morphodynamic simulations to test the upstream-influence hypothesis by varying the initial alluvial slopes upstream of a self-formed delta plain within a range (1.13x10-4 to 3.04x10-3) representative of global deltas and recording avulsions, while leaving all other parameters constant. Avulsion timing and location were recorded in six scenarios modelled over a 400-year period. We measured independent morphometric variables including avulsion length, delta lobe width, bankfull depth, channel width at avulsion, topset slope and sediment load and compare these to natural and laboratory deltas. We find that larger deltas take more time to avulse as avulsion timing scales with avulsion length, delta lobe width and bankfull depth. More importantly, we also find a strong ($p<0.05$) negative correlation between delta topset slope and avulsion timescale. We argue that topset slope is directly dependent on the varying upstream alluvial slope which determines sediment supply to the delta. Increases in upstream alluvial slope raise transport capacity so bringing more sediment into a delta plain, leading to higher aggradation rates and, consequently, more frequent avulsions. These results induce further debate over the role of downstream controls on delta avulsion.

Keywords: delta, avulsion, numerical model

How do we define academic success amidst a climate and environmental crisis?

Lucy E. Clarke[1], Erin L. Harvey[2], Daniel N. Schillereff[3], Stephen Tooth[4], Heather A. Viles[5]

[1]Nottingham Trent University

[2]Durham University

[3]King's College London

[4]Aberystwyth University

[5]University of Oxford

The academic geomorphological community is well acquainted with the reality of the current climate and environmental crisis. In addition to 'core' research, teaching, administration and academic citizenship activities, arguably there is a need for institutions and individual academics to take a lead in responding to this crisis. Given this context, what mix of activities could or should constitute academic success? This presentation is based on a dialogue between five UK-based academic geographers who collectively span different career stages from postdoctoral researcher to professorial.
We discussed three core questions:

1) how do we define academic success in the context of the climate/environmental crisis?

2) given the routine, and often escalating, demands of our jobs, do we feel we have the capacity to address whatever the appropriate measures of success may be?

3) do we feel that the measures of success are appropriately valued by our colleagues and institutions?

Key questions that emerged from the conversation include: How is academic success portrayed today? What value is given to work on tackling the climate and environmental crisis? What actions are institutions taking? How to prioritize actions within limited workload capacity? Are geomorphologists visible enough in discourse on this topic? How does public engagement on the climate and environmental crisis fit within the traditional breakdown of academic responsibilities? We welcome discussion of our recommendations within the wider geomorphological community.

Keywords: climate crisis, academic success, career stage, impact, public engagement

Talk Session 7

Thursday 5th September 14.15-14.30

Removing barriers from our rivers. What are the pros and cons?

John Boardman[1], Ian D. L. Foster[2]

[1]University of Oxford

[2]University of Northampton

There is much debate over the need to create ‘free flowing rivers’ and there are especially good ecological reasons for doing so. European Commission Biodiversity Strategy aims for ‘25,000 km of free-flowing rivers by 2030’. Many of the arguments focus on the movement of migratory fish. In France and the USA, barrier removal has made significant progress compared to the UK. However, there are reasons to be cautious. Many barriers have cultural, historic and flood protection significance. Geomorphologically, barriers often store large quantities of sediment which on release would have ecological consequences. We use as a case study of these issues, the Western Rother in southern England.

Keywords: river barriers, sediment, connectivity, stakeholder debate

The importance of connectivity in sustaining the dynamics of oxbow lakes.

Joshua Ahmed[1], Savannah Worne[2], Joshua E. Johnson[1], Reinaldo C. Bravo[3], C. M. Azogue Jiminez[3], Jesús Y. Ichu[3], Daniel R. Parsons[2]

[1]University of Hull

[2]Loughborough University

[3]Universidad Autónoma del Beni

Oxbow lakes serve as rich habitats for wildlife, natural contaminant filters, and an essential source of sustenance and prosperity for riverine communities around the world. Despite their significance, little is known about their interannual hydrological variations, how these are controlled, and the impact they have on lake physiochemistry. Without an understanding of how these environments currently function, it will be challenging to protect them from the pressures of climate change and land use conversion, thus threatening their ability to deliver a range of ecosystem services in the future. Data from 76 recently formed (1984-2022) oxbow lakes along two near-pristine Amazonian tributaries in Bolivia are presented to evaluate the role of rainfall and channel connectivity in driving variations in water surface area (WSA) over interannual timescales. These results were extracted from multispectral satellite imagery using a range of semi-automated workflows leveraging a range of band rationing techniques. Over interannual timescales, lakes were observed to diminish by up to 97% and increase by over 200% relative to the WSA in the previous year. We find that these changes are primarily controlled by proximity of the mainstem channel to the lake, and that tie channels are critical for sustaining nutrient-rich contributions to the lakes. Changes in hydro-climate, flow regulation, and land use will alter these key hydrological controls in fluvial systems, thus potentially altering the functioning of lakes in the future and threatening those communities who rely on the lakes for survival.

Keywords: oxbow lakes; meandering; remote sensing; hydrology

Let the riverscape grow! Post-restoration wood dynamics in a restored Scottish upland gravel-bed river.

Lucy J. Daniels[1], Richard D. Williams[1], Laura Quick[1], Maggie J. Creed[1], Craig J. MacDonell[1]

Glasgow University

To improve riverscape health and resilience, river restoration schemes across Scotland have increased in number in recent years, particularly those which utilise in-channel large wood (LW) and riverscape planting. Despite the popularity of LW, long-term (>10 years) empirical evidence on its geomorphic influence in Scottish river restoration is limited. To address this gap, this research aims to answer the question: How is wood influencing the adjustment of the Allt Lorgy riverscape post-restoration? Allt Lorgy, Carrbridge was restored in 2012 using a process-based approach through the removal of embankments, placement of in-channel LW and the construction of a deer fence. To date, repeat high-resolution topographic surveys have been undertaken every 1-3 years post-restoration using RTK-GNSS, Total Station, and Unpiloted Aerial Vehicle Structure-from-Motion photogrammetry and LiDAR to construct 0.2 m DEMs. These have been fed into Geomorphic Change Detection software and the Geomorphic Unit Tool to quantify geomorphic change, and map geomorphic unit development associated with in-channel LW. Mapping of riverscape regeneration was undertaken in March 2024 to contextualise LW dynamics within the riverscape ethos. Results indicate that placed LW plays a key role in developing stable in-channel depositional features, encouraging lateral migration in the mid-reach. LW is naturally recruited upstream by bank erosion, and downstream via an avulsion. Deer fencing has encouraged riverscape-wide tree regeneration, ensuring a future supply of large wood to the channel. The results from this work will contribute towards the need for long-term empirical, geomorphological studies on LW and riverscape regeneration within the process-form-habitat-biota continuum.

Keywords: river restoration, large wood, riverscape, high-resolution topography

Drivers of channel morphology in semi-alluvial boulder-bed rivers and implications for river restoration.

Richard J. Mason[1], Lina E. Polvi[1]

Umeå University

Fluvial geomorphology has focussed on alluvial sand and gravel-bed channels. However, many rivers worldwide are semi-alluvial, constrained by boulders, bedrock or clay, and knowledge of fundamental processes in these rivers is critically lacking. We aimed to understand the controls on river form and process in semi-alluvial boulder-bed rivers in northern Sweden; in particular, the relative roles of fluvial processes versus the boulder legacy of Pleistocene (de)glaciation. Additionally, we explore the implications of these findings for river management. We first identified 20 boulder-bed river sites minimally impacted by humans and conducted morphological surveys to infer the level of fluvial control. Further, we monitored hydromorphological response of 8 river sites to process-based restoration, over a 3-year period. Our results indicate that river channel morphology is predominantly controlled by legacy glacial landforms, including boulders, with alluvial processes operating within this relatively immobile template. This was indicated by a lack of self-organisation at the reach scale (e.g. between river width, depth and slope) and the low occurrence of clustered boulders. Together, the studies indicate that restoration of semi-alluvial rivers needs to consider local geomorphic processes, and that traditional alluvial river management approaches may not be appropriate. For example, process-based restoration typically aims to reduce constraints on river processes but in semi-alluvial rivers these constraints are integral to the system. In semi-alluvial rivers, restoration should restore static non-alluvial templates, such as boulder cascades, while promoting alluvial processes within these constraints.

Keywords: river, restoration, alluvial, management, sediment, boulder

Posters

Geomorphological impacts of large woody debris during the 2009 and 2015 floods, River Derwent, Cumbria, UK

Andrew J. Russell[1], Andrew R.G. Large[1]; Stuart A. Dunning[1]; Matthew T. Perks[1]

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Modelling of flood inundation area and hydraulics requires knowledge of river channel characteristics such as cross-sectional area, shape and individual roughness elements. The acquisition, transport and deposition of Large Woody Debris (LWD) during floods can alter local, cross-sectional and reach scale flow hydraulics leading to significant channel change generating increased flood risk.

This paper examines the geomorphological impacts of LWD during the record breaking 2009 and 2015 floods on the River Derwent, Cumbria, UK. Reach-scale geomorphological change was characterised by pre- and post-flood ground (dGPS, Total Station and TLS) and airborne (aerial photography and LiDAR) surveys.

