Wireless access for visitors to Aberystwyth University

Visitors wishing to make use of the Aberystwyth University wireless service must ensure their computer:
• has the latest service pack and updates installed for their operating system;
• has up-to-date anti-virus software;
• is free from viruses and spyware before coming to campus.

All use of the Aberystwyth University network is governed by the Information Services Regulation and Guidelines and the JANET Acceptable Use Policy.

Visitors from other academic institutions

Aberystwyth University participates in the JANET Roaming Service.

This means that visitors from other participating academic institutions can connect to their own institution’s network via Aberystwyth University’s eduroam wireless network while visiting our campus. You can check whether your institution participates in this service on the JANET Roaming Service website.

All other visitors, conference and event attendees

Aberystwyth University subscribes to The Cloud wireless service. Any visitor to campus who is not able to use eduroam can connect to WiFi Guest. Once logged in, you can access the internet.

You can find help with using this service on The Cloud’s FAQ pages.

This service is available throughout all Aberystwyth University teaching and administrative buildings, but not in halls of residence.

How do I connect to The Cloud wireless service?

• Select the WiFi Guest from the list of available wireless networks.
• Once connected, open your web browser and refresh the page.
• The Cloud’s log in page will appear.
• Select Get Online or register now.
• Choose Free Cloud WiFi.

If you have registered to use The Cloud previously, please enter your email address and password.

If you haven’t registered to use The Cloud before, click on Create an Account.

Once logged in you can access the internet.

You can find help with using this service on The Cloud’s FAQ pages.
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Getting to Aberystwyth University</td>
<td>3</td>
</tr>
<tr>
<td>2. Accommodation, Registration and Venues</td>
<td>4</td>
</tr>
<tr>
<td>3. About Aberystwyth University</td>
<td>5</td>
</tr>
<tr>
<td>4. About the Department of Geography and Earth Sciences</td>
<td>6</td>
</tr>
<tr>
<td>5. Welcome by the Head of the Department of Geography and Earth Sciences</td>
<td>7</td>
</tr>
<tr>
<td>6. Meeting Organising Committee and Emergency Contacts</td>
<td>8</td>
</tr>
<tr>
<td>7. Meeting Programme</td>
<td>9 - 14</td>
</tr>
<tr>
<td>8. Oral Presentation Abstracts</td>
<td>15 - 51</td>
</tr>
<tr>
<td>9. Poster Presentation Abstracts</td>
<td>52 - 78</td>
</tr>
</tbody>
</table>

*Middle Chubut River valley, Patagonia, Argentina*
1. Getting to Aberystwyth University

Travel by Train

There are regular train services to Aberystwyth from north Wales and the Midlands (travelling from the east, all services pass through Shrewsbury). Please refer to the National Rail Enquiries web site for train times and route options. Aberystwyth Railway Station is situated in the town centre, adjacent to the Bus Station and Taxi Rank. From Aberystwyth Bus Station, a number of bus services regularly travel to Penglais Campus. On foot, the walk to Penglais Campus takes approximately 20 minutes.

Travelling by Car

Aberystwyth is easily accessible by road. Whichever way you’re approaching from, you will experience beautiful scenery. From the east, the A44 climbs through the Cambrian Mountains and winds down to the coast, and from the north or south, the A487 offers spectacular views over Cardigan Bay.

When you approach Aberystwyth by road, you’ll see signs directing you to Aberystwyth University; these will lead you to Penglais Campus. Look out for these bright yellow square signs containing a picture of a mortarboard.

If you are planning on using a Sat Nav to navigate to Aberystwyth, you will find the following information useful:

Penglais Campus Location Post Code:  SY23 3BY  Grid Reference:  52.417739, -4.065292

Online Resources

For interactive maps, directions and transport information visit the University website:
www.aber.ac.uk/en/maps-travel
2. Accommodation, Registration and Venues

If you have booked university accommodation, you will be staying in Fferm Penglais, a 5-10 minute walk from the main Penglais Campus. Separate instructions about checking in and out, car parking, and breakfast arrangements will have been provided by the Conference Office.

Many other accommodation options are located nearer to the town centre, a 15-20 minute walk from the main Penglais Campus.

Most of the activities at the meeting will take place in the Medrus Conference Suite (Early Career Workshop), Physical Sciences Building (oral presentations), or the Llandinam Building (posters and other displays).

The Llandinam Building houses the Department of Geography and Earth Sciences. From 12 noon to 4 pm on Monday 10th September, registered meeting attendees can collect their conference packs and name tags from Melin Drafod/Think Tank on 8 floor of the Llandinam Building. At any other time, registered meeting attendees can collect their conference packs and name tags from outside Physics Main Lecture Theatre in the Physical Sciences Building.

The Ice Breaker will take place in Medina, an eatery located on 10 Market Street in the town centre (Monday 10th September, 7.30 pm onwards).

The Conference Dinner and Awards Ceremony will take place in Medrus Mawr on Penglais Campus (Tuesday 11th September, 8pm onwards).
3. About Aberystwyth University

Background and name

Aberystwyth University (in Welsh, Prifysgol Aberystwyth) is a public research university in Aberystwyth, Wales. Aberystwyth was a founding member institution of the former federal University of Wales. The university has almost 8000 students studying across its various academic institutes.

Founded in 1872 as University College Wales, Aberystwyth, it became a founder member of the University of Wales in 1894 and changed its name to the University College of Wales, Aberystwyth. In the mid 1990s, the university again changed its name to the University of Wales, Aberystwyth. On 1 September 2007, the University of Wales ceased to be a federal university and Aberystwyth University became independent again.

History

In the middle of the 19th century, eminent Welsh people were advocating the establishment of a university in Wales. One such person was Thomas Nicholas, whose 1863 book “Middle and High Class Schools, and University Education for Wales” is said to have “exerted great influence on educated Welshmen”.

Funded through public and private subscriptions, and with five regional committees (London, Manchester, Liverpool, North and South Wales) guaranteeing funds for the first three years' running costs, the university opened in October 1872 with 26 students. Thomas Charles Edwards was the Principal. In October 1875, chapels in Wales raised the next tranche of funds from over 70 000 contributors. Until 1893, when the college joined the University of Wales as a founder member, students applying to Aberystwyth sat the University of London's entrance exams. Women were admitted in 1884.

In 1885, after a fire in what is now known as Old College, the Gogerddan Estate was donated to the university and would become the location of Penglais Campus, the university's principal campus. Incorporated by Royal Charter in 1893, the university installed the Prince of Wales as Chancellor in 1896, the same year it awarded an honorary degree to British Prime Minister William Gladstone.

The university's coat of arms dates from the 1880s. The shield features two red dragons to symbolise Wales, and an open book to symbolise learning. The crest, an eagle or phoenix above a flaming tower, may signify the College's rebirth after the 1885 fire. The motto is Nid Byd, Byd Heb Wybodaeth (A World Without Knowledge Is No World At All).

In the early 1900s, the university added courses that included Law, Applied Mathematics, Pure Mathematics, and Botany. The Department for International Politics, which Aberystwyth says is the oldest such department in the world, was founded in 1919. By 1977, there were eight Fellows of the Royal Society (FRS) on the university's staff, including Gwendolen Rees, the first Welsh woman elected as a FRS.

The main campus of the university is situated on Penglais Hill, overlooking the town of Aberystwyth and Cardigan Bay, and comprises most of the university buildings, the Arts Centre, Students’ Union, and many of the student residences. Just below Penglais Campus is the National Library of Wales, one of Britain’s five legal deposit libraries. The landscaping of the Penglais Campus is historically significant and is listed. The CADW listing states:

"The landscaping of the University of Wales, Aberystwyth campuses, particularly the earlier Penglais campus, is of exceptional historic interest as one of the most important modern landscaping schemes in Wales ... One section of the Penglais campus was designed by the well known landscape architect Brenda Colvin and is one of the very few of her schemes to have survived. A number of women have played a key role in the development and planting of the whole site."
In the academic session 2017-18, the Department of Geography and Earth Sciences at Aberystwyth University has been celebrating its Centenary. Although Geography had been taught at the University College of Wales, Aberystwyth as part of the general degree since the college’s foundation in 1872, the Department of Geography was established in 1917 with the appointment of H.J. Fleure as the Gregynog Professor of Geography and Anthropology. This was followed in 1918 by the admission of the first students registered for an Honours degree in Geography (as opposed to studying Geography as part of a general degree). Indeed, Aberystwyth was only the third university in Britain to offer an Honours degree in Geography (following Glasgow in 1912 and Liverpool in 1917), and was the first to offer both a BA and a BSc degree in Geography.

Over the subsequent hundred years, Geography has grown to become one of the largest departments in the university and, for periods, was one of the largest Geography departments in Britain. It moved from Marine Terrace to Alexandra Road and finally into the Llandinam Building on the Penglais Campus. In 1988, the department merged with the Department of Geology (itself founded in 1910) to form the Institute of Earth Studies, renamed as the Institute of Geography and Earth Sciences (IGES) in 1997, and then the Department of Geography and Earth Sciences (DGES) in 2012.

From its early days, Geography at Aberystwyth played a significant role in shaping the development of the discipline, both in Britain and around the world. It was the first headquarters for the Geographical Association (whilst H.J. Fleure was the Association’s Secretary) and was the first place outside the ‘golden triangle’ of London, Oxford and Cambridge to host the annual conference of the Institute of British Geographers. Alumni from the department have become lecturers and professors in universities across Britain and internationally, in many cases as pioneers of university geography in their country.

Given that the most recent QS University Rankings place Aberystwyth in the top 100 Geography departments worldwide, the Centenary is a timely occasion on which to celebrate the achievements and legacy of the department. This includes achievements by its staff, students and graduates across all the subject areas that the department has encompassed, including Physical Geography and Human Geography, Environmental Science, Environmental Earth Science and Geology.

Through public lectures, field tours, and other outreach events, the Centenary has provided an opportunity to promote the department to prospective students, employers, teachers and the local community – as well as to the global Geography and Earth Sciences community – and to re-connect with our alumni to benefit current and future students and enhance our research and research impact.

Geomorphology overlaps or interfaces with many of the subject areas encompassed by the department, and over the decades, many staff, students and graduates have made a significant contribution to the development of geomorphological data, concepts, theory, and application. Hence, it is fitting that the Annual Meeting of the British Society for Geomorphology – which is being held in Wales for the first time in many decades – provides the culmination of the Centenary Year celebrations.
5. Welcome by the Head of the Department of Geography and Earth Sciences

“I am delighted to welcome you to the 2018 Annual Meeting of the British Society for Geomorphology, hosted by the Department of Geography and Earth Sciences (DGES). This is a particularly timely meeting because DGES, one of the oldest departments of Geography and Earth Sciences in the UK, is celebrating its Centenary throughout 2017-2018.

DGES is one of the most prominent and well-respected departments of Geography, Earth and Environmental Sciences in the UK. Our staff are research innovators, undertaking work that is widely recognised as ‘internationally excellent’ or ‘world-leading’ in nature. Our research and teaching interests cover a diverse range of themes, including Earth surface processes, Earth observation, Quaternary environmental change, glaciology, and cultural and political geography. Currently, we have active research projects on all 7 continents, underlining our international outlook and reputation.

Geomorphology interfaces with many of these themes, with research and teaching in geomorphology always being a strong element in the department. Indeed, the famous American geomorphologist W.M. Davis was accompanied on part of his 1911 European tour by O.T. Jones, the 33 year old newly-appointed UWA Professor of Geology. This interfacing is most obviously allied to the more physical environment-oriented areas of the discipline, but increasingly geomorphology also forms a key component of many multi-, inter- and trans-disciplinary themes, such as those related to concepts of sustainability, resilience thinking, and the Anthropocene.

Nestled between the Cambrian Mountains and Cardigan Bay, Aberystwyth is ideally located for a meeting on geomorphology. We hope that the mix of events in our ‘local laboratory’ will stimulate new and exciting ideas for your research, and for communicating to the wider public the value and importance of geomorphology.

I do hope that you have a profitable and rewarding few days with us in Aberystwyth.”

Professor Paul A. Brewer, Head of Department, Geography and Earth Sciences, Aberystwyth University
6. Meeting Organising Committee and Emergency Contacts

In case of problems at the meeting, including advice on First Aid, the above personnel should be the first port of call.

Alternatively, for First Aid emergencies, contact AU Telephone Operators (during working hours) by dialling 222 (internally) or 01970 623111 on a mobile and request a First Aider. Stay on the line to give exact location details and obtain confirmation that aid is on its way.

In case of other emergencies, the Emergency Services (Fire, Ambulance, Police, Coastguard) can be contacted:
• 9999 (from internal AU telephone)
• 999 (from payphones or mobiles)

Site Security can be contacted on:
• 01970 622649 (external)
• 2649 (internal)
• 07889 596220 (mobile telephone)
# Meeting Programme

**Monday 10th September**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.00-09.00</td>
<td>Breakfast for those staying in campus accommodation on Sunday night</td>
</tr>
<tr>
<td>09.00-12.30</td>
<td>BSG Executive Committee Meeting</td>
</tr>
<tr>
<td>12.00-16.00</td>
<td>Registration desk open</td>
</tr>
<tr>
<td>12.00-16.00</td>
<td>Tea and coffee available</td>
</tr>
<tr>
<td>13.00-15.30</td>
<td><strong>Early Career Workshop</strong></td>
</tr>
<tr>
<td></td>
<td>Led by Brian Whalley (University of Sheffield),</td>
</tr>
<tr>
<td></td>
<td>Richard Jeffries (Environment Agency) and Katy Kemble (Jacobs)</td>
</tr>
<tr>
<td></td>
<td>1. Communicating through teaching in Geomorphology (Brian Whalley).</td>
</tr>
<tr>
<td></td>
<td>To include consideration of questions such as:</td>
</tr>
<tr>
<td></td>
<td>* Why is geomorphology seemingly so hard to teach?</td>
</tr>
<tr>
<td></td>
<td>* What do undergraduates do in field and laboratory classes over the three years of a typical degree?</td>
</tr>
<tr>
<td></td>
<td>* Do we have educational curricula fit for teaching and assessing geomorphological knowledge and skills?</td>
</tr>
<tr>
<td></td>
<td>2. How applied geomorphology professionals and academics communicate (Richard Jeffries, Katy Kemble - please see separate flyer).</td>
</tr>
<tr>
<td></td>
<td>To include consideration of questions such as:</td>
</tr>
<tr>
<td></td>
<td>* What challenges and opportunities are there when communicating from those who know to those who need to learn?</td>
</tr>
<tr>
<td></td>
<td>* How can academic and applied professional geomorphologists benefit by sharing knowledge and skills?</td>
</tr>
<tr>
<td></td>
<td>* Where is the common ground?</td>
</tr>
<tr>
<td>16.00-16.30</td>
<td><strong>Conference Opening</strong></td>
</tr>
<tr>
<td></td>
<td>Professor Elizabeth Treasure (Vice Chancellor, Aberystwyth University)</td>
</tr>
<tr>
<td></td>
<td>and Stephen Tooth (Conference Chair)</td>
</tr>
<tr>
<td>16.30-18.30</td>
<td><strong>Session 1</strong></td>
</tr>
<tr>
<td></td>
<td>Chair: Hywel Griffiths</td>
</tr>
<tr>
<td></td>
<td><strong>J. Croke</strong>, <em>Who do you think you are you talking to?</em></td>
</tr>
<tr>
<td></td>
<td><strong>B. Whalley</strong>, <em>Are landscapes in the heads of geomorphologists?</em></td>
</tr>
<tr>
<td></td>
<td><strong>K. Kemble</strong>, <em>The science and ‘art’ of geomorphology: how fluvial geomorphology contributions to industry sectors and individual projects are developing and maturing over time</em></td>
</tr>
<tr>
<td></td>
<td><strong>S. Llywelyn, S. Tooth, H.M. Griffiths, C. Jones</strong>, <em>How can we integrate geomorphology into the promotion of Wales’s geoheritage?</em></td>
</tr>
<tr>
<td></td>
<td><strong>Frost Lecture</strong></td>
</tr>
<tr>
<td></td>
<td>(45 minutes + 15 for questions/discussion)</td>
</tr>
<tr>
<td></td>
<td><strong>Phobias and Phobias</strong></td>
</tr>
<tr>
<td></td>
<td>John Lewin (Aberystwyth University)</td>
</tr>
<tr>
<td>19.30-22.00</td>
<td><strong>Ice breaker event (to include buffet dinner)</strong></td>
</tr>
<tr>
<td></td>
<td>Medina eatery (<a href="http://www.medina-aberystwyth.co.uk/">http://www.medina-aberystwyth.co.uk/</a>)</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>08.00-09.00</td>
<td>Breakfast for those staying in campus accommodation on Monday night</td>
</tr>
<tr>
<td>09.00-10.30</td>
<td><strong>Session 2</strong></td>
</tr>
<tr>
<td></td>
<td>Chair: T. Ralph</td>
</tr>
<tr>
<td></td>
<td>G.C. Nanson, S. Tooth, <em>Why are Australian rivers so unlike those elsewhere?</em></td>
</tr>
<tr>
<td></td>
<td>C. Feeney, H. Smith, R. Chiverrell, J. Cooper, J. Hooke, <em>Modelling river channel change and estimating floodplain sediment residence times using CAESAR-Lisflood</em></td>
</tr>
<tr>
<td></td>
<td>B. Bodewes, R.L. Fernandez, S.J. McLelland, D.R. Parsons, <em>Impact of vegetation on braided river bank erosion and morphodynamics under changing flood conditions in a physical model</em></td>
</tr>
<tr>
<td></td>
<td>H. Sanders, S.P. Rice, P.J. Wood, <em>Biotic and abiotic drivers of the burrowing behaviour of invasive signal crayfish (Pacificastacus leniusculus): mesocosm experiments</em></td>
</tr>
<tr>
<td></td>
<td>W. Bertoldi, M. Welber, <em>The effect of discharge unsteadiness on glacier-fed river morphodynamics</em></td>
</tr>
<tr>
<td></td>
<td>I.D. Rutherfur, A. Flatley, <em>Mining river diversions: designing the largest artificial ‘natural’ channels on Earth</em></td>
</tr>
<tr>
<td>10.30-11.15</td>
<td>Tea/coffee break</td>
</tr>
<tr>
<td>11.15-12.45</td>
<td><strong>Session 3</strong></td>
</tr>
<tr>
<td></td>
<td>Chair: A. Thomas</td>
</tr>
<tr>
<td></td>
<td><strong>Gordon Warwick Award Lecture</strong></td>
</tr>
<tr>
<td></td>
<td>(45 minutes + 15 for questions/discussion)</td>
</tr>
<tr>
<td></td>
<td><em>On the role of process (bio + rock) geomorphology in landform evolution and urban ecosystems</em></td>
</tr>
<tr>
<td></td>
<td>Larissa Naylor (University of Glasgow)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>D.H. Buchanan, L.A. Naylor, M.D. Hurst, W.J. Stephenson, <em>Seasonal to decadal-scale shore platform erosion and boulder transport dynamics</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M. Mac Arthur, L. Naylor, J. Hansom, M. Burrows, <em>Hartlepool Headland ecological enhancement: findings from live coastal defence schemes</em></td>
</tr>
<tr>
<td>12.45-14.00</td>
<td>Lunch</td>
</tr>
<tr>
<td></td>
<td>To include a ‘brown bag’ discussion by Richard Jeffries and Katy Kemble</td>
</tr>
<tr>
<td></td>
<td>who will introduce the work of the new BSG Sub-Committee for Professional Geomorphologists</td>
</tr>
<tr>
<td>14.00-15.45 pm</td>
<td><strong>Session 4</strong></td>
</tr>
<tr>
<td></td>
<td>Chairs: Hywel Griffiths, Tom Holt</td>
</tr>
<tr>
<td></td>
<td><strong>David Linton Award Lecture</strong></td>
</tr>
<tr>
<td></td>
<td>(45 minutes + 15 for questions/discussion)</td>
</tr>
<tr>
<td></td>
<td><em>Geomorphology, complex systems, cross-disciplinarity and applications: a few bullets to feed the debate and let the rivers flow</em></td>
</tr>
<tr>
<td></td>
<td>Hervé Piégay (Université de Lyon)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rapid fire poster introductions (1 min, 1 slide maximum per presenter)</td>
</tr>
<tr>
<td>15.45-16.45</td>
<td>Tea/coffee break with poster session (see separate list of poster presentations)</td>
</tr>
<tr>
<td>Time</td>
<td>Location</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>16.45-17.45</td>
<td>Physics Main Lecture Theatre,</td>
</tr>
<tr>
<td></td>
<td>Physical Sciences Building</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>18.00-19.15</td>
<td>Physics Main Lecture Theatre,</td>
</tr>
<tr>
<td></td>
<td>Physical Sciences Building</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>19.30-22.30</td>
<td>Medrus Mawr, Penbryn Building</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>08.00-09.00</td>
<td>Ta Med Da, Penbryn Building</td>
</tr>
<tr>
<td>09.00-10.30</td>
<td>Physics Main Lecture Theatre,</td>
</tr>
<tr>
<td></td>
<td>Physical Sciences Building</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>10.30-11.15</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Location</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>11.15-12.30</td>
<td>Physics Main Lecture Theatre,</td>
</tr>
<tr>
<td></td>
<td>Physical Sciences Building</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>12.30-14.30</td>
<td>Physics Main Lecture Theatre,</td>
</tr>
<tr>
<td></td>
<td>Physical Sciences Building</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>14.30-16.00 pm</td>
<td>Physics Main Lecture Theatre,</td>
</tr>
<tr>
<td></td>
<td>Physical Sciences Building</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>16.00-16.15</td>
<td></td>
</tr>
<tr>
<td>16.30-21.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thursday 13th to Friday 14th September