Timing of introduction of LWD during these floods was controlled by the exceedance of critical thresholds for debris entrainment via flotation or river bank and hillslope failure. Isolated grounded LWD acted as major obstacles to the flow resulting in classic obstacle marks. Denser accumulations of LWD resulted in flow deflection producing localised zones of river bank erosion. Numerous linear depressions eroded into cohesive flood plain sediments are interpreted as ‘tool marks’ associated with ploughing of the vegetated surface with the larger ones deepened and widened by processes of corrasion and fluid stressing. In places, linear scours convey water and sediment from the main channel across the flood plain allowing the development of upstream migrating knick points which result in channel avulsion.

Woody debris clearly exerts a major influence on flood flow dynamics and associated geomorphological response. Knowledge of woody debris acquisition during floods and erodibility of floodplain materials is crucial for management river corridors

Keywords: Large Woody Debris, Flood, Avulsion, Geomorphology

Litter in the Skye: wind blown microplastic transport and deposition on the Isle of Skye

Annie G. Dowse, Thomas Stanton, Joanna E. Bullard, Adrian Spencer

Loughborough University

As the ocean has generally been considered a sink for microplastics (1 µm – 5 mm), very few studies have investigated the potential aeolian movement of microplastics from the ocean onto land via beaches. In terrestrial environments, previous windblown microplastic studies have focused on fine-grained sediments, and in comparison, there have been no studies into the entrainment and transportation of microplastics over coarse-grained sediments. This project therefore aims to investigate the onshore aeolian movement of microplastics over coarse-grained beach sediments.

The significant plastic pollution, dominance of coarse-grained beach sediments, and potential for strong wind conditions on the Isle of Skye, Scotland, make it the ideal setting to observe this process. To identify the presence, quantity, and onshore transport of microplastics, a transect of sea-facing BSNE samplers will be used. These transects will primarily be located on gravel and cobble beaches where high densities of both macro and microplastics are reported in the inter-tidal zone. A transect of BSNE samplers will also be deployed on a sandy beach to compare the availability and transport of microplastics between the two types of beaches. Sediment cores will be collected from coastal peatlands to determine whether deposited microplastics are accumulating in adjacent coastal sediments. This project's findings will provide an understanding of the entrainment of microplastics from coarse-grained sediments. More broadly, findings will also provide an understanding of the transportation of microplastics in a coastal area that is significantly affected by plastic pollution, focusing on the role of aeolian processes.

Keywords: microplastic, aeolian, transport, entrainment, gravel

Uncovering Anthropogenic Hydrological Transformations in the Major Indian Peninsula Basin

Anubhuti Singh[1], Somil Swarnkar[1], Soumya Kundu[1] and Shivendra Prakash[2]

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Human activities have greatly changed the worldwide circulation of hydrological fluxes from land to ocean. These hydrological adjustments refer to changes in the volume, frequency, and duration of the natural river flows. Our study looks at the effects of human activity in the largest peninsular basin in India, the Godavari basin, specifically concerning the construction and operation of large-scale infrastructure. The Godavari basin is one of the most severely impacted basins in the world, with over 900 small and large dams constructed throughout. Therefore, assessing the scope and size of these human-induced modifications to the hydrological system is essential to assure sustainability over the long run. Our data analysis shows that the construction and operation of dams and reservoirs in the central Godavari region is the primary source of the large decrease in suspended material at the Godavari basin's outlet. Furthermore, smaller unrestricted tributaries have significantly reduced the negative effects of dams and reservoirs on the movement of suspended material to downstream regions during high-flow conditions. During high-flow circumstances, sediment movement occurred at a rate greater than 80%. It was also observed that constant construction of barrages in the downstream regions between Perur and Polavaram has significantly reduced the amount of suspended sediment movement to the downstream deltaic zones. This has raised the risk of coastal erosion and floods as the delta development process slows and sea levels rise owing to climate change. This work may help policymakers manage hydraulic infrastructure in the Godavari basin more effectively for long-term viability

Keywords: Suspended Sediment Load, Dams, Reservoirs, Godavari, India

Flood Risk Assessment in the Gandak Basin using multi-criteria decision analysis: A hydro-geomorphic approach

Arushi Jha[1], Naresh C. Gupta[1]; Bratati Dey[2]

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Flood represent one of the most destructive natural occurrences, causing significant and repetitive loss of life, property, and resources worldwide. In India the monsoon season poses a major flood risk, particularly in the flat Gangetic plains in the Himalayan foreland. Bihar stands out as one of the most flood-prone states in India, with about 76%of the population in north Bihar consistently facing the threat of the flood devastation. This region is particularly vulnerable due to its location at the outfall of the Himalayan catchment, weak geology, delicate ecosystem, steep slopes, and the the impact of heavy rainfall and snowmelt. The primary drainage in north Bihar is through two major rivers Kosi and Gandak, along with other smaller. Regarding the lower Gandak Plain, the challenges are particularly severe due to the presence of a vast mountainous catchment and a small plain basin, creating highly unfavourable conditions and resulting in substantial losses. This research assesses flood hazard and vulnerability separately and then combines these factors to evaluate flood risk in the Gandak watershed. Utilizing geomorphological, hydrological and socio-economic data, a GIS framework is employed along with the Analytical Hierarchy Process (AHP), a multi-criteria decision tool. This integrated approach is applied to generate a process based flood risk map for both Nepal and India (Bihar). The collected data undergo processing in the ArcGIS environment and the analytic hierarchy method to create a comprehensive flood danger map. The study reveals that approximately 34% of the area is susceptible to high and very high flood risk zones. Consequently, the findings suggest the implementation of regular and sustainable flood prediction, early warning, and management practices in the region.

Keywords: Flood risk reduction, Flood Hazard, Flood Vulnerability, Multi-Criteria decision making, Analytical Hierarchy Process

Spatio-temporal floodplain evolution under the influence of valley constrictions, lateral fan input, and reworking of glacial deposits and implications for upland river restoration.

Arved C. Schwendel[1], David J. Milan[2], Richard J.J. Pope[3], Richard Williams[4], Warren Thompson[5]

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Post-glacial evolution of upland floodplains has been influenced by temporal changes in vegetation, sediment supply and hydrological regime driven by climatic change, and more recently direct and indirect anthropogenic activities, e.g. deforestation, floodplain land use and channel modification. Current drives towards river restoration, often use floodplain topography as a guide to appraise such a planform state, however, reconstruction of former channel state is often restricted to surface features visible on historic maps and aerial photographs, an approach also taken for the recent planform realignment at upper Swindale Beck, Lake District, UK. This research shows the potential of Ground Penetrating Radar (GPR) to reconstruct a wider array of past channel pattern and evolution at a site characterised by largely aggradational conditions and consistent sediment supply from glacial deposits at the valley head. Analysis of GPR data from 40 intersecting GPR survey lines revealed several stratigraphic units, including gravel braidplains, berms, chutes and bars, several levels of larger channels and their layered fill as well as backwater deposits. GIS analysis allowed the interpretation of individual evolutionary stages, including braided systems, dynamic wandering planform and single-thread meandering systems with spatial transitions conditioned by alluvial fans supplying sediment and forcing channel migration. Such information can be particularly valuable for restoration projects to aid design of channel dimensions, planform configuration, channel gradient, vertical connectivity and connection with tributaries. GPR-based floodplain analysis provides a non-invasive approach to understand possible evolutionary trajectories and to appraise a wider range of climate-resilient restoration options and sustainable resources.

Keywords: Ground Penetrating Radar; Alluvial stratigraphy; Paleochannel reconstruction; River re-naturalisation; Geomorphological tools

Geolocating geomorphological landscapes: Acrostic solutions to track landsystem approaches to landform development

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Geolocating landforms by decimal latitude-longitude [dLL] not only identifies them uniquely but allows landform-landscape relationships to be explored. Observations are located in space/time and associated metadata (e.g. C14 dates) and adding [dLL] locations provides geolocation of information (e.g. literature citations, other data) uniquely compared to place labels alone. This simple device allows locations and transects to act as information stores (information tensors) where attributes (materials, processes and geometries) can be contained and used for comparisons of rates and material fluxes over time. Digital searchIng for [dLL] tensors can be undertaking when scientific literature is summarised in this manner. This paper summarises these tools with examples showing how they can be used in planetary geomorphology, (geomorphological) mapping for planning, geoconservation and for repeated measurements. Additionally, [dLL] locations accord with data from a variety of satellite/remotely sensed data and the FAIR data principles to improve data cost effectiveness. Burgeoning literature requires keeping track of information and using it across disciplines. Geo(morphologically)-referenced data should be at the forefront of Critical Zone Science for example. Using [dLL] maximises data availability for problem solving via various Machine Learning and data analytical methods. The principle of least action and Lagrangian approaches to landscape development can also be utilised by [dLL]. Information landscapes and landsystems can be built as acrostic puzzles around geolocated ‘points’ and ‘geomorphological units’ of 1m2. Examples presented include slopes and the denudation of the Derbyshire dome, valley incision, rockslide and extreme events and rock glacier formation.

Keywords: [dLL] geolocation, information tensors, FAIR data, Critical Zone Science

A GIS-based approach to site vegetated buffer strips for erosion control within an agricultural catchment in southern England

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Agricultural soil erosion is largely caused by intensified farming practices and greater mechanisation. Runoff from arable land and intensively managed grassland transports sediment and contaminants across the landscape and into watercourses, causing crop loss, land degradation, and water quality issues. A cost-effective and low-maintenance nature-based approach to alleviate these problems is the use of vegetated buffer strips (VBS); grassland along field margins designed to trap sediment and contaminants and reduce transportation rates. GIS modelling using terrain and land parcel data can help to identify priority areas for intervention from sub-catchment to farm scale.

Here, we present a user-friendly runoff risk model tested in the lower Rother catchment, West Sussex. The model uses the Normalized Difference Vegetation Index (NDVI) applied to satellite images as a soil erodibility proxy and identifies locations along pathways that are conceivably at greatest risk of sediment accumulation and transfer, guided by field observations. We analysed current and historical field boundaries near these high-risk areas, assessing the potential of their margins to mitigate runoff risks.

Our findings offer practical recommendations for implementing VBS and highlight the additional benefits of restoring historical field boundaries. This rapid assessment tool, with minimal data requirements, efficiently identifies critical sediment runoff locations and priority intervention sites. It can equip decision-makers with the necessary insights to effectively target and implement soil erosion and runoff control measures such as VBS, enhancing both agri-environmental outcomes and cultural heritage preservation.

Keywords: Sediment accumulation; runoff risk; GIS modelling; field boundaries; vegetated buffer strips; field margin restoration; soil erosion; erodibility

Geomorphology controls the establishment of and interactions between co-occurring high-priority invasive species.

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Geomorphic processes control the creation and maintenance of habitats, which in combination with the presence of other species, controls species colonisation and establishment. 'Invasion Meltdown Hypothesis' poses that established invasive species facilitate the establishment of further invasive species, but evidence for this at both the experimental and site scale is contradictory.

Using Environment Agency riverbed substrate data, we constructed a riverbed sediment grainsize model for England and Wales, and examined the co-occurrence of the well-established invasive mollusc Dreissena polymorpha (zebra mussel) with three invasive Ponto-Caspian amphipods (Dikerogammarus villosus, Dikerogammarus haemobaphes, and Chelicorophium curvispinum) in association with in-situ sediment grainsize. For all three amphipod species, substrate grainsize where amphipods co-occurred with D. polymorpha was finer than when recorded in isolation. Subsequently, we confirmed this via aquarium experiments with D. villosus and D. polymorpha. Experiments demonstrated that D. villosus actively sought shelter on or near D. polymorpha, with their co-location being more prevalent in finer grained substrates (sand > gravel > cobble) across three tested populations. D. polymorpha may therefore facilitate Ponto-Caspian amphipod establishment in otherwise suboptimal, fine sediment dominated locations, whereby mussel shells provide favourable structural habitat for the amphipods, analogous to the presence of coarse-grained sediment.

Our analyses show that interactions between the same invasive species differ depending on the geomorphic context. Therefore, not considering geomorphology in species interaction assessments may have resulted in previous contradictory results. Incorporating geomorphology into ecological toolsets, such as species distribution modelling, will be vital to understanding future species invasions and reintroductions.

Keywords: sediment grainsize; biogeomorphology; invasive species; rivers; fluvial geomorphology

Quantifying understorey vegetation dynamics along river corridors using environmental sensing techniques

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Despite the importance of vegetation in fluvial geomorphology and its influence on the aquatic-terrestrial transition zone, current research is dominated by an ecological perspective which misses the bi-directional processes present within the river corridor. Climate (light availability and temperature) and fluvial disturbance is thought to be the most influential factors influencing vegetation dynamics along river corridors. Yet, forestry-focused and a number of riparian studies tend to predominantly focus on trees, in particular characteristics such as canopy height and diameter at breast height, typically quantifying above ground biomass for estimating carbon storage. As such, there is limited attention given to the role of understory vegetation within fluvial systems, despite the important role they play in modulating overbank flow, stabilising banks, and sequestering carbon. This research aims to quantify how understorey vegetation varies seasonally along river corridors under different disturbance regimes and river types, quantifying the biomass of understory vegetation and its influence on flow. The structural complexity of riparian and floodplain understorey vegetation (<1m) is captured from a variety of methods to determine best practice. These include TLS scans, backpack LiDAR, alongside UAV-LiDAR, and UAV-RGB and Multispectral Imagery. TLS scans and Digital Hemispherical Photography (DHP) are used to capture the transition between below-canopy understory vegetation through to more open floodplain, enabling links between phenological cycles, light availability, and understory growth patterns to be explored in the context of fluvial disturbance. Fluvial disturbance is approximated from the spatial elevation data along with flow data from diver pressure transducers and EA gauging stations. The interactions between understory vegetation, fluvial disturbance, and subsequent morphology, can then be examined to identify the processes occurring within this section of the river corridor and how they vary in both space and time.

Keywords: Environmental sensing, Fluvial biogeomorphology, Phenology, Disturbance, River corridors

Local topographic and texture change around large wood on bars: implications for sediment transfer

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We analysed local morphological and grain roughness changes around pieces of large wood on the Allier River, France, between Nov 2020 and June 2022. Repeat terrestrial LiDAR was undertaken around several large trees positioned on their sides on dry bar surfaces, scanning the full tree structure and details of the local topography around the wood. Topographic and roughness changes were established through subtracting elevation and local roughness height grids. Trees 074B33 and 074ACC were recruited to the active channel following a high summer flood event of 600 m3s-1, and deposited together on a bar surface broadly aligned with the roots facing upstream to the flow direction. Between Nov 2020 and June 2021, a 560 m3s-1 flood failed to mobilise the two trees, however notable local topographic changes were evident; ~0.5 m of scour around the root, and deposition of ~0.4 m high lobes of sand and fine gravel within and around the branch structure. Zones of scour on the lee of the trees were also seen to have an influence for ~ 50m downstream. Net erosion of 19m3 was found in the zone of influence the trees. Grain roughness changes were also detected with coarsening coincident with scoured areas, and fining associated with depositional lobes. Both coarse and fine ribbons were also observed to extend from the lee side of the tree. Upscaling sediment budget information around trees on bar surfaces to larger reaches of the Allier, should improve understanding of the effects of large wood on sediment transfer dynamics.

Keywords: Large wood; DEM differencing, grain roughness, sediment transport, terrestrial LiDAR

Quantifying patterns of glacial erosion in Arctic landscapes

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Greenland currently hosts the fastest melting ice sheet, which is therefore a key contributor to 21st century sea-level rise. However, many uncertainties remain as to how the ice sheet will respond to further climate warming. Glacial landscapes of the past provide a window into ice sheet history through the recorded signature of past patterns of glacial erosion, which provides us with crucial data for calibrating models of future ice sheet change. Much of the information required for understanding Greenland's ice history still lies hidden beneath the modern ice sheet, limiting our understanding of its behaviour during past warmer climates. Nonetheless, advances in data collection - including a growing catalogue of ice-penetrating radar and high resolution surface elevation models - and data processing - including big data and machine learning approaches - can be used to address this problem. By applying a range of these techniques rigorously and creatively, the aim of this PhD project is to use quantitative metrics of landscape-scale geomorphology to characterise and map styles of glacial erosion across the Arctic, and to extend this understanding to the ice-covered parts of Greenland, in order to obtain information needed to constrain models of the Greenland Ice Sheet under warmer climate conditions than today.

Keywords: Greenland, glacial erosion, morphometry, landscapes, classification

Sediment Cascades and Climate Change' 2024 workshop: Insights into developing an inclusive research community

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A BSG network grant supported the first "Sediment Cascades and Climate Change" workshop in Los Queñes, Maule Region, Chile. This bilingual, interactive 4-day workshop aimed to establish new collaborations and research focused on enhancing our knowledge around geomorphic hazards and climate change. The 27 attending researchers came from South and North America and Europe, spanning the disciplines of geomorphology, hydrology, climatology, and geology, all with a shared interest in the workshop themes. The workshop featured invited talks, group discussions, team-building activities, a field excursion up the Rio Teno, and a "Meet the Local Community" event in Los Queñes. A key learning outcome of this event was recognising both the importance and practical challenges of building an inclusive research environment when bringing together researchers from different backgrounds and languages. In this presentation, we will provide more details about the workshop and plans for maintaining and further developing this new network and pursuing shared research goals.

Keywords: Networking workshop, geohazards, climate change

Understanding how reservoirs influence riverine ecosystem: Investigating ecosystem health in a changing climate

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This research investigates the threat posed by UK reservoirs as both recipients and sources of pollution to downstream river environments. Globally recognized for their vital ecological functions, reservoirs play key roles in water storage, flood control, hydroelectricity, and biodiversity preservation. In the UK, 274 reservoirs account for over 91% stored water resources.

Reservoirs, typically created by damming rivers, exhibit limited horizontal water movement, rendering them particularly susceptible to environmental and anthropogenic changes. They critically impact river systems through alterations to natural hydrology, sedimentation, and water chemistry, with compensation discharge delivering water and sediment downstream. Existing research identifies reservoirs as significant sinks for various pollutants, including legacy contaminants like PFAS, bisphenol analogues, and heavy metals. However, little is known about how these contaminants, once phased out, may re-enter water systems due to environmental shifts and reservoir operations.