08.00-09.00
Ta Med Da, Penbryn Building

Breakfast for those staying in campus accommodation on Wednesday night

09.30 onwards, returning to Aberystwyth by mid-late afternoon on the following day (Friday)

Optional mid Wales fieldtrip on Communicating Geoscience (Geomorphology and Quaternary Science)

Co-sponsored by the Quaternary Research Association

Leaders: Stephen Tooth, Hywel Griffiths, Marie Busfield, Sioned Llywelyn, Andrew Thomas

Destinations: Ystwyth, Elan, Clywedog and Dyfi valleys, and the adjoining coastline

List of poster presentations (alphabetical by first author, presenting author underlined):

E.R.C. Baynes, D. Lague, The destination and the journey: steady-state and transient configurations of bedrock channel geometry under variable sediment supply

L. Camelo, Understanding geomorphic response to flood events: filling in the data gaps

S.D.A. Clark, J.R. Cooper, P. Rameshwaran, P.S. Naden, M. Li, J. Hooke, Risk of river flood inundation under climate change: the effects of in-stream vegetation growth on flow conveyance

R.R. Colucci, M. Žebrė, E. Maset, C. Torma, A decadal positive mass balance of very small glaciers in the southeastern European Alps controlled by extreme seasonal precipitation events

C. Feeney, R. Chiverrell, H. Smith, J. Cooper, J. Hooke, Quantifying floodplain sediment residence times using a landform evolution model and Geographic Information System

G.C.H. Goodwin, S.M. Mudd, Salt marsh platform elevation within the tidal frame across Europe and North America: implications for wetland survival in the face of sea level rise

H. Griffiths, L. Barker, A. Corns, G. Devlin, T. Driver, S. Davies, P. Robson, R. Shaw, Geomorphological risks to coastal heritage: insights from Ynys Enlli, Wales, and Dunbeg fort, Ireland


R.M. Harries, L. Kirstein, M. Attal, A.C. Whittaker, B. Gailleton, What’s the gravel not telling you?

A.J. Hepburn, B. Hubbard, F.S.L. Ng, T.O. Holt, Quantitative comparison of Martian fretted terrain and Earth’s mesas


J.E. Johnson, D.R. Parsons, C.R. Hackney, The role of receiving basin substrate cohesivity in delta morphodynamics


R. Lewington, C. Newsham, Is this a Welsh landscape (after R.S. Thomas)? Perceptions of the changing Welsh landscape

P.E. Lisenby, S. Tooth, T.J. Ralph, Product vs. process? The role of geomorphology in wetland characterisation
K.E. Miles, B. Hubbard, D.J. Quincey, E.S. Miles, A.V. Rowan, T.D.L. Irvine-Fynn, Characterising the subsurface hydrology of a Himalayan debris-covered glacier using dye-tracing

I.E. Osumboroquwu, J. Wainwright, L. Turnbull-Lloyd, Gully-landslide interactions: an ecogeomorphological investigation

C. Pont, A. Whittaker, G. Roberts, Constraining landscape response times to tectonic forcing

T.J. Ralph, P. Harvey, Matching stakeholder concerns and scientific data for floodplain wetland management: a rapid assessment approach

T.J. Ralph, M.C. Rupic, Water and mud? Communicating and visualising wetland geomorphology for non-specialist stakeholder engagement

A.M Stefaniak, N.G. Midgley, S.J. Cook, Structural controls on supraglacial lakes identified through the application of Ground Penetrating Radar (GPR)


I. Thompson, J.W. Bridge, A. Savage, Characterisation and instrumentation of a small upland site for conservation-led Natural Flood Management: balancing science output with community monitoring

B. van der Waal, S. Tooth, P. Lisenby, F. Ellery, A geomorphological approach to the prioritisation of wetlands for sediment trapping: Tsitsa River catchment, South Africa

S.E. Watkins, A.C. Whittaker, R.E. Bell, S.A.S. Brooke, V. Ganti, Straight from the source’s mouth: controls on sediment export across the Corinth Rift, central Greece
8. ORAL PRESENTATIONS
(alphabetical order by first author, presenting authors underlined)
Since Pliocene times, the South Rifian Ridges (SRR) assumed their present structural setting as propagation anticlines and have accommodated partially the southwestward expulsion of the Rif chain in northern Morocco. This motion, which has continued to recent times, is due to the collision between the African and European plates and is favoured by the presence of the subsiding Gharb Basin, the distribution of deep Triassic rocks that constitute the main detachment level, as well as the activity of NE-SW major sinistral faults. These faults would have been reactivated to strike-slip mode, giving rise to salt tectonics during the Neogene and Quaternary compressive phases (e.g. the Nzala des Oudayas fault system), and also favoured fluid circulation (Sidi Fili fault system, in addition to the Ain Lorma fault). We are investigating the southern anticlines of the east branch of the arc of the SRR in order to evaluate the relative landscape maturity along these structures. However, no study has been done to compare the relative growth in this area. To do so, we characterised the tectonic geomorphology using geomorphic indices such as surface roughness, surface index, basin hypsometric curve and integral, as well as a normalized steepness index. Our geomorphic analysis suggests that the Quaternary landscape evolution was governed by tectonics, with a relatively high degree of tectonic activity along the eastern branch, especially In Dehar N’Sour as influenced by salt tectonics, and also in Nesrani and Takerma-Kannoufa anticlines close to the Nzala des Oudayas fault system, which is still active. Moreover, fault zones exert a strong influence on the morphology of the streams and adjacent area.

Keywords: landscape maturity, southeastern anticlines, South Rifian Ridges, Morocco
Extreme flood events have the potential to cause catastrophic landscape change in short periods of time ($10^0$ to $10^3$ h). However, their impacts are rarely considered in studies of long-term landscape evolution ($>10^3$ a), because the mechanisms of erosion during such floods are poorly constrained. Here, we use topographic analysis and cosmogenic $^3$He surface exposure dating of fluvially sculpted surfaces to determine the impact of extreme flood events within the Jökulsárgljúfur canyon (northeast Iceland) and to constrain the mechanisms of bedrock erosion during these events. Surface exposure ages allow identification of three periods of intense canyon cutting at ~9 ka, 5 ka, and 2 ka, during which multiple large knickpoints retreated large distances (>2 km). During these events, a threshold flow depth was exceeded, leading to the toppling and transportation of basalt lava columns. Despite continuing and comparatively large scale (500 m$^3$/s) discharge of sediment-rich glacial meltwater, there is no evidence for a transition to an abrasion-dominated erosion regime since the last erosive event because the vertical knickpoints have not diffused over time. We provide a model for the evolution of the Jökulsárgljúfur canyon through the reconstruction of the river profile and canyon morphology at different stages over the last 9 ka and highlight the dominant role played by extreme flood events in the shaping of this landscape during the Holocene.

Keywords: canyon formation, erosion, extreme events, flooding, knickpoints
Discharge and sediment supply in glacier-fed rivers exhibit daily and seasonal cyclic fluctuations, which may impact the sediment transport processes and the morphological evolution at various temporal and spatial scales. In this study, we used a physical model of a gravel-bed river to investigate the effect of discharge unsteadiness on: 1) the sediment transport flux; 2) the bed surface grain size distribution; and 3) the river bed morphology. The physical model consisted of a 24 m long, straight channel with fixed banks. Three values of channel width (0.2, 0.4 and 0.6 m) were reproduced in order to obtain a range of channel configurations (plane bed, alternate bars, wandering). The flume was filled with a poorly-sorted sediment mixture with median grain size of 1.3 mm. Discharge and sediment supply were software controlled, and bedload was monitored using a continuous weighing system. Topographic information was acquired using a Structure-from-Motion photogrammetry technique, and continuous photographic survey provided innovative data on bed load activity and surface grain size distribution. Daily discharge fluctuations were simulated as sequences of 30 identical, symmetrical triangular hydrographs, with sediment supply set to: 1) transport capacity; and 2) an anticipated peak by assigning a phase lag to the transport capacity. Results show that mean bedload output is higher during the rising phase, resulting in a clockwise hysteresis cycle with respect to water discharge. Active width shows opposite behaviour, with a counterclockwise hysteresis. In the case of alternate bars and wandering morphologies, clear sorting patterns are also visible. The experiments highlighted complex flow, sediment transport, and grain size relationships with significant differences when a sediment supply lag is introduced, as possibly caused by selective transport processes and river bed morphological adjustment.

Keywords: bedload transport, discharge unsteadiness, physical model, sorting pattern

Social Media: https://glori.projects.unibz.it/
Off-site impacts of soil erosion and runoff: why connectivity is more important than erosion rates

J. Boardman [1,2], K. Vandaele [3], R. Evans [4], I.D.L. Foster [5,6]


Off-site impacts of soil erosion are of greater social and economic concern in western Europe than on-site impacts. They fall into two related categories: 1) muddy flooding of properties; and 2) ecological impacts on watercourses due to excessive sedimentation and associated pollutants. Critical to these impacts is the connectedness of the runoff and sediment system between agricultural fields and the river system. We argue that well-connected systems causing off-site damage are not necessarily related to areas of high erosion rates; emphasis should therefore be on the way in which connections occur. In temperate, arable systems, important elements of connectivity are anthropogenic in origin: roads, tracks, sunken lanes, field drains, ditches, culverts and permeable field boundaries. Mapping these features allows us to predict how they affect runoff, to evaluate its impacts, and to design appropriate mitigation measures. Published maps and models are not reliable guides to connected systems. Field mapping and observation, aided by remote sensing, is necessary.

Keywords: connectivity, field mapping, runoff and sediment flux, soil erosion, off-site impacts
Climate change predictions suggest both a higher magnitude and an altered frequency of flood events, both of which will impact braided river systems. However, there is uncertainty regarding how the behaviour of river systems will change in response to new patterns of flood events and how vegetation, which may also be altered by new climate regimes, will influence these changes. Small-scale physical models are a valuable tool to investigate the processes of channel change, and previous work has shown how surrogate vegetation interacts with fluvial processes in braided rivers (e.g. Tal and Paola, 2007, Bertoldi et al, 2015).

This study aims to investigate how surrogate vegetation at different stages of growth interacts with different flood sequences. Using two 2.5 m wide and 10 m long flume channels, we allowed a braided river system to evolve under constant flow and sediment input conditions. After an equilibrium braided river system was allowed to develop, we periodically seeded Alfalfa, a cress-like species, and allowed it to grow over variable periods. Following each period of vegetation growth, we introduced a sequence of low and high magnitude flood events in order to capture the change in morphology. Digital Elevation Models (DEMs) of the braided river system evolution were captured using a laser scanner (1 mm resolution). These DEMs are used to evaluate the impact of surrogate vegetation in stabilising river channel morphology, and the effect of flood events on erosion and deposition throughout the braided river system. The distinct patterns of erosion and deposition not only allow us to investigate the effect that flow and vegetation have on the braided system, but also enable us to pinpoint these effects on the evolution of important morphologic features like bars and banks. Ultimately, this can give an indication of how different flood events induce change in braided river systems and the stabilizing influence of vegetation.

Keywords: braided rivers, physical models, vegetation, DEM, morphology

References:

Social Media: @basbodewes
Rock coast erosion is an irreversible process since the eroded material is inevitably broken down or transported away from the system. Recent studies have demonstrated that significant changes can take place during single storm events or storm seasons, but a detailed understanding of processes and rates of rock coast evolution remains enigmatic. Previous studies on shore-platform erosion have focused on surface downwearing (mm) over short timescales (~1 to 2 years), with block-scale erosion (cm to m) receiving comparatively little attention. The differences in spatial scale and the stochastic nature of block generation on shore platforms motivate further study of the detachment and transport of shore platform blocks. The integration of processes operating at the event scale to drive long-term landscape change remains an outstanding frontier across geomorphology. Therefore, this research combined observations of short-term erosive events and longer-term coastal change to quantify the morphogenesis of a rocky coast.

Here, we present one of the first intertidal rock coast studies operating at a meso-scale (cm to m) over multiple decades to seasons. First, we quantified the volumetric rate of platform erosion over a multi-decadal, decadal, and seasonal scale on the Glamorgan Heritage Coast. The geomorphic change was analysed using Unmanned Aerial Vehicle (UAV) and soft-photogrammetry techniques to construct Digital Elevation Models (DEM$s$), and the volumetric analysis was undertaken in ArcGIS$. Our results demonstrate a non-linear threshold dominated system, whereby the observed change was episodic and quick. Second, blocks are liberated from shore platforms and are subsequently transported. Therefore, we tracked the movement of 160 clasts over the winter season. We quantified the boulder transport dynamics to understand boulder residency times within boulder accumulations and also delineated the hydrodynamic forcing required to initiate transport.

Keywords: boulder transport, intertidal, platform erosion

Social Media: @dhbuch
Blanket bogs are designated for unique flora and fauna, and for terrestrial carbon storage. These habitats are rare and predominantly form in oceanic climate conditions. In Spain, blanket bogs have only been studied in Galicia and Bizkaia regions but a significant number of unmapped blanket bogs exist in other regions in northern Spain. These areas are unprotected and therefore exposed to anthropogenic pressures that might be influencing peat stability.

This study assessed two unmapped blanket bogs in Cantabria (Ilsos de Zalama and Collado de Hornaza) and one protected bog in Bizkaia (Zalama). Conventional techniques were used to map the extent of the blanket bog and more novel techniques involving Terrestrial Laser Scanning (TLS) were applied to understand the current rate of surface change in ultra-high resolution (<2 mm) and estimate the rate of peat and carbon loss. A total extent of 18.3 ha of previously unmapped blanket bog was identified, with maximum peat depth ranging from 2.16 to 2.82 m. Annual rates of erosion range from ~3.9 cm/a in the protected Zalama bog, to ~5.5 cm/a in Ilsos de Zalama and ~7.4 cm/a in Collado de Hornaza. However, high rates of deposition were also identified at each site, reducing the overall surface change (lowering) to ~1.3 cm/a in Zalama, ~0.5 cm/a in Ilsos de Zalama and ~2.8 cm/a in Collado de Hornaza, and highlighting that not all eroded peat is leaving the system. The proportion of organic material in the peat has been determined from peat cores and the annual rate of carbon loss is being assessed. Annual erosion rates determined in these blanket bogs are higher than the global mean peat erosion rate (2.2 cm/a) and ultimately are driven by fluvial and aeolian processes. However, the determined erosion rates were greater in unprotected (unfenced) areas, which highlights the potential impact of grazing livestock and suggests that protection and restoration is required to prevent carbon loss.

Keywords: carbon loss, erosion, peatlands, Spain, TLS

Social Media: @guaduneth
Over the past few years, several papers have explored the notion that Geomorphology as a discipline is potentially less visible in its contribution to help solve many of the key environmental challenges typical of the twenty-first century. It has been suggested that this is in part due to how we ‘communicate’ our science, a key theme of this meeting. Many of these earlier works propose solutions for better communication strategies: getting the message clear and adopting sensible principles of clear communication style. However, whether intentionally or unintentionally, they endorse the paradigm of ‘us and them’: there is ‘us’ the knowledge keepers and ‘them’ the knowledge seekers. This presentation explores my direct experiences and learnings over the past three decades of research in Australia where I held positions that put me on both sides of this invisible ‘fence’ and provided fertile ground for the (re)-evaluation of communicating geomorphology. Rather than focusing entirely on ways to change ‘them’, I am proposing the benefit of first having the ‘more uncomfortable conversations’ amongst ourselves. Specifically, I examine the ‘three Ts’ – terminology, territoriality and tribalism – and their role in how and what we communicate. Unclear and inconsistent terminology is a key barrier to the practical application of our research in policy and planning. Likewise, traditional and somewhat systemic practices of territoriality allow for limited creativity and scientific questioning in some areas of research or geographic location. Tribalism, whether we are conscious of it or not, often forms a barrier to honest, open and effective communication. Open-hearted exploration of these ‘three Ts’ may provide fruitful insights into some invisible barriers to communicating better and with greater integrity.

Keywords: communication, terminology, territoriality, tribalism
Exploring the hidden potential of error bars on geochronological data sets for better delineation of flood and drought events

J. Croke [1], R. Denham [2], J. Vitrovsky [2]


Over the past decade, the required standard of geochronological data sets has increased considerably with much greater attention now given to the quality of the dated material (e.g. using radiocarbon, or optically stimulated luminescence (OSL)) and also to the associated statistical methods employed to assure their appropriate statistical integrity. Numerous studies have explored different methods to interpret statistical distributions of geochronological data sets from single or multiple catchments and broader geographic regions. The necessity to report standard error bars seems logical given inherent uncertainties but there is limited real ‘use’ of the resultant distribution and there seems no way of using this information to help determine improved understanding of the timing of discrete events such as floods. This presentation uses a comprehensive data set of over two hundred OSL dates obtained from southeast Queensland in Australia to explore the possibilities of using error bars to better determine the frequency of discrete flood events. It provides a positive contribution to the field of geochronological data interpretation and opens up the possibility of improved certainty in determining flood frequency over time.

Keywords: error bars, flood events, geochronology, statistical distributions
On the conflict between geomorphic processes and land use activities in Wadi Soba watershed


Urbanization in Khartoum State, Sudan, rapidly increases and is accompanied by remarkable land use change, including in rural areas. During the 2013 rainy season, some villages in the Wadi Soba rural watershed were severely damaged due to a devastating flood. The cause could not be clearly related to natural or man-made reasons, so this study uses remote sensing (RS) change detection analysis techniques coupled with a Geographical Information System (GIS) platform to investigate the relation between land use practices and fluvial geomorphic processes. Landsat satellite data are reviewed, including MSS/1972, TM/1987, ETM+1999 and OLI 2013. Different RS/GIS pre-processing techniques were applied, including subsets, radiometric and atmospheric corrections. Flood magnitude was quantified by applying the US Natural Resources Conservation Services (US-NRCS) method. The major changes detected and interpreted in Wadi Soba watershed between 1972 and 1987 were the construction of Elsiliet Scheme and the developments of farms at the watershed outlet. This causes obstruction of the natural runoff of the main channel of Wadi Soba and diverts water in a southeast direction. Between 1987 and 2000, the Elsiliet Scheme expanded, including urban expansion around Soba and Magharba areas. This plays a major role in disturbing the geomorphic processes, especially the surface runoff and water flow to open spaces rather than the main wadi channel, which is populated by new urban expansions. The major land use change between 2000 and 2013 is the construction of Elailafon Highway. The rainfall-runoff analysis shows that the values of the weighted Curve Number for the soil antecedent moisture conditions AMCI, AMCII, and AMCIII were 71%, 85% and 93%, respectively. For the year 2013, out of 11 daily rainfall events, only two were effective (16 mm (AMCII) and 41 mm (AMCI)), resulting in 4.46 mm annual runoff. The computed volumes are 6.5 and 5.9 million m³ for 1456 km² (watershed) and 1325.6 km² (sub watershed), respectively. 80% of the annual runoff was generated from the 41 mm event (5.1 and 4.7 million m³ for the respective watershed areas). Bearing in mind that this rain event happened in a dry soil moisture condition (AMCI), then the resultant runoff in the case of moderate and wet conditions would be much more catastrophic. Although the flood volume seems to be high, it is clear that the destruction happened due to the land use change, particularly the unplanned settlement expansion and the construction of Elailafon Highway.

Keywords: change detection analysis, flash floods, land use, Wadi Soba
Floodplain sediment storage has numerous implications for soil and water quality, notably the persistence of sediment-bound macronutrients and potentially harmful elements (e.g. metals released from historic mining activity). River channel change is the primary means of sediment removal and storage in floodplains via erosion and deposition. Sediment storage and removal is monitored through a variety of methods such as fallout radionuclide tracing and reconstructing historic morphological changes from Ordnance Survey maps. Landform evolution modelling can complement these methods by capturing detailed channel changes over longer timescales and by simulating hypothetical scenarios to enhance understanding of drivers of changes in fluvial sediment storage. CAESAR-Lisflood is a landform evolution model capable of simulating variable channel width, divergent flow, and both braided and meandering planforms at reach and catchment scales. This is a more complete set of lateral floodplain reworking processes than has been captured by utilising topographic steering models.

Here, historic channel changes along 10 reaches were reconstructed by modelling and compared with mapped data. Simulation periods were defined by the intersection of available historic map and daily flow datasets. Light Detection and Ranging (LiDAR)-derived 2 m Digital Elevation Models were modified to introduce historic channel locations and re-sampled to coarser resolutions to reduce run times. Calibration consisted of modifying selected parameters - primarily the lateral erosion rate and in-channel erosion rate parameters - to obtain best fits between observed and modelled channel planforms. Estimated residence times from modelled channel changes were compared with the historic map record. Results suggest the model accurately reproduces observed recent historic planform changes, as well as average erosion, deposition and lateral migration rates.

Keywords: channel change, floodplain, sediment, residence times
The role of large earthquakes in developing topography in continental collision zones has been debated over recent years. Large earthquakes (magnitude >6.5) erode rock by producing vast numbers of bedrock landslides. The volume of landsliding can match the volume of crust that is uplifted during an earthquake. However, as large earthquakes are rare events (return periods >500 a), the importance of these quakes for the overall generation of erosion in mountains remains poorly understood.

We calculate the importance of earthquakes in orogenic development via a seismic volume balance model. We model the regolith thickness, surface and bedrock uplift in a mountain range with stochastic earthquakes. The results demonstrate that the regolith can remain within an orogen for the length of a seismic cycle and reduce bedrock erosion during this time. Regolith moves from the hillslope slowly in a cascade like fashion, spending much of its time primed for failure via infrequent events in first order catchments. Earthquakes with a magnitude >7 are responsible for ~37% of bedrock erosion in continental collision zones and are the largest regolith production events. Uplift from smaller earthquakes and aseismic processes build topography after large earthquakes as the regolith shields the bedrock from erosion. Short term erosion rates are therefore highly dependent on the maximum earthquake magnitude and the sediment flux out of the system. Long term erosion rate estimates need to average across a time period with at least one large earthquake to be representative. During landscape evolution, models commonly assume that there is a coupling between fluvial and hillslope sediment fluxes but hillslope fluxes are much less well constrained than fluvial due to the stochastic nature of regolith production. The stochastic nature of earthquakes and catchment sediment cascades must be taken into account when looking at the long term evolution of landscapes.