To address this knowledge gap, this study combines field and laboratory analyses to characterize reservoir-river ecosystems. Sediment samples will be collected and analysed to create a chemical fingerprint and characterise chronological historical records of contaminants using 210Pb dating. Paleolimnological records will be examined alongside known contaminant phase-out dates to understand anthropogenic impacts. Analytical techniques such as extraction followed by chromatography tandem mass spectrometry will be employed to analyse sediments for compounds flagged by regulatory bodies.

The study aims to provide the first comprehensive assessment of overlooked contaminants in UK reservoir sediments, enhancing understanding of reservoir pollution's risks to ecosystem function, water quality, and human health, and informing management strategies to mitigate the adverse effects of reservoir pollution.

Keywords: Reservoir pollution, legacy contaminants, sediment chemistry, paleolimnology, contaminant desorption/re-suspension, downstream ecosystems

Future Coastal Change Predictions Using Satellite-Data-Driven Modelling

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Coasts are highly dynamic landscapes, currently being squeezed between encroaching land development and anthropogenic interference, and climate change driven sea level rise and storms which submerge and erode the shoreface. As these issues worsen, our understanding and management of coastal change needs to adapt, so we can become more resilient to these impacts. Modelling is necessary for generating repeatable predictions of short- to medium-term coastal change, to better prepare our coastal infrastructure and communities. Data-driven models require little prior knowledge of how different coastal processes interact, and are relatively simple in construction and computational demand. However, to make more robust predictions, these models rely on regular, repeated measurements of coastal change metrics to form an understanding of how a coast has been changing. The advent of publicly available satellite observations, and automated techniques for deriving coastal change information from them, now provides past information at the regularity and scalability required for successful data-driven modelling. Seizing upon this new opportunity for integration, and the recent democratisation of satellite imagery through cloud-based services, we present a data-driven framework for predicting coastal change, utilising solely satellite-derived change metrics for training. A Deep Learning approach is explored as it has been proven to perform well in forecasting short-term shoreface change using dense ground-based timeseries as training. The framework is then compared to a process-based model for benchmarking purposes. Machine learning models coupled with satellite-derived data may present a revolution in automated, scalable and efficient solutions for predicting and managing coastal responses to climate change.

Keywords: coastal change, erosion, climate change, satellite imagery, machine learning

Giving Voices to Rivers: Promoting Creative Engagements Through Art-Science Collaborations

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The world's rivers are vital for Earth system and societal functioning but are among the most abused and threatened features. If they could speak, what would rivers say about to their shape, size, water quality and ecology resulting from climate change, water abstraction, damming, dredging and pollution? Here we present initial reflections from the 'Giving Voices to Rivers' project which aimed to draw together various publics to discuss this common theme. By 'giving voices to rivers', we mean challenging commonplace views that rivers exist solely in the service of humanity, and adopting more river- or eco-centric views. By 'listening' from different perspectives (e.g. social history/culture, geology/geomorphology, ecology), what stories can rivers tell us, literally and figuratively? How can we then recite these stories to enhance appreciation of, and care for, rivers? Previous work has invoked various artistic approaches (e.g. compiling historical accounts, composing poetry, music or other artworks, making documentaries, and developing ethical environmental stances e.g. articulating 'river rights') and here we assess initial findings of four activities in the Afon Rheidol catchment, west Wales, that together, combine these elements : 1) a focus group of geomorphologists and artists discussing the concept and potential application of the 'voice of the river'; 2) an open day held on World Rivers Day 2023 during which various artistic and scientific activities were trialled; 3) a walking tour of Aberystwyth town, themed around hidden hydrological histories; and 4) a field workshop integrating arts and sciences held at a bedrock reach of the river.

Keywords: river, geomorphology, art-science, communication

Reconstructing late Cenozoic spatio-temporal patterns of Alpine topographic changes from glacial morphometric signatures and low-temperature thermochronology

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Improving our understanding of the timing, rates, and distribution of erosion across mountain ranges plays a key part in resolving longstanding debates on how landscape dynamics are influenced by the interactions between climate, tectonics, and erosion. In particular, the colder, more variable climate of the Pliocene-Quaternary has been invoked to explain an inferred global increase in erosion rates, and glacial imprinting has been suggested to produce higher topographic relief with potential tectonic feedback through isostatic response. Nonetheless, many questions about the temporal and spatial impact of glacial erosion remain. The Tauern Window, a crystalline massif in the Eastern European Alps, presents an ideal natural laboratory to isolate these interdependent effects due to its well constrained tectonic history of rapid uplift until ~8 Ma. Here, we present new apatite (U-Th)/He data distributed along elevation profiles through several glacial valleys in the western Tauern Window, where youngest recorded dates are time congruent with the onset of glaciation. Our profiles indicate variations in exhumation rates with elevation, which we suggest to be associated with altitude-dependent glacial erosion intensity. The patterns we observe and model are compared to the glacial morphometry of the western Tauern Window to determine possible links between observed denudation over the last few million years and present-day markers of glacially reshaped topography. We further analyse our findings in the context of variations in topographic signals and their possible drivers across the entire Alpine orogen.

Keywords: glacial morphometry, thermochronology, European Alps

Steering through the storm: Dust as a road transport hazard in Arizona.

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Dust blowing across highways is a well-recognised transport hazard resulting in reduced visibilities and traction on the road surface. Under these conditions, impaired vehicle handling and different driver reactions can result in single and multi-vehicle collisions. Despite widespread media attention on the number of fatalities and economic losses from such events, few studies provide in-depth analysis on spatial and temporal dust related crash risks to improve road safety. This research examined incident reports from the Arizona Department of Transport from 2017 to 2021 to characterise the hazard of blowing dust across the State. Surface data from weather stations was utilised to assess the horizontal visibility and windspeeds associated with crashes. Moderate Resolution Imaging Spectrometer (MODIS) enabled the identification of point sources of dust and their proximity to the road network. For the 5-year record, 401 dust related crashes were recorded, resulting in 148 injuries and 1 fatality. 70% of crashes occurred in the southwest of Arizona from June to September, when meteorological conditions favoured the formation of dust phenomena known as haboobs. Dust emission was greatest from shrubland (45%) and barren land (25%), with 26% of hotspots identified within 5 km of a highway. The results indicate that Arizona's road system is not yet resilient to the hazard of blowing dust, due to delayed warning systems and different driver reactions resulting in rear-end collisions. A greater spatial network of dust detection cameras and dynamic message signs would help warn of blowing dust in real time and improve driver decision making.

Keywords: Dust storms; crash records; MODIS imagery; Arizona; visibility; windspeed.

Monitoring glacier evolution and evaluating glacial lake outburst flood hazard in the Bolivian Andes

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This research focuses on changes to glaciers and glacial lakes across the Bolivian Andes between 2016 and 2022. During this period, the total glaciated area of the Bolivian Andes decreased by 9.1%, from 316.6 ± 3.2 km2 to 287.8 ± 2.9 km2; a rate of loss of 4.8 km2 a-1. As glaciers continued to retreat across the region, the number and surface area of glacial lakes increased. The number of lakes grew by 2.6%, from 704 in 2016 to 770 in 2022. Over the same period, the total surface area of glacial lakes expanded by 1.9%, from 37.1 ± 0.7 km2 to 37.8 ± 0.8 km2. A comprehensive glacial lake outburst flood (GLOF) hazard analysis was undertaken for the 2022 lake inventory. The results of this identified nine lakes as ‘high hazard’, sixteen as ‘medium hazard’ and fourteen as ‘low hazard’. A previously unreported GLOF event was discovered to have taken place in late 2019 or early 2020. Subglacial topographic analysis was undertaken to predict potential future sites for lake formation. Sixty new lakes, with a surface area of ~8.5 km2 are expected to form given continued deglaciation. The model was tested by applying it to areas where glaciers retreated between 2000 and 2022. Forty-four (46%) of the ninety-six lakes predicted by the model existed in 2022. This is the first time that an inventory of potential future lake sites has been produced for the region.

Keywords: Glaciers, Glacial Lakes, Deglaciation, Outburst Floods, Hazard

Controls on the response and recovery of the glacier and proglacial meltwater system to the December 2021 jökulhlaup, Skeiðarárjökull, Iceland.

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Climatic-driven glacier margin recession has resulted in the formation and growth of proglacial lakes. Proglacial lakes decouple glaciers from sandar or outwash plains, reducing sediment fluxes, altering the hydrodynamic behaviour of these rivers especially during jökulhlaups or glacial outburst floods with implications for downstream geomorphological change and infrastructure. Although jökulhlaups are recognised as important geomorphological and hazardous processes, models of the controls on their impacts haven't fully considered the role of proglacial lake formation.

This project aims to determine the controls on the impacts and response of the recently decoupled meltwater system of Skeiðarárjökull to the December 2021 jökulhlaup which flowed through a system of interconnected proglacial lakes and spillway channels with discharge peaking at ~3000m3 s-1.

Impacts of the jökulhlaup were determined by mapping proglacial lake and calved iceberg area, glacier margin position and the active river channel from 2017-2023. Uncrewed Aerial System (UAS) surveys were completed to generate an orthomosaic and digital elevation model (DEM).