Keywords: earthquakes, landslides, landscape evolution

Social Media: @GeomorphOllie
Debris flows, rapidly moving flows of sediment and water, are a major source of risk after a large earthquake. They are particularly damaging within the context of the earthquake hazard chain that includes aftershocks, landslides, landslide dams, debris flows, and enhanced flooding and sedimentation. Within this multihazard context, each hazard presents a different challenge to developing resilience, in part because each hazard has a varying spatial distribution. Developing resilience in this multi-hazard environment requires flexible, honest hazard models, and strong leadership and governance within the administrative areas affected by the hazard. Complicating the development of resilience is that administrative boundaries are disconnected from catchment boundaries, meaning that different administrative units will be exposed to contrasting elements of the hazard chain. Hence, the management of risk and resilience is strongly dependent on the scale of the administrative unit and the scale of hazards.

We examine the case for the use of adaptive management strategies to improve the resilience of towns to debris flow risks. First, we demonstrate the inherent challenges with statistical and engineering strategies that cannot adequately evaluate the strongly non-linear response of debris flows to differences in pore water pressures within the flow and bed material. In light of these challenges, we suggest that reliance on statistical and engineering approaches may give local areas a false sense of potential risk (or lack thereof), the so-called levee effect. Second, we develop a method for using detailed physically-based hazard models as a tool for simply describing hazard. Third, we discuss this method as a pathway to developing resilient adaptive strategies in post-earthquake environments.

Keywords: debris flows, hazards, risk, resilience, hazard chain

Social Media: @tchalesnz
Debris flow hazards pose a risk to inhabitants of the Longmenshan, China, as they attempt to recover from the 2008 Wenchuan earthquake, which generated in excess of 3 km$^2$ of sediment via coseismic landsliding. Identifying catchments most at risk to debris flow hazards is a key component of management strategies seeking to build resilience to geohazards in the region. In the Longmenshan, inadequate assessment of the final volume and runout extent of extreme events has resulted in the catastrophic failure of a number of mitigation measures.

To assess the controls on debris flow volumes, we adapted a physically based model of debris flow evolution (Massflow). We constrained the model parameters by replicating an historic debris flow event from the Longmenshan, and then performed a sensitivity analysis to understand the role of each parameter in controlling debris flow bulking. We demonstrate that the model is most sensitive to the parameter representing the amount of water incorporated into the flow from the underlying bed material, with the final runout volume increasing several orders of magnitude within a narrow range of expected parameter values. We then applied the parameterised model to adjacent catchments, where it was able to model debris flow extents adequately. We suggest that once parameterised, this detailed, physically based model may act as a useful predictive tool for estimating the possible extent of extreme events, and thus form the basis of a catchment-scale debris flow hazard assessment.

Keywords: debris flows, natural hazards, Wenchuan earthquake, susceptibility mapping
Despite remarkable improvements in both water quality and ecological status in many UK rivers over the past three to four decades, microplastic contamination of channel systems has passed under monitoring and regulatory radars. More widely, the global microplastic budget is not well understood because fundamental processes and data associated with sources, stores and fluxes are poorly documented. We report patterns of microplastic contamination, classified by type, size and density, in channel bed sediments at 40 sites across urban, suburban and rural river catchments in the upper Mersey and Irwell of northwest England. The geomorphology of these systems is typical of many rivers across the UK and beyond. Microplastic contamination was pervasive on all river channel beds. In areas with both high population densities and industry, we observed multiple urban contamination hotspots with a maximum microplastic concentration of >500 000 particles/m². After a period of severe flooding in the winter of 2015/16, microplastic concentrations fell at 28 sites and 18 saw a decrease of one order of magnitude. Following flood-driven channel bed scour, hydraulic sorting, and microplastic flushing, we observed a distinctive reorganization of microplastic types. The winter flooding exported approximately 70% of the microplastic load stored on these river channel beds (equivalent to 0.85 ± 0.27 tonnes or 43 ± 14 billion particles) downstream and eradicated microbead contamination at several sites. We discuss potential sources of microplastics in these systems. We conclude that microplastic contamination is efficiently flushed from river catchments during flooding and that heavily populated urban rivers are the major supplier of microplastics to the oceans.

Keywords: catchment, channel, contamination, microplastic
Large, deep-seated landslides are common throughout the southeastern San Juan Mountains of Colorado and New Mexico, USA, but their timing and initiation are not well understood. Determining when the landslides occurred would aid in clarifying the mechanisms for initiating landslides in the region and would help us to understand post-glacial landscape evolution. We studied seven pre-historic landslides located within the Tertiary volcanic rocks of the San Juan Volcanic Field. The landslides range in area from ~0.8 km$^2$ to ~11.3 km$^2$ and most are located in areas that were previously mapped as having been ice covered during the last glaciation. Landslide deposits were dated using a variety of methods including surface exposure dating ($^{36}$Cl), radiocarbon dating of basal bog sediments and organic material buried in soils, and relative soil development. The resulting limiting ages range from approximately 14 ka to 2 ka and show that deep-seated landsliding has occurred throughout the post-glacial period. This broad range in ages is inconsistent with our initial hypothesis, which proposed that landslides were likely the result of debuttressing of glacial walls during glacial retreat. Furthermore, the timing of landslides does not seem to correlate with documented post-glacial climatic shifts. Therefore, we conclude that landsliding in the region was the result of wetter than normal periods lasting months to years acting on weak bedrock that was preconditioned to failure and prepared by glacial debuttressing. Our findings suggest that the study area is likely still susceptible to deep-seated landsliding and may become even more prone to large-scale slope failure if future climate change increases precipitation in the San Juan Mountains.

Keywords: landslide chronology, precipitation, post-glacial landscape evolution, San Juan Mountains, climate
Holocene flood histories in UK and Irish river catchments


Extended records of riverine flooding are needed to ascertain the magnitude-frequency relations of high-magnitude floods in order to produce accurate estimates of present and future flood hazard. Analysis of vertically-accreted floodplain sediments can supply evidence of major flood events through the late Holocene. This study uses high-resolution analysis to identify deposits of major floods within floodplain sediments from catchments in the UK and Ireland. Floodplain geomorphology at sites within the Severn, Wye and Boyne catchments was mapped using Light Detection and Ranging (LiDAR) data and field survey. Sediment cores were collected from palaeochannel and floodbasin environments. Profiles of variation in elemental abundances with depth are provided by Itrax XRF core scanning. Log ratios of lithogenic elements are employed as sediment grain size proxies to indicate varying flood magnitudes. The suitability of each potential grain size proxy is assessed by comparison with independent grain size data at two different scales: results from laser granulometry for subsamples of 5-10 mm thickness, and direct analysis of particle size at the sub-millimetre scale using images acquired by scanning electron microscopy. Ages are assigned to the flood record using a combination of radiocarbon dating, sediment chemistry, and comparison with instrumental and historical flood records. The instrumental and historical flood data are also used to assess the likely magnitudes of major floods identified within the sedimentary record. The project reports on temporal variations in flood magnitudes and frequencies during the late Holocene.

Keywords: floodplain, Holocene, palaeoflood, sedimentary archives, XRF core scanning
The application of geomorphology to help solve water-related problems in industry has developed considerably over the past decade, to the extent that it now often forms a key part of the design of projects (from strategy to concept, feasibility, design, construction and post-construction). Significantly, geomorphology is pivotal in compliance with environmental assessments such as the Water Framework Directive. Geomorphology sits between conventional engineering approaches and traditional ecology disciplines and, therefore, has a key role in sustainable development. There are many examples of successes, as I will demonstrate. However, numerous challenges to delivery of sustainable projects remain. These includes tight programmes and budgets, continued omission of geomorphology as a discipline early in the life of a project, lack of numbers of experienced/skilled geomorphologists, and the need for training and awareness of the next generation of water managers. Geomorphology requires available scientific knowledge but also needs the application of that knowledge through the ‘art’ of informed professional judgement. A crucial part of this ‘art’ is understanding the environment in which the problem or issue lies, and trying to select/adapt tools that can be applied. Geomorphology can provide a key spatial and temporal context that could be overlooked by a more traditional engineering approach. This presentation focuses on two key project examples: a reservoir discontinuance near Glossop in northwest England, and a collapsing road bridge near Ullapool in northwest Scotland. It then draws upon generic learning lessons from the author’s experience in working on many projects, and comes up with some good practice guiding principles for integrating geomorphology into industry.

Keywords: geomorphology, industry examples, sustainable development
Various in-channel constructions affect the morphology of the Tisza River (Hungary), distorting the channel and confining the floodplain, thus influencing the flood conveyance. Our aims are to analyse the hydrological and morphological responses of the lower Tisza River given these engineering works, and to evaluate the river’s equilibrium state. Artificial cut-offs and embanked levees were made until the 1880s, and the next decades (1890-1920s) demonstrate the response time. Channel cross-sectional parameter changes include incision (+2.4 m), widening (+10 m), and area increases (+124 m$^2$). Therefore, the duration of low stages increased (6 times), the lowest water stages dropped (+1.38 m), and floods became shorter in duration. As floods could not spread on the former floodplain, however, the peak flood levels increased (+0.88 m). These processes were terminated by revetment constructions (1930-1960s). Channel cross-sectional area declined (-11%) despite the ongoing incision (+3.2 m) because point bar development decreased the channel width (-12-48%). As the flood conveyance capacity and the slope decreased, the duration of floods increased (30-33 d/a) and new peak flood levels (+0.74 m) developed. The considerable upward shift of the QH-curves refers to flood conveyance loss. As revetments increased the incision, new low water level records were set, and the duration of low stages increased. The incision became so intensive that most of the point bars disappeared and a quarter of the revetments was destroyed. Since 1977, a downstream lock dam affects the river. The level of mean and low stages increased and the slope drastically decreased due to the impounding effect of the dam. The hydromorphological responses of the river to the various engineering interventions varied depending on the possibility of self-regeneration, and the duration of disturbance. The non-equilibrium state is not uniformly expressed along studied reach, as the upper section got farther from the equilibrium.

Keywords: artificial cut-off, levee construction, revetment construction, hydromorphological response, disequilibrium state
Biological soil crusts (BSCs) have been reported from all the Earth’s drylands. They develop from the association of soil particles and organic matter with varying proportions of cyanobacteria, algae, lichens and mosses. They affect numerous soil processes and characteristics, including carbon and nitrogen cycles, moisture, microbial diversity, and erodibility. Although this microscopic component has the potential to modify dryland geomorphological, hydrological and ecological processes over local to landscape scales, the links between BSC characteristics (e.g. composition, successional state) and functions remain poorly understood. This is partly due to the significant spatial diversity of BSC types at different scales. To illustrate some of the spatial and temporal complexities in BSC characteristics and function, this presentation will draw on data from different global drylands, including sites in China, Botswana and Spain.

In the Tengger Desert near Shapotou, China, BSC succession generally proceeds from cyanobacterial, through lichen, to moss crusts. By contrast, in the Qubiq Desert near Dalate Banner, China, BSCs succeed directly from cyanobacterial to moss crusts without a lichen stage. A comparison of these BSCs reveals that crust silt content has a facilitating effect on lichen development and succession to lichen-dominated stage. Early colonizing cyanobacterial species in BSCs not only provide a stable soil surface, but also the biomass basis for succession. Further experimental work undertaken in Dalate Banner, where mosses were artificially inoculated, suggests that prior crusted soil surfaces and water holding capacities >4% are pre-requisites for moss germination and succession to a moss-dominated stage. Moss-dominated BSCs also have significantly higher carbon (C) fixation efficiency compared to cyanobacterial and lichen-dominated BSCs.

In addition to BSC development and succession, different geomorphological settings influence the amount of C that BSCs can sequester and store. In the Qubiq (Zhuangeer Banner, China) and Kalahari (Tsabong, Botswana) deserts, sandy BSCs on dunes possess relatively low C contents (1.82-9.64 g/C/kg), while silty BSCs on gypsum-rich pans near Alcañiz in Spain possess significantly higher C contents (45.7-78.3 g/C/kg). Increased soil C content is associated with a significant reduction in cyanobacterial abundance and an alteration of species composition from *Microcoleus steenstrupii*-dominated to *Microcoleus vaginatus*-dominated BSCs. Depending on BSC development, succession and C storage, different dryland management measures may be needed to maintain the integrity of the crusts and associated ecosystem services.

Keywords: biological soil crusts, dryland, succession, carbon, geographic regions
Does pebble abrasion influence detrital age population statistics?

C. Lavarini [1], M. Attal [1], C. A. da Costa Filho [1], L.A. Kirstein [1]

[1] School of GeoSciences, University of Edinburgh, Edinburgh, UK

Pebble abrasion is a key factor controlling the release of minerals into sand, but few attempts have been made to model how it could influence the liberation of minerals into the size fraction used in detrital geochronology. We perform a series of experiments with an abrasion model to test this influence using natural and synthetic datasets. Our results demonstrate that pebble abrasion can change the zircon mixing proportions of upstream source units as well as the age distribution of mixed fluvial sands. This change is particularly significant when there is strong contrast in rock resistance within the watershed. Pebble abrasion is one of many factors that can change the mixing proportion of sands, including hillslope gravel supply, erosion rates, and mineral fertility. In our study case (Marsyandi watershed, Himalaya), the abrasion model predicts age distributions that are statistically indistinguishable from those predicted by a no-abrasion model. However, the relative erosion rates estimated by our model largely differ from the results of a no-abrasion model, and are closer to those from other studies that suggest a strong correlation between modern erosion rates, tectonics, and precipitation intensity in the Marsyandi watershed. These findings highlight that, even in cases where there is no statistical evidence of change between the modelled age distributions, abrasion can affect the erosion rates estimated from them. Therefore, quantifying the influence of abrasion on sand production is an essential step not only to predict mixing proportions but also to accurately retrieve erosion rates from the measured grain age distributions.

Keywords: abrasion, bias, geochronology, provenance, sediment
Relating to a conference theme of communication in geomorphology, three broad questions are addressed using images past and present – messaging through images being perhaps the most powerful means for transmitting convincing ideas. For the realm of geomorphology, such images are here used to explore what societies like and what they fear. Changing philias and phobias have come to form complex amalgamations of belief, and this is illustrated using a set of images covering about the past 500 years.

The question is then posed as to whether we, as professionals, are satisfying what’s wanted in this context. Do we sufficiently satisfy – or change for the better – belief complexes at levels from the political to the personal with the renderings of reality that we can now give? Relevant fluvial illustrations for what some research has more recently evolved to provide come from 50 years of personal explorations of rivers and floodplains. Linking public perceptions to professional geomorphological knowledge, such as to command mutual understanding and benefit, appears still to be a major challenge.

Keywords: belief, communicating, images, public perception
How can we integrate geomorphology into the promotion of Wales's geoheritage?

S. Llywelyn [1], S. Tooth [1], H. Griffiths [1], C. Jones [1]

[1] Department of Geography and Earth Sciences, Aberystwyth University, Aberystwyth, UK

There is a need to increase the visibility of geomorphology as a discipline; as a term it is unfamiliar and poorly understood. There is also a need to improve the communication of geomorphology as a subject matter, both to wider scientific audiences and the general public, so that its importance to society can be demonstrated. One key area of importance is geomorphology's potential role in geotourism. Here, we discuss how identification of geomorphosites can be used to promote outdoor opportunities and also enhance visitors' experiences. Geomorphosites (first defined by Panizza, 2001) are landscape sites to which different values can be attributed (mainly scientific value, but also cultural, historical, ecological, aesthetic and economic). Using three published methodologies, and one bespoke methodology, we have identified and assessed 30 potential geomorphosites across Wales. A numerical score is given for four values at each site: scientific; cultural; additional (ecological, aesthetic); usability. For higher-scoring sites, can integration of cultural elements be used as a gateway to interest or inform about landscapes and geomorphological processes, and thus enhance the overall visitor experience?

We have used three case studies to test this approach (Devil's Bridge waterfalls, local coastal/glacial features in Ceredigion, Elan Valley uplands). Using various outreach approaches (brochures, audio trails, science-culture events, leaflets, interactive websites), their usefulness and effectiveness in enhancing the visitors' experience are being tested using different qualitative methodologies (questionnaires, open feedback, interviews, focus groups). Thus far, findings show that despite abundant links between landforms, culture and heritage across Wales (e.g. in literature, art, poetry, music), and the fact that Welsh geomorphosites are of comparable importance to those in continental Europe, many remain under-promoted and under-utilised as visitor attractions. Interdisciplinary approaches that blend different information (e.g. geomorphology, geology, ecology, archaeology, literature, visual arts, legends) are a key way to attract more visitors and enrich their experiences.

Keywords: communication, geoheritage, geomorphosites, geotourism, outreach

Reference:

Social Media: @sionedllywelyn
The Hartlepool Headland Coastal Defence Scheme began construction in 2015 and consists of a new seawall and rock armour installation. Recommendations were made to optimise the ecological and habitat potential of the site. This was done through material choice, selecting the construction material based on roughness, and carefully positioning the boulders for the rock armour so that surface depressions were oriented upwards to replicate natural features on rocky shores. These were implemented at the onset of construction in order to maximise ecological potential and fulfil engineering criteria. To determine whether these passive forms of ecological enhancement made a difference, species richness and abundance were compared between passively enhanced boulders and non-enhanced boulders at the site. After 12-18 months, species richness on passively enhanced rock armour was greater on average than non-enhanced areas. Initial data also show that with carefully enhanced design criteria, the installation can match baseline biotope conditions for several key species after 18 months.

Following these results, a further study was developed examining the importance of material choice in influencing colonisation of species. This study compares Shap granite at Hartlepool with Norwegian granite that has been deployed for the same length of time at nearby Skinningrove. Results indicate that the lighter, rougher, passively enhanced Shap granite had greater mobile species abundance after 24 months than the darker, smoother Norwegian granite that was not deployed with passive enhancement recommendations. This work reports on the findings from the design and ecological enhancement criteria recommendations that have been gathered from the continued monitoring of these sites. These findings will be used to better inform more sustainable engineered designs in future.

Keywords: coastal engineering, ecological enhancement

Social Media: @macmairi1
The Aral Sea basin in central Asia, along with its major rivers the Amudarya and Syrdarya, was the centre of one of the world’s most important river civilizations. Extending over an area of c. 1.5 million km$^2$, it was the principal hub of the Silk Roads that connected China, India, Mesopotamia and the eastern Mediterranean over a period of more than 4000 years. Floodwater farming in the region was practiced on alluvial fans in the Tien Shan and Pamir piedmont, in floodouts, in river valley corridors, and in delta distributaries adjacent to the Aral Sea. However, since pioneering research by Soviet archaeologists in the 1970s, these culturally influential potamic societies have not been the subject of modern geoarchaeological investigation, particularly those using AMS 14C and luminescence dating techniques.

This presentation reports the results from new, multi-period geochronological studies of central Asian riparian settlements and river systems, including irrigation canals of the Otrar oasis in the Syrdarya basin (a UNESCO World Heritage Site) that were destroyed by the invading Mongol army in 1219. Past and present regional river dynamics and flooding are controlled by runoff generated by glacier and snow melt from mountain headwaters in the southern part of the Aral Sea basin. Periods of increased Holocene river flow and high water levels in the Aral Sea were associated with neoglacial episodes. These hydrological conditions were conducive to agricultural expansion in the Aral Sea basin lowlands, whereas floodwater farming in upstream piedmont regions developed under conditions of lower or reducing flow. Probably more than any other Old World river civilization, warfare and the deliberate destruction of irrigation infrastructure had a more significant impact on the evolution of river morphodynamics. Together with significant climate-related fluctuations in hydrology, this has resulted in punctuated settlement timelines that are also spatially variable along river corridors.

Keywords: Central Asia, climate change impacts, floodwater farming, river civilizations, Silk Roads
The underwater architects of gravel-bed rivers

R. Mason [1], S. Rice [1], P. Wood [1], M. Johnson [2]

[1] Department of Geography, Loughborough University, Loughborough, UK; [2] Department of Geography, University of Nottingham, Nottingham, UK

Traditionally, fluvial geomorphology has focused on physical processes within river systems. Increasingly, however, animals and plants are recognised as having substantial impacts on the erosion, transport and deposition of sediment. Caddisfly (Trichoptera) are sediment engineers. The construction of structures, including mobile and static homes (cases), has enabled this order of aquatic insects to cope with a wide range of environmental conditions and become exceptionally widespread, abundant and diverse. However, the extent and geomorphic consequences of caddisfly case building has received little attention.

This study aimed to quantify the mass and size distribution of mineral sediment used by case building caddisfly. Paired caddisfly and bed sediment samples were collected from riffle habitats spaced along a gravel-bed stream. For each caddisfly family, within each sample, a detailed grain size distribution of the sediment incorporated into the cases was determined. This enabled comparison of intra-species, inter-species and inter-site case architecture and resource use by caddisfly. The mass of sediment used by case building caddisfly averaged 31.81 g/m². Sediment was primarily coarse sand, although a wide range of grain sizes were found in caddisfly cases (0.063 to 4 mm). Sediment use was dominated by surface dwelling taxa, particularly Glossosomatidae. Glossosomatidae require moving water for respiration and therefore usually reside on the surface of exposed gravel particles. This family effectively circumnavigates gravel-bed armour layers, transporting fine, sand-sized sediments vertically onto the upper faces of gravel and consequently increasing its flow exposure. These results provide an important preliminary step in developing a fuller understanding of the geomorphic impacts of these widespread and abundant ecosystem engineers and the wider importance of biology within fluvial geomorphology.