The jökulhlaup resulted in a rapid increase in the area of calved icebergs and growth of proglacial lake area. Between October 2021 and 2022 the glacier margin receded by an average of 60m. Impacts on the river system included some channel widening, reduction in channel sinuosity, large-scale bar deposition and the progradation of a delta graded to temporarily elevated lake levels. Post flood recovery included increased channel sinuosity and braiding complexity. The controls on the jökulhlaup's impacts were identified and compared with models to see if they are still applicable in decoupled systems.

Keywords: jökulhlaup, proglacial system decoupling, geomorphological impacts

Geomorphological classification of aeolian dust sources in ice-free Greenland

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Interactions between fluvial and aeolian systems in drylands have long been recognised for their influence on spatial and temporal patterns of dust emissions. Contemporary dust emissions originating from ice-free regions within the Arctic have also been associated with fluvial (and glacio-fluvial) dynamics but the nature of cross-system interactions at high latitudes remains poorly constrained, particularly at the regional scale.

Using true colour Sentinel-2AB (10 m spatial resolution) satellite imagery we mapped dust emissions from ice-free Greenland from 2016-2021 using conservative cloud and scene coverage settings. Of the c.1000 potential sources examined, active dust emission was observed from >80 locations with the frequency of dust events from each location ranging from 1 to 24 over the six years.

We developed a land-surface classification of the identified dust sources that includes 3 active delta forms, 4 non-deltaic glacio-fluvial landforms and other landforms including alluvial fans, moraines and sand dunes. Lake and fjordhead deltas are widespread dust sources and are associated with the highest number of dust days. The spatial distribution of dust sources maps closely to the distribution of land-terminating glaciers with fluvial outwash systems, particularly those that discharge high concentrations of suspended sediment. The nature and orientation of valley topography provides a strong control on dust plume trajectories. Given that suspended sediment delivery to proglacial floodplains and deltas is increasing and many Greenland deltas are prograding it is expected that the extent of, and fine sediment supply to, potential dust sources will increase over the next few decades.

Keywords: Arctic, Greenland, dust, deltas

Ice Flow and Drumlin Asymmetry at Múlajökull glacier, Iceland

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Ice flow direction is one of the most fundamental properties of ice sheets, and is preserved in the morphology of an archive of glacial landforms. Classically, individual drumlins record the orientation of the ice flow that formed them. This is incorrect, and Digital Elevation (DEM) analyses of drumlin flow sets demonstrate populations of soft-cored drumlins to be typically close to longitudinally symmetry. However, it has been recently shown that flow direction is preserved in the polarity and strength of asymmetry within sub-sets of drumlins of a size that could be useful in spatial analysis (i.e., 10s-100s). How this should this sub-set asymmetry best be measured? Does asymmetry reflect glacial processes? This work focusses on drumlins at Múlajökull glacier. The motivation is that LiDAR data, recent deglaciation and a heavily studied site minimize confounding factors (i.e., DEM fidelity, post-glacial alteration and vegetation growth, drumlin mapping uncertainty). Analysis shows that (i) that slightly annoyingly, if conveniently, mean height-derived asymmetry is the most statistically powerful metric, and (ii) that weak spatial variations do not bear an obvious relationship to features of the glacier lobe (e.g. moraines, position to the centre or edge of the flow).

Keywords: palaeo glaciology, geomorphometry

Mapping Hazard Zones for Snow Avalanches in the Northern Western Himalayas Using Object-Based Image Segmentation

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Snow avalanches pose significant hazards in mountainous regions, particularly in the Northern Western Himalayas, where rugged terrain and heavy snowfall create conditions ripe for avalanche occurrence. Traditional methods of avalanche hazard mapping often rely on field surveys and topographic data, which can be time-consuming and challenging to update regularly. In this study, we explore the use of object-based image segmentation (OBIA) techniques to map hazard zones for snow avalanches.

High-resolution satellite imagery and digital elevation models (DEMs) were utilized to identify and delineate avalanche-prone areas based on terrain characteristics, such as slope steepness, aspect, and curvature. The OBIA approach allowed for the extraction of homogeneous image objects, which were then classified into different hazard zones using a combination of spectral and spatial features.

The study area encompassed select regions of the Northern Western Himalayas (NWH) known for their susceptibility to avalanches, including the states of Jammu and Kashmir, Uttarakhand and Himachal Pradesh. Validation of the hazard zones was conducted using historical avalanche records and ground truth data collected from field surveys and local experts.

Results indicate that OBIA provides a robust framework for mapping avalanche hazard zones, offering spatially explicit information that can aid in disaster preparedness, land use planning, and risk mitigation strategies. This research contributes to the advancement of remote sensing applications in mountainous environments and underscores the importance of integrating technological innovations with traditional knowledge for effective hazard management in avalanche-prone regions.

Keywords: Snow Avalanches, DEM,OBIA, NWH, Hazard Zones

Sustainable management of riparian vegetation: Tree hinging as an alternative to clearcutting

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Riparian vegetation improves ecosystem services in riverine environments but also increases the roughness, and it is often clearcut from banks and floodplains to increase conveyance during floods. As an alternative to clearcutting, hinging flexible stems of Salix species have been tried in the River Witham (Lincolnshire). We measured flow levels and water slope in reaches with and without hinged trees, and back-calculated the Manning's rough-ens. Preliminary results indicate that, for low to moderate discharge, the roughness decreases as the discharge increases. Interestingly, the periodic maintenance of the annual vegetation growing on the lower banks have a larger effect on roughness if compared to the difference between reaches with or without riparian vegetation. At higher discharges the dense riparian vegetation causes the roughness to increase but the reaches with hinged trees feature a roughness closer to reach without vegetation rather than reaches with dense riparian vegetation.

‘Sentinel wetlands’ in drylands: what are they and how can we find them?

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Identifying reliable indicators of environmental changes is crucial for effective ecosystem management, particularly in drylands which are prone to climate change impacts. This study explores the potential of wetlands in drylands to serve as ‘sentinel wetlands’: natural features that are highly sensitive to subtle hydroclimatic and anthropogenic changes. These wetlands may act as early warning systems, reflecting the cumulative effects of various stressors on their state. By integrating remote sensing technologies, time series analysis, advanced data science techniques, and ground-based observations, we aim to find, map, and assess the sensitivity of these wetlands to environmental perturbations. The data products will enable us to monitor and evaluate their responses to stressors, including by tracking subtle changes in wetland dynamics and correlating these changes with climate and human activity.

We have developed a method to automatically map them and characterise their wetness dynamics at pixel-scale using time-series multispectral satellite data. We have applied the method to hot drylands (western India, southwest Spain) and validated the mapping results by field visits. We are currently applying this method in cold drylands of India (Ladakh) and the Australian and Argentinian drylands.

Knowing the wetness dynamics of sentinel and non-sentinel wetlands will help us identify and separate the stressors that might impact future water availability and hence water security of the drylands. This separation is crucial for developing targeted management strategies. By characterising the sensitivity of sentinel wetlands, our research will enhance predictive models and provide actionable insights for sustaining water resources amidst ongoing climate changes.

Keywords: wetland dynamics, dryland wetlands, remote sensing of environment, water security and climate change

‘HotRocks’? Biogeomorphological thermal interactions on rocky shores

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The geomorphic roles of intertidal organisms on rocky shores are well recognised, including influences on temperature-driven breakdown processes. In comparison, little has been done to consider how and to what extent rocky substrates influence the temperatures experienced by colonising epibiota. This has relevance given the increasing occurrence of extreme thermal events (i.e., heatwaves) across the globe, which are associated with thermal stress, mass mortality events, and biodiversity loss.

I report ‘proof-of-concept’ research on rock type influences on the body temperatures of intertidal epiliths. I used biomimetic loggers (‘robolimpets’ and ‘robomussels’) to obtain comparable body temperature data when attached to contrasting substrates (limestone, sandstone, basalt, and concrete). Owing to their size, shape, and colour, these types of loggers are more representative of body temperatures than those more commonly deployed in environmental research. Substrate sub-surface temperatures were simultaneously recorded. The different substrates and loggers were deployed on a chalk platform at Seaford Head, East Sussex, at low tide, on multiple days in summer 2023, and in an environmental cabinet in the laboratory under ‘warm’ (20 °C), ‘hot’ (30 °C) and ‘extreme’ (40 °C) conditions.

This simple set-up allowed me to collect ecologically relevant thermal data on different substrates—simultaneously—in the same location and under the same heating conditions for the first time. Significant thermal differences were recorded between the substrates, which were broadly mirrored in the biomimetic logger temperatures. The degree of contact between the ‘organism’ and the substrate, and the evaporative cooling properties of the substrate proved key factors.

Keywords: biogeomorphology, rock costs, climate change, thermal biology, rock type, simulation

The application of machine and deep learning to the identification and mapping of geomorphic and biogeomorphic features from aerial and satellite imagery – a selective review.