Keywords: bed armouring, biology, caddisfly, fine sediment, macroinvertebrates

Social Media: @RiccoMason
Why are Australian rivers so unlike those elsewhere?

G.C. Nanson [1], S. Tooth [2]

[1] School of Earth and Environmental Sciences, University of Wollongong, Australia; [2] Department of Geography and Earth Sciences, Aberystwyth University, Aberystwyth, UK

Over the past several decades, evidence for an unusual fluvial geomorphology of Australia has arisen from several sources. Warner’s (1988) edited volume (‘Fluvial Geomorphology of Australia’) provided the first overview. Miller and Gupta’s (1999) edited book (‘Varieties of Fluvial Form’) included four chapters, each describing unusual river styles or processes linked to Australian rivers (e.g. floodouts, reforming channels, anabranching/anastomosing rivers). Miall’s (1996) text (‘The Geology of Fluvial Deposits’) states that: “The distinctive climate of Australia has led to the development of several unusual, or even unique, fluvial styles within that continent”. We contend, however, that it is not just the climate that is important when considering the Australian continent’s fluvial geomorphology.

Our aim in this presentation is to set up a framework for understanding and explaining Australian river systems. We identify ten key factors that have contributed to the development of a highly distinctive, unusual, and in some respects unique, collection of river styles. Many of these river styles arise from the distinctive characteristics of the Australian continent, particularly those that apply across the extensive dryland continental interior. The ten factors, many of which are interrelated, are: 1) a very low mean elevation of just 340 m; 2) a tectonically stable Cainozoic history; 3) an overall arid climate (mean annual rainfall of 465 mm and mean annual pan evaporation of 2747 mm); 4) declining downstream discharges along many rivers; 5) a prolonged and largely uninterrupted history of weathering and alluvial induration; 6) no significant glaciation since the Permian; 7) very low sediment loads along most rivers; 8) a cyclical climate with flood- and drought-dominated regimes; 9) rivers that have co-evolved with a unique riparian vegetation assemblage; 10) a long history of profound fluvial-aeolian interactions. Rivers on other continents are influenced by some of these factors and have developed some similar river styles, but Australian rivers exhibit distinctive, unusual, or even unique styles on a frequency and over spatial scales unknown elsewhere. Recognition of the diversity of Australia’s river styles provides a challenge to many ‘textbook’ descriptions of river processes, forms and behaviours, and ongoing analysis will contribute further to the development of fluvial theory.

Keywords: Australian rivers, river styles, river evolution, river variability
On the role of process (bio + rock) geomorphology in landform evolution and urban ecosystems

L. Naylor

Department of Geographical and Earth Sciences, University of Glasgow, Glasgow, UK

My presentation will be in two parts. Part A outlines my key contributions to biogeomorphology and rock coast geomorphology. It highlights how my work has been used to advance methodological and theoretical approaches to geomorphology, including changing the scales and processes we study in these systems. For example, the bioprotective role of organisms (from individual species to communities) is now recognised as an important mediating process across landscapes. My work has challenged the notion that some landscapes, such as rock coasts, ‘change slowly’ and instead demonstrates that these systems are erosional, non-linear and threshold-dominated landscapes that can change rapidly. The risks that this poses are noted in the latest IPCC report. I will then highlight future research needs for bio- and rock geomorphology, most critically the need for process geomorphology studies to better align with the scale(s) at which erosion and threshold-induced landform change occurs. Coupled with better incorporation of the role of process geomorphology in driving landform evolution, this can help us to improve models of landform evolution in geomorphology and more broadly our contributions to models of climate-land surface interactions.

Part B will focus on how process and evolutionary geomorphology can be communicated more effectively and thus help ‘buy’ geomorphologists more presence in key debates. This discussion will focus on contributions we can make to the growing challenge of living in the anthropocene, particularly in rapidly urbanising (coastal) cities. Using examples, I will illustrate how geomorphology can contribute to improved urban resilience to growing environmental hazards. This includes: 1) how process-geomorphology can be used at the interface with infrastructure to measure, predict and mediate asset resilience (via bioprotection, for example); 2) how decadal to centennial scale understanding of coastal/fluvial systems can inform flood alleviation engineering designs; 3) geomorphic contributions to using and valuing nature (e.g. natural capital, net gain, ecosystem services, nature-based solutions); 4) geomorphology and urban ecosystems; and 5) geomorphology and urban resilience in an age of climate extremes. Each of these areas presents avenues for fruitful geomorphological science alongside opportunities to raise awareness of the benefits of geomorphological contributions to these debates and practical initiatives. Recent collaborations with artists, designers, engineers, material scientists and social scientists at the science-policy-practice interface will be used to illustrate how and where the global geomorphological community can meaningfully contribute, enriching both our science and its societal relevance.

Keywords: biogeomorphology, communication, organisms, rock coast, urban resilience
Geomorphology, complex systems, cross-disciplinarity and applications: a few bullets to feed the debate and let the rivers flow

H. Piégay

CNRS, Université de Lyon, UMR 5600 EVS, Site ENS de Lyon, France

Geomorphology can be seen as a scientific field at a disciplinary crossroads, with different disciplines (e.g. geography, geology, hydraulic engineering) providing understanding about how landforms evolve. Since the 1950s, a quantitative geomorphology based on process-based understanding has been promoted, with a focus on physical laws governing landforms. Some geomorphologists also explore the temporal framework for understanding complex evolution of landforms at different temporal scales. Whether functional or evolutionary, holistic or reductionist, these approaches are complementary and help to understand complex earth systems.

From the view of a geographer working in geomorphology, my first aim is to introduce an integrative perspective to understand fluvial systems in the Anthropocene context, especially by highlighting the major landscape changes in the European Alps and their consequences for river trajectory, natural hazards, and ecosystem and environmental quality. The second aim is to show how understanding of complex systems needs to be explored collectively with cross-disciplinary views and expertise. The role of vegetation is critical in geomorphology, and conversely geomorphology also influences vegetation as well as other biocenoses. River management and development influence river morphology and vice versa, with a cascade of consequences and potential retroactions in both cases. Ecogeomorphology and sociogeomorphology are two emerging branches of the discipline that are exploring these questions. Geomorphology, as a fundamental science, can be applied if knowledge is translated into forms that can be understood by practitioners and lawyers. If expanding their spatial and temporal framework, decision makers can use geomorphology to diagnose river health, anticipate risk situations, and plan and target management actions.

The community of (fluvial) geomorphologists is now faced with a few issues that will have to be considered in the coming decades. Rationality and scientific knowledge are not valued in all countries, with potentially critical consequences for resource management and human wellbeing and equity. The public attitude of scientists must adapt to the social context in which they are doing science. Because we are part of the public debate, we are both scientists and actors and our message is not only scientifically-based, so a constant critical view of our scientific practices and public message delivery is needed. There are still barriers to cross-disciplinary debate and applications of geomorphology due to corporatism. Promotion of integrative sciences, open-mindedness and kindness in scientific practices are necessary. The emergence of ‘big data’ and new technologies is just beginning and is progressely changing the way we do research. There is a real challenge in terms of pooling expertise, designing collective strategies to provide knowledge, facilitating interactions between research and training, and improving data management and sharing.

Keywords: complex systems, cross-disciplinarity, river management, vegetation
The relationship between channel curvature and migration rate for meandering rivers has long been established, with theoretical models using a weighted aggregate of local, upstream and downstream curvature to estimate migration rates. However, research has also suggested that instability is an inherent feature of meandering rivers, and that the chaotic behaviour of channel bends needs to be considered along with the basic controls of energy and resistance to help better understand the patterns of behaviour in meandering channels. Accurate historic mapping is widely available across the United Kingdom and provides the opportunity to examine the relationship between channel curvature and migration rate as it develops through the evolution of a meander bend. Many rivers can appear stable over short periods of time and a long-term dataset is required to fully understand meander behaviour.

This study tests the relationship between channel curvature and erosion rates in a number of active meandering reaches in two different catchments in the United Kingdom and examines the extent to which it fits theoretical patterns, whether different types of behaviour are apparent, and whether the relationship is different between rivers. A new method for measuring bend curvature is proposed, namely a weighted aggregate of upstream and downstream curvature from the apex of each bend. Width-averaged channel curvature and migration rate were measured for each bend in the reaches for each of the available map years, and trajectories were analysed in a curvature-migration rate phase space. Results show a general increase in erosion rate as curvature becomes higher; however, the trajectory of single bends follows a complex pattern. The highest rates of erosion and channel curvature were measured in the River Lugg catchment. The highest rates of erosion were measured between 1955 and 1970. Further research is investigating the factors influencing the different types of behaviour.

Keywords: channel curvature, chaos, meander migration
Numerous rivers are diverted (or more properly, relocated) for large mining operations. Streams are diverted, either around the mining pit to avoid flooding, or diverted into an entirely new path to allow access to ore. In Australia alone, there are many hundreds of these diversions, with some being tens of kilometres long. In the past, these diversions have been nothing more than engineered trenches, but rapid erosion and multiple failures mean that standards of design have improved greatly. Regulators now demand that the diverted channel should eventually mimic the morphology of the original channel. This means that: 1) geomorphologists are now working alongside engineers in the detailed design of these diversions; and 2) these diversions now represent massive experiments in river evolution, in particular the interaction of sediment and vegetation. Little is written about these diversions, often because they are commercially sensitive. This presentation will review the global history of river relocations, describe past design failures, and use examples from the Pilbara of arid Western Australia to illustrate the role of geomorphology in recent designs.

Keywords: fluvial, river, mining, diversions, restoration
Biotic and abiotic drivers of the burrowing behaviour of invasive signal crayfish (*Pacifastacus leniusculus*): mesocosm experiments

H. Sanders [1], S. P. Rice [1], P. J. Wood [1]

[1] Department of Geography, Loughborough University, Loughborough, UK

The introduction of invasive crayfish to Europe has had significant geomorphic consequences via their burrowing and foraging activities. The signal crayfish (*Pacifastacus leniusculus*) rarely burrows in its native range in North America, but burrowing is common in invaded rivers in the UK. This causes extensive damage to river banks and increases fine sediment recruitment to rivers, both as a direct result of transferring burrowed sediment into the channel and by promoting mass failure. Quantifying the volume of sediment that signal crayfish contribute to river systems is increasingly important for understanding and managing fine sediment dynamics in invaded catchments. However, we do not know what biotic and abiotic factors control the propensity to burrow.

To complement a large field campaign that is measuring and modelling these variables, a series of hypothesis-driven mesocosm experiments established the role of key environmental and biological factors in driving burrowing activity. Two communities of crayfish were investigated – one collected from a site where burrowing is prolific, and one from a site where burrowing does not occur – and these were introduced to mesocosms fitted with simulated river banks. Results demonstrate for the first time that the availability of an alternative refuge and increasing population densities are significant behavioural drivers. There were no observable differences between the two populations, suggesting that burrowing may be an instinctive as opposed to a learned behaviour, with the implication that crayfish may have a geomorphological capacity in any river system that they are introduced to. Understanding what drives crayfish burrowing will ultimately help to model how the spread of crayfish will affect sediment recruitment, sediment dynamics, and channel change in infested rivers. These results also demonstrate that animals have a significant impact on the geomorphic functioning of river systems, and should be greatly considered in future sediment transport and river functioning models.

Keywords: bank stability, ecogeomorphology, fine sediment, sediment recruitment, turbidity

Social Media: @crayfish_harry
The timing of late Pleistocene and Holocene aeolian activities in the Pannonian Basin, central Europe


The rivers of the Pannonian Basin in central Europe built extensive alluvial fans in the past. Due to postgenetic tectonic and geomorphic processes, several of these fans have been uplifted, and aeolian processes have dominated under dry climatic conditions in the late Quaternary over vast areas of the basin. The main period of aeolian activity is placed in the Last Glacial Maximum, but there are numerous pieces of evidence indicating that dune formation renewed several times during the Pleistocene-Holocene transition, and even during the drier phases of the Holocene.

Previously, the earlier timing of aeolian phases was assessed on the basis of geomorphological analysis and a limited number of radiocarbon dates. In the past decade, however, a growing number of optically stimulated luminescence (OSL) age data have been published from these areas, mostly by the Luminescence Dating Laboratory at the University of Szeged. The primary aim of the present research was therefore to make an inventory of the available published and unpublished OSL ages, and to assess the temporal and spatial pattern of aeolian activity in the past 20 ka. In total, nearly 150 ages were considered from 18 sites, representing four large sand dune areas that were developed on the alluvial deposits of the Danube (Somogy alluvial fan, Danube-Tisza interfluve, Deliblato Sands) and the Tisza River (alluvial fan). Beside interpreting the total distribution of the dataset, ages were grouped in time according to the climatic phases. The strength of the aeolian signal for each phase was determined by the number of coinciding data, the number of sites affected, and the deposition rate where it was calculable. Although results correspond to the general framework of aeolian history in the region, they also underscore the significance of local events, especially in the Holocene and in relation to human activities.

Keywords: aeolian processes, climatic signal, human activity, OSL, Pannonian Basin
Although the term ‘wetlands in drylands’ sounds like a contradiction, many drylands host a range of ephemeral wetlands. Pans, for example, are widespread features in many drylands, representing topographic depressions of varying size and shape that host ephemeral, sometimes saline, bodies of shallow water following infrequent precipitation or river flooding events. Pans are included in many wetland classifications, and are the most ubiquitous wetland types in many drylands. Pans are ‘hotspots’ of biological activity and their hydrology, geochemistry and distinctive soil microbial communities mean that they may sequester and store substantial amounts of organic and inorganic carbon (C). The C cycle on pans is unusual in that in the absence of vascular plant cover, C is sequestered by autotrophic organisms, such as cyanobacteria, in biological soil crusts (BSCs). BSC organisms can also facilitate biomineralization and the formation of carbonates, which effectively lock up C in stable, inorganic, long-term stores.

Our understanding of dryland cyanobacterial photosynthesis and C sequestration is hampered by a fundamental lack of information on: 1) the nature and spatial distribution of soil microbial communities; 2) the relative importance and synergistic effects of the diverse controls on photosynthetic activity and respiration; and 3) the fate of C sequestered by cyanobacteria and its longevity in sediment and soils. This prevents us from knowing where, why and how much C is sequestered and how this might be affected by future climatic changes. Without an improved conceptual understanding and quantification of these factors, changes to the wider C cycle within and beyond drylands will remain uncertain and difficult to predict. Here we present data on C stores, CO₂ fluxes and microbial composition of sediment and soils on pans from the Kalahari in Botswana and the Monegros region of northeast Spain. Our data go some way towards demonstrating the importance of dryland pans for local and regional C cycles.

Keywords: pans, dryland wetlands, carbon, biocrusts, carbon sequestration and storage

Social Media: @ADThomas_1970
At previous BSG Annual Meetings, I have asked ‘Where have all the landscapes gone?’; contending that ‘landscapes,’ as opposed to landforms and processes, are not currently important for practitioners. However, communicating geomorphology to the general public is via ‘landscapes,’ an area that geologists have now taken on board. Thus, how to communicate geomorphology is a problem, not least because process studies and landforms need to be incorporated into explanations of visual scenes. Textbooks now generally concentrate on detailed process and landform explanation, compared with greater attention to landscapes fifty years ago. But geomorphologists, I assume, still ‘know’ how to explain landscapes. How can they do this better?

Kastens and Ishikawa (2006) considered three groups of geoscience tasks: describing and interpreting objects; comprehending spatial properties and processes; and issues concerned with metaphorical usage of spatial thinking. I shall explore these very briefly in relation to communicating about landforms and landscapes, suggesting that even simple descriptions may present cognitive problems. The simplest may be related to names (distinguishing between a mesa and a butte) or to mechanisms responsible for features (e.g. tafoni, honeycomb alveolat weathering). Added to nomenclature, we have associated rates of activity and timescales involved (very short to very long).

So how can we convey these complex ideas simply for a general audience (which may also include our students)? I outline some problems of a cognitive as much as geomorphological nature, in terms of metadata and information content of a scene (which also bears upon art aesthetics). I will use audience participation to help answer these questions and generate some simple, but I hope informative, data.

Keywords: Landscapes, Landforms, Communication, Cognition

Reference:

Social Media: @BrianWhalley
High resolution topographic (HRT) surveys that capture river morphology before and after river restoration are proliferating, enabling the mapping and quantification of patterns of erosion and deposition. However, such approaches to interpreting topographic change tell us little about how habitat has been shaped. More traditional, field based approaches to mapping morphology and habitat are always subjective, with high potential for ‘operator variance’ that makes repeat surveys virtually quantitatively worthless.

This presentation will pose the question: “if we restore bank erosion and sediment transport to recreate what was once a dynamic, wandering gravel-bed river, do we get more diverse in-channel habitat?” We use a series of before and after HRT surveys acquired from one river restoration scheme (Allt Lorgy, Scotland) to systematically map a time-series of geomorphic unit (GU) mosaics, using new GU Toolbox (GUT) software. This software implements topographic definitions to discriminate between a taxonomy of fluvial landforms that have been developed from an extension of the River Styles framework. There are three tiers of processing: 1) differentiation between in-channel deposits and overbank areas; 2) classifying form into one of six categories (mound, bowl, trough, saddle, plane, wall); and 3) mapping GUs based on a range of attributes such as position and orientation. Consistent GU mapping shows that restoration of Allt Lorgy has created a rich assemblage of GU diversity. Results show that once bank protection is removed and sediment supply augmented, active bank erosion enables the formation of lateral and point bars, and diagonal bar complexes, while instream wood creates forced plunge pools and riffles. This presentation provides: 1) the first systematic quantification of how geomorphic unit diversity increases when a gravel-bed river is given freedom space; and 2) a framework for using HRT surveys to test design hypotheses and conceptual ideas associated with process-based restoration.

Keywords: River restoration, high-resolution topography, GIS, geomorphic units

Social Media: @DynamicRivers
9. POSTER PRESENTATIONS
(alphabetical order by first author, presenting authors underlined)
Bedrock rivers respond to tectonic or climatic change through the evolution of their morphology, including the channel width and slope. The understanding of the role of coarse sediment transport in controlling channel geometry is not well understood, nor is the transient response of channel geometries to new forcing conditions. We present a combined field and laboratory study to explore the importance of bedload transport on bedrock channel geometry. The Rangitikei River, New Zealand, is deeply incised (> 80 m since 12-13 ka) into a uniform weak lithology, with tributaries to the east supplied with hard, coarse, material sourced from the Ruahine mountain range while tributaries to the west have a very limited supply of coarse material. The impact of this coarse sediment supply is apparent in the channel geometries across the region, with channels supplied with coarse sediment systematically wider than those without a coarse sediment supply. In the lab experiments under constant discharge, steady-state configurations of channel width, slope and the distribution of shear stress within a channel vary significantly under different sediment supplies. After a perturbation to steady-state conditions, the response of the channel geometry is dependent on the type of perturbation. Channel width responds first, through narrowing or widening to reduced or increased sediment supply respectively, followed by the adjustment of the channel slope, generating a dynamic hysteresis pattern of channel geometry in width-slope space. These results demonstrate the importance of sediment supply in setting bedrock channel geometry, with implications for the modelling of landscape evolution or using bedrock channel geometry or preserved topography to infer past tectonic or climatic conditions over multiple timescales.

Keywords: bedrock river, channel geometry, sediment, steady-state, transience

Social Media: @EdwinBaynes
Recent technological developments - particularly in small Unmanned Aircraft Vehicles (UAVs) and Structure-from-Motion photogrammetry (SfM) - provide the opportunity to obtain data in the 'sweet spot' of high resolution and wide spatial coverage. This project exploits these developments to create and apply an image-based 'sediments toolkit' for the characterisation of river bed sediments at local to catchment scales. This will be used to improve the management of river sediments and modelling of flood risk in Scotland and will be applicable to river research and management problems in the rest of the UK, and beyond. In addition, this research will compare the accuracy and applicability of structure-from motion with other methodologies for extracting topographic information (e.g. DGPS, Terrestrial Laser Scanning, LIDAR) and assess limitations of using UAV-based structure from-motion (e.g. computational limitations; replicability of results under different flight conditions).

Keywords: river bed, sediments, Structure-from-Motion, Unmanned Aerial Vehicle
Risk of river flood inundation under climate change: the effects of in-stream vegetation growth on flow conveyance

S.D.A. Clark [1], J.R. Cooper [1], P. Rameshwaran [2], P.S. Naden [2], M. Li [1], J. Hooke [1]


Climate change is predicted to exaggerate fluvial flood risk by increasing the intensity and frequency of precipitation events. A key yet neglected aspect of flood risk modelling is how this change will exacerbate the role of in-stream vegetation in decreasing local velocities and channel capacity, increasing flow depth and, with it, flood risk. Future climatic warming is expected to alter the growth cycle of vegetation, extending plant growth beyond current die-back periods to result in higher abundances during periods of increased precipitation. Thus understanding river response to changes in vegetation and flow regime are key in developing methods to better predict future floods and inform effective river management strategies. Previous research has identified the phenomena resulting from flow-vegetation interactions, however the influence of precipitation events on such phenomena and the degree to which climate changes alters the resulting flood risk has remained unaddressed. This research uses 3D finite-element modelling techniques to simulate flow-vegetation interactions and their effect on flood frequency, taking into account changes to flow regime and vegetation abundance under climate change with respect to seasonality.

The open-source solver-suite Telemac-3D was used to simulate the impact of seasonal variation in the abundance and distribution of in-stream vegetation patches on flow for the River Blackwater, Hampshire. Modelled velocities and turbulent kinetic energy were analysed in order to determine changes to the spatial representation of flow as well as the vertical flow profile. A series of scenarios were created to simulate changes to vegetation patches under climate change and their influence