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The identification and mapping of geomorphic and biogeomorphic features from sequential aerial and satellite images is now an established technique for change detection that relies on image segmentation and object identification. Similar image analysis requirements across a broad range of fields such as remote sensing, medical imaging, and video surveillance, have resulted in this being a highly active research area leading to rapid advances in AI techniques and models. Within this paper alternative approaches to object-based image segmentation and analysis for geomorphic feature identification are described including Machine Learning using Support Vector Machines, Deep Learning using trained Convolutional Neural Networks and the use of Foundation Models such as Segment Anything (a combination of a CNN and a Generative Adversarial Network). Examples applying the techniques to the segmentation and mapping of exposed riverine sediments and riparian vegetation are presented. The current limitations of the methods such as the availability of training datasets are discussed.

Keywords: Artificial Intelligence, Deep Learning, Remote Sensing, Fluvial Geomorphology

Integrating field and flume observations of flow over early-stage aeolian bedforms

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The initiation and early-stage growth of aeolian sand dunes is a fundamental aspect of bedform development but remains poorly understood. Protodunes are bedforms within a continuum of early-stage depositional aeolian features that exist between flat sand patches and small dunes. As transitory bedforms with the potential to develop into dunes, the detailed study of protodune morphodynamics can provide significant insights into nascent dune development where the feedback between flow and form drives patterns of deposition. This paper reconciles field and Refractive Index Matching (RIM) flume measurements of flow over a range of early-stage bedforms with varying morphologies. Among other flow responses, we find maxima in velocity located upwind of the crests, even on very small bedforms, which provides a mechanism for their growth and agrees with broader theoretical models. While there is agreement between field and flume measurements, the strongest response of flow to topographic forcing in laboratory experiments occurs close to the surface at heights where field measurements are currently impractical due to instrument size. Our findings suggest that the use of geomorphic proxies in the field for determining flow and transport (e.g., ripple dynamics or non-invasive measurements) may offer an alternative approach to traditional near-surface boundary layer methods for understanding early stage bedform development.

Keywords: Dunes, aeolian, flow-form interaction, experimental

Ten Years On from Rock Coast Geomorphology. A Global Synthesis. Progress and Future Research Directions in Rock Coast Geomorphology.

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Rock coasts constitute a major component of global coastal systems. However, until recent decades rock coasts were relatively understudied compared to their soft counterparts. The publication of the Global Synthesis on Rock Coast Geomorphology (Kennedy et al., 2014) marked growth in interest and advancement in scientific knowledge within the subdiscipline on a global scale. This accounted for theories, boundary conditions, and particularly emerging technologies for modeling the dynamics and behavior of rock coast evolution over various spatiotemporal scales. The global synthesis showcased diverse approaches and methods utilised by coastal geomorphologists to investigate processes, environmental controls, erosion rates, dynamics, and evolution of rocky coastlines.
The global synthesis also classified important areas for further investigation under the following themes; modeling, scale issues, rock coast and climate change, rock coast hazards, and rock coast geodiversity. A decade after the publication of the Global Synthesis, it is of analytical significance to review progress since 2014 to assert the progress within the subdiscipline of rock coast geomorphology and identify trends and future research pathways. The review has three aims: 1. Identify the trends/patterns, impactful authors, and journals within the subdiscipline; 2. assess if and how the recommendations for future research made in the synthesis have been addressed; and 3. highlight emerging research themes and principal areas for future research.
This is achieved through bibliometric analysis based on three hundred, and ninety (390) articles from Scopus Elsevier published from 2015 to 2024 to track the growth in research and patterns within rock coast geomorphology research.

Keywords: Rock Coast Geomorphology, Bibliometric Analysis

Erosion rates and Holocene sediment storage dynamics inferred from in-situ 14C concentrations in Glen Feshie, Scotland

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Scotland's Highlands are tectonically quiescent but have experienced high rates of isostatic uplift in response to deglaciation. To understand the effects of both deglaciation and regional uplift on landscape evolution, we measured the concentration of cosmogenic in-situ 14C in river sands collected in Glen Feshie (Cairngorms). Like other terrestrial cosmogenic radionuclides, in-situ 14C can be used to calculate basin-wide denudation rates over millennial timescales. 14C has a short half-life relative to other in-situ cosmogenic radionuclides, giving it an advantage in post-glacial landscapes: very little 14C will be inherited from exposure before glaciation of the landscape, meaning that concentrations will reflect sediment production and transport in the late Holocene. Denudation rates calculated assuming basin-wide homogeneity of erosion show no correlation with topographic metrics such as the normalised channel steepness index. Based on field and remote sensing observations, we suggest that 14C becomes diluted downstream due to sediment supply from paraglacial terrace material, and develop a mixing model to test this hypothesis. We identify the terraces that are likely to contribute sediment to the channels through flood modelling, geomorphic mapping and remote sensing observations. Our mixing model indicates that the observed distribution of 14C concentrations can be explained if terrace escarpments retreat tens to hundreds of cm during large flood events. This interpretation is consistent with remotely sensed images of channel activity and terrace bank retreat within the catchment. Our results show that paraglacial sediment stores dominate sediment fluxes in the late Holocene and highlight the on-going glacial legacy on landscape evolution.

Keywords: Erosion, Sediment, Post-glacial landscapes, Cosmogenic Radionuclides, 14C, Scotland

Investigating the Correlations Between SL-Index, Knickpoints, and Concavity Variability within the Dhauli Catchment, Western Himalaya

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Geomorphic and morphometric analysis, employing geomorphic indices, is crucial for comprehending drainage development and the impacts of diverse driving forces such as tectonic activities, climatic conditions, erosion stages, and land surface processes. In this investigation, we computed the Channel Concavity (θ) Index, SL-Index, Channel Steepness (ks) and chi-index using Digital Elevation Models (DEM) across the Dhauli Catchment. The SL-Index, one of the geomorphic indices, is sensitivity to variations in river gradient, serves as a valuable tool for identifying topographic discontinuities or knickpoints along river network. Our study implemented various segmentation methods with fixed horizontal spacing values (dL) of 1000 m, 1500 m, and 2000m. Additionally, we conducted SL-Hot spot analysis across the entire basin to delineate spatial distributions of hot and cold spots, aiding in the identification of zones prone to large landslides and principal knickpoints. The θ serves as a sensitive indicator of the differential uplift-erosion rate and selecting the most appropriate reference concavity (θref) for calculating relative ks values is critical.
Our study reveals strong relationships between SL-Index and knickpoints, reflecting their impact on SL intensity and indicate variability of θ across different landscapes, enhancing a new understanding of geomorphic processes such base-level shifts, tectonic activity, and rock differential erosion. Our findings highlight how major geological such as the South Tibetan Detachment System (STDS) of the Higher Himalayas and the Vaikrita thrust (MCT-I) within the Munsiyari group of rocks, as well as the other minor faults, contribute to our understanding of the region's landscape evolution and geomorphic processes.

Keywords: SL-Index, Knickpoint, Dhauli Catchment, Channel Steepness

The Stones of Darius Palace: A Geoarchaeological Investigation in Susa, Iran

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The research paper delves into the ancient city of Susa in southwestern Iran, occupied from about 4000 B.C until the 13th century A.D. It was the center of Elam as per ancient Uruk texts and was part of the Achaemenid Empire between 521-311 BC. Darius the Great established his residence here, building a palace with stones from Hapiratush, Elam. Laboratory tests identified these stones as limestone from the Sarvak formation, part of the Bangistan group. Geological maps and ArcGIS software analysis helped understand the provenances of Sarvak, their direction, accessibility, and distances to Susa. The paper also covers the first archaeological explorations in Khuzestan between 1852 and 1840, leading to the discovery of a large pillared hall resembling the one in Persepolis. Further excavations in 1970 unveiled inscriptions related to the palace foundation. The research aims to identify the stones used in the palace's columns and determine their formation distribution in the Zagros mountains. This could assist future studies in ancient sciences and geosciences to find the provenance of the stones. The research objectives include conducting petrology tests, performing field studies to understand the appearance of rocks, and preparing a distribution map of geological formations in the Zagros Mountains. The paper concludes that the information obtained will enable future researchers to locate the relevant quarries more efficiently and provide an answer to the historical uncertainty regarding the origin of the stones of Darius's Palace. This research contributes significantly to the understanding of the historical and geological aspects of Susa and the Achaemenid Empire.

Keywords: Archaeology; Petrography; Petrology; Cathodoluminescence Microscopy, Geoarchaeology; Geomorphology; Sarvak;

Restoring river-valley connectivity: Early results from UK Stage Zero restoration

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Many UK rivers are incised and disconnected from adjacent landscapes, reducing the ecosystem services they provide and their resilience to a changing climate. Valley-reset restoration is a novel strategy to provide a blank canvas and re-instate river processes by in-filling incised river channels to the level of the valley floor. It emerged as a method of restoring rivers to Stage Zero condition; a depositional anabranching or river-wetland complex with high hydrological connectivity. Restoration to Stage Zero using this approach began in the USA and has increased in momentum over the last decade. Valley-reset, however, remains a novel and relatively untested method, especially in Europe, where the landscapes, anthropogenic constraints and social context are different. Here we explore the potential of valley-reset restoration to Stage Zero in a UK context. We document the initial hydromorphic response of two UK rivers within the first year post restoration; the Rivers Aller (Somerset) and Witham (Lincolnshire). Initial results from both sites show that the >1 m increase in riverbed elevation during restoration prompted a similar increase in water table elevation and a vast increase in the area of aquatic habitat. However, the subsequent geomorphic evolution of the sites has differed due to differences in their fluvial power and sediment availability. We use these initial results to inform a wider discussion on the potential and practicality of valley-resetting to Stage Zero in anthropogenically constrained catchments, to provide a timely resource which can guide future research and management.

Keywords: river restoration, Stage Zero, (dis)connectivity, river management, fluvial geomorphology

Topographic roughness and flow resistance in rough-bed rivers: flume experiments

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Flow resistance in rivers can be predicted as a function of the channel bed grain size distribution or standard deviation of bed surface elevations. However, prediction accuracy is lower in rough-bed rivers where the flow depth is not much greater than the channel roughness elements. In these channels, predictions need to account for the influence of multiple scales and shapes of roughness, including boulders, sediment patches, exposed bedrock and irregular banks. But, we do not yet have suitable methods for making these predictions.

Here we present a set of physical modelling flume experiments to investigate how irregular river-beds affect bulk flow resistance. High-resolution topographic field data was used to create 1:10 scale 3D reproductions of two different river beds, and scaled boulders were incrementally added with coverage up to 55%. The flow depth across a range of bulk discharges was measured for each bed/boulder configuration, enabling the calculation of the Darcy-Weisbach friction factor. For both beds, as boulder density increased, flow resistance initially increased and then decreased, which likely represents the transition between wake interference and skimming flow regimes. We subsequently identify which topographic (surface roughness) metrics best represent the effect of the differing river-bed properties on bulk flow resistance, and hence offer the most promise for improved predictive equations.

Keywords: Fluvial, Hydraulics, Flow Resistance

Modeling the Effects of Landslide Debris on the Mass Balance of Svínafellsjökull Using COSIPY

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The global rising temperature is one of the main causes of glacier melt, significantly altering glacier mass balance. Many researchers and scientists are currently working on this aspect; using various models they are trying to project how climate change will affect glacier mass balance in the future. However, understanding how landslide debris affects glacier mass balance by depositing substantial volume of debris onto the glacier surface remains incomplete. This study investigates the impact of a significant landslide event on the mass balance of the Svínafellsjökull in southeast Iceland. In late February 2013, a large landslide deposited approximately 5.33 ± 0.08 × 106 m3 of debris on Svínafellsjökull, making it the largest recorded landslide in Iceland. These large debris materials altering glacier's surface properties. To understand how this debris cover influences the glacier's mass balance, we employed the COupled Snowpack and Ice Surface Energy and Mass Balance Model in Python (COSIPY). We conducted simulations for two distinct scenarios: pre-landslide (clean glacier) and post-landslide (debris-covered glacier). The pre-landslide scenario utilized standard glacier surface properties, while the post-landslide scenario incorporated observed debris characteristics, including an average debris thickness. Meteorological data, glacier geometry, and other relevant topographic parameters were consistent in both simulations to ensure comparability. This study highlights the importance of considering glacier mass balance changes due to landslide debris. By comparing pre- and post-landslide simulations, this research aims to provide insights into the complex interactions between glacier dynamics and landslide events.

Keywords: Keywords: Mass Balance, Landslide Debris, Svínafellsjökull, COSIPY Model, Simulations

Quantifying the impact of fire disturbance events on potential dust emissions from partially vegetated dune surfaces in the Namibian Kalahari

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Fire is a common occurrence in the Kalahari and has been linked to increased dust emissions in dryland environments. Yet, substantial gaps exist in our knowledge of whether the Kalahari can emit dust. To explore the process relationships between vegetation, fire, and aeolian erosion, 180 measurements using a portable wind tunnel (PI-SWERL) were made in the Namibian Kalahari Desert. Burned and collocated unburned control sites were utilised to comparatively measure erosion thresholds and dust fluxes using a PI-SWERL. Overall, our data also suggest that the Kalahari linear dune system has a lower potential to emit dust in comparison to other desert landscapes even at a high shear velocity. Furthermore, there was no significant difference in dust emission flux on burned and control surfaces, but significantly higher erosion thresholds on burned surfaces. The data strongly suggests that even when devoid of vegetation, the Kalahari linear dune system is sediment availability limited. The lack of available sediment can likely be explained by the persistence of biological crust (BSC) cover on the surfaces conglomerating sediments and preventing emissions. Where the surface had been mechanically disturbed, our data suggest that dust emission fluxes can exceed 4x those of unburnt vegetated surfaces. Our results suggest that fire alone does not result in increased dust emissions from the Kalahari linear dunes. In addition, these findings add valuable data to the debate over the potential of the Kalahari to become a dust source in the future and subsequent parameterisations of aerosol loading and climate models.

Keywords: Aeolian Transport, Wildfire, Wind tunnel

Analyzing Slope Asymmetry and Ridge Variability in Martian Craters

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This study investigates the relationship between the orientation of ridges along crater rims and the asymmetry of their slopes. It also attempts to establish the extent of spatial variability of ridges across different scales: along the ridges themselves, within craters, and at various longitudes and latitudes across Mars. Using HiRISE Digital Terrain Models (DTMs), hillslopes were delineated and transects established to extract elevation data. A Divide Asymmetry Index (DAI) was calculated to classify slope biases and analyze spatial trends. Although hillslope morphologies are more complex than fluvial sites, this analysis provides context on the erosional processes shaping these craters, including the roles of water, wind, mass wasting, and solar irradiance imbalance on the slopes.

Crater sites were selected based on criteria including freshness, size, and morphology. Focus was placed on relatively fresh impact craters with diameters ranging from 1 to 10 km, prioritizing those with well-preserved morphological features and high-resolution images better than 50 cm per pixel. Craters located between 50°S and 40°N were chosen to minimize the influence of latitude-dependent mantles.

Initial results suggest a correlation between ridge orientation and slope asymmetry. Northern and southern-oriented ridges exhibit more variable slope gradients, with no clear pattern of asymmetry over larger regions. In contrast, eastern and western-oriented ridges tend to show more uniform asymmetry. These findings highlight a directional influence on hillslope asymmetry, with eastern and western orientations appearing more susceptible to larger-scale changes. This research enhances the understanding of crater ridge geomorphology and the broader landscape formation processes on Mars.

Keywords: Mars, crater ridges, hillslope asymmetry, geomorphology

Assessing Flood Risk and Morphodynamics of the Ghaghra River, Ganga basin, India

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The Himalayan rivers, known for their significant sediment loads and high monsoon season discharges, cause extensive flooding, erosion of river banks, and dynamic changes in channel morphology in the Ganga basin. This has significant impacts on populations inhabiting the basin. The Ghaghra River is a major tributary of the Ganga River and is located in the central section of the Ganga basin. The combined effects of excessive channel sedimentation, huge monsoonal discharge and increasing population in the flood plain areas have increased the flood risk multifold. The channel morphodynamics and flood risk potential of the Ghaghra remains poorly characterised. Here we employ Optical and SAR datasets to evaluate reach wise flood-risk and channel morphodynamics and identify their hotspots along the river. We have utilised the Google Earth Engine platform to analyse historical flood-dynamics and channel-morphodynamics along a 35 km stretch of the Ghaghra river from its confluence with Sharda River. Our preliminary analysis reveals that the width of the flood zone in the selected stretch of the Ghaghra extends from 4 to 7 km, based on the flood records from 2017 to 2023. Furthermore, based on change in active channel of the river between 2000 and 2020 we infer that the river has experienced a net loss of 60 square kilometres of its active area (deposition) and has gained an additional 53 square kilometres (erosion) indicating substantial morphodynamics in the region.
This study provides policymakers and local communities with the necessary information to prevent and reduce hazards associated with rivers.

Keywords: Flood risk, morphodynamics, SAR, GEE

Fold inter-limb angle as geomorphic marker of tectonic tilting or equilibrium profile

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Fold interlimb angles are conventionally used as secondary structures for deformation study of geological. However here this structure has been used decadal documentation of island tilting or post tsunami adjustment of equilibrium profile. More than 10 evidences were collected in outcrop scales in various time for explaing the fact of tilting or readjustment of beach profile. All observations were properly documented using stereonet for quantifying the tilt.

Keywords: Fold interlimb angle, outcrop, tectonic movement

Quantifying Human Impacts on Suspended Sediment Delivery Using Deep Learning Frameworks

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Dams profoundly alter river hydrology by modifying flow timing, magnitude, and frequency, leading to hydrologic regimes distinct from natural conditions. Accurate assessment of suspended sediment load (SSL) in rivers is crucial for effective water resource management, particularly in dam-affected systems where sediment transport dynamics are significantly altered. Traditional SSL estimation methods often fall short due to their reliance on empirical formulas and inadequate consideration of complex human interactions. Thus, this study employs deep learning frameworks—Feedforward Neural Network (FFNN), Radial Basis Function Neural Network (RBFNN), Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU)—to predict daily, weekly, 10-daily, and monthly SSL in the Godavari River at Polavaram. Using 50 years of daily discharge and SSL data (1970–2020), we have divided between pre-1990 (pre-dam) and post-1990 (post-dam) periods. LSTM consistently outperforms other models in the pre-1990 period, achieving correlation coefficients of 0.864 (daily), 0.952 (weekly), 0.953 (10-daily), and 0.951 (monthly). Post-1990, simple RNN performs better with correlation coefficients of 0.919 (daily), 0.963 (weekly), 0.957 (10-daily), and 0.959 (monthly). Further, we used these developed deep-learning frameworks to assess the impacts of dam operations on suspended sediment delivery. The findings provide valuable insights for ecologists and river management experts, aiding in the planning of reservoirs to maintain flow regimes and manage sediment loads effectively. Moreover, deep learning algorithms demonstrate their utility in reliably estimating SSL using input factors such as river discharge, offering computationally efficient frameworks for water resource management and environmental planning.

Keywords: Suspended sediment load, Human Impact, Deep learning, Godavari, India

Quantifying topographic variability in forested landscapes

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The role of forests in influencing geomorphic processes has long been recognised. However, quantifying relationships between ecological and geomorphological processes remains challenging. Many of the world's forests are experiencing significant physical and climatic pressures, leading to changes in forest properties, alongside changes in hillslope sediment dynamics. The advent of new remote sensing technologies offers opportunities to examine forested landscapes in a novel way. The high-resolution point clouds produced by Terrestrial Laser Scanning (TLS) are revolutionising the study of forest ecology, allowing for new insights into above-ground forest structure and ecosystem dynamics. High-resolution digital elevation models can also be produced using TLS measurements within these landscapes, allowing for the coupling of ecological and topographic parameters at unprecedented scales.

Wind-driven tree throw is a major disturbance in forests, that mobilises significant quantities of sediment downslope as trees are uprooted. Tree throw leaves distinct pit-and-mound structures, producing characteristic topographic roughness within forested landscapes. Quantifying this roughness across a range of ecosystems across a climate gradient will allow us to disentangle the complex relationship between climate, trees and sediment transport. Enhancing our understanding of sediment flux in forested landscapes has many important consequences for forest and landscape management, including soil availability and production, terrestrial carbon stocks, soil hydrology, and hillslope stability.

Keywords: Geomorphology; remote sensing; Terrestrial laser scanning; TLS; hillslopes; forests

Flow and wake structure around flexible submerged vegetation patches

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Vegetation patches are a common feature in riverine and coastal environments and play an important role in determining flow and sediment dynamics, through the formation of wakes. For rigid, emergent vegetation patches, the factors that affect the horizontal wake and turbulence structure are relatively well understood. However, for submerged flexible vegetation patches where both vertical and horizontal shear layers exist and interact, the processes are more complex and wake length and sediment deposition can be affected by flexural rigidity. The aim of this work is to investigate how the flow structure around vegetation patches varies with plant posture and Reynolds number and thus what the processes are that result in different wake characteristics for different flexural rigidities.

Computational fluid dynamics (CFD) simulations of flow around isolated vegetation patches were conducted using the Reynolds-averaged Navier-Stokes Equations. Vegetation patches consisted of groups of individual flexible porous shoots, parameterized using field data from saltmarsh vegetation. Simulations covered a range of flexural rigidities (EI = 0.000015 – 0.15 Nm2) and velocities (0.2 - 0.7 m/s) to capture flow structure under different plant postures and patch Reynolds numbers (60,000 - 210,000).

The results show the presence of secondary circulation cells behind the patches. For relatively rigid vegetation, the circulation cells occur at the patch top, away from the bed and are relatively weak. For more flexible vegetation, they are stronger and occur near the bed, causing deflection of the horizontal shear layers, with implications for flow and sediment processes within the patch wakes.

Keywords: flow-vegetation interaction, flexural rigidity, secondary circulation, wake flow

Characterizing sequential earthquake and rainstorm-driven landslides in Taiwan over a 30-year period

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Landslides induced by earthquakes and rainstorms are the main sediment source from land to ocean in mountainous terrain. The landslide proximity to the river network plays a crucial role in sediment transport, impacting the sediment dynamics and other parts of the Earth system. This study aimed to determine how landslide characteristics, including their hillslope position to the river network, vary according to the trigger (rainfall and earthquakes), event magnitude and the temporal sequencing of triggering events. This study modified the Automated Landslide Detection Index (ALDI) algorithm to create optimized landslide maps at a monthly scale in the Choshui catchment in Taiwan. From this temporal inventory, we extracted 26 event-induced landslide maps between 1991 and 2019, and then computed the normalized landslide distance and the ratio of probability to quantify landslide location. The results show that earthquake-induced landslides tend to occur primarily on the crest of hillslopes, although some are located near river channels. In contrast, rainstorm-induced landslides tend to occur at the toe of hillslopes. The temporal variation in landslide position shows large earthquakes can impact the position of subsequent rainstorm-induced landslides for up to two years. We also found that enlarged landslides occur nearer to the ridge where the slope is steep, whereas new landslides are nearer to streams where the slope is more convex, indicating the location of the landslide is not only dominated by the triggering mechanism, but also impacted by hillslope topography.

Keywords: Earthquake-induced landslide, rainstorm-induced landslide, ALDI, Taiwan

First global estimation of bankfull river discharge

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The accurate estimation of bankfull discharge (QBF) plays a central role in multiple disciplines including geomorphology, hydrology, and ecology. For example, bankfull discharge is an essential input in many large-scale flood models. However, in the context of extremely limited bankfull discharge observations, these Global Flood Models typically assume that bankfull discharge has a spatially uniform recurrence interval, with a value of 1-2 years widely adopted. In reality, many studies have found that the recurrence of bankfull discharge is highly variable. Therefore, more reliable estimates of bankfull discharge that account for river variability across different regions and climate zones are vital. Here, we train a random forest model to estimate bankfull discharge from global datasets encompassing river catchment characteristics, river geometry, topography, reservoir capacity, hydrological and climate indicators, alongside a newly compiled bankfull discharge database with over two thousand observations. The trained machine learning model is then used to develop the first estimate of bankfull discharge for 19.6 million km of rivers globally, using a newly developed, high-resolution, multi-threaded river network, Global River Topology. Independent testing against observed values of QBF shows that the random forest model has good performance (R2=0.79), and the estimated QBF has better accuracy compared to the use of uniform recurrence-interval flows. This is the first study to estimate bankfull discharge for rivers at the global scale. Our dataset aims to improve bankfull representation in large-scale flood modelling, and to support river and water resources research more generally.

Keywords: Bankfull discharge; hydraulic geometry; flood risk

Global signatures of life in landscapes: magnitude and coherence of animal geomorphic effects

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Animals acting as geomorphic agents are globally diverse and abundant, with the potential to make significant contributions to geomorphic work by reworking soils and sediment (bioturbation), removing or stabilising materials (bioerosion and bioprotection, respectively) and producing and accumulating materials (bioconstruction). To date, most zoogeomorphic research has focused on single species, is dispersed across disciplines and often emphasises the effects of larger-bodied and charismatic animals (e.g. beaver, salmon), precluding a full understanding of the overall nature and significance of zoogeomorphic impacts. We used systematic review and meta-analysis to evaluate the coherence and generality of geomorphic signatures of life across freshwater and terrestrial landscapes. We computed over 750 effect sizes (standardised differences between control and impact treatments) for 66 variables across 63 species, derived from 64 empirical papers. There was evidence for larger effects in freshwaters than in terrestrial environments, though biome did not predict zoogeomorphic effect size. In general, the presence of an animal reduced fine material and increased porosity but with some variability. There was no evidence of a strong relationship between elevation and the magnitude of zoogeomorphic effects, suggesting that the role of animals can be significant in both low and high energy environments, in contrast to prevailing assumptions. These findings contribute new insights into the potential consequences of changes to the distribution and abundance of geomorphically-active species within the context of global biodiversity decline.

Keywords: biogeomorphology, zoogeomorphology, ecosystem engineer, meta-analysis

Linkage between sediment transport and heavy metals dispersal in catchments affected by legacy mines.

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Although most of the metal mines in the UK are now closed, the release of heavy metal pollutants from legacy mines often represents a severe environmental hazard for nearby river and catchment. Sediments are the main carrier for metal pollutants in river system: heavy metals generated from anthropogenic activities enter rivers and migrate in rivers and through catchments with sediment. Sediment transport occurs through erosion process, and fluvial transport of gravel. These processes are driven by various environmental factors such as rainfall intensity and the seasonality of hydro-climatic conditions of the catchment. However, the linkage between sediment transport and metal pollutants mobility in historical mining affected rivers and catchments remains poorly understood. Therefore, my PhD project intends to conduct field sampling and laboratory analysis to study sediment and heavy metals dispersal in catchments affected by historical mining. The study area will be the Leadhills and Wanlockhead mining districts, which used to be the largest lead-zine mining area in Scotland. Specifically, I aim to: (1) Identify the sources of both heavy metal pollutants and sediments polluted by heavy metals in the river environment. (2) Characterize the spatio-temporal distribution of heavy metal pollutants in the catchment. (3) Understand the seasonal changes of heavy metals distribution associated with sediment transport driven by rainstorm event in the catchment.

I will present preliminary results of the geochemical analysis of modern and floodplain sediment along rivers in the study area, as well as samples collected from tailing ponds and waste heaps that may constitute potential sources.

Keywords: legacy mines, sediment transport, heavy metals dispersal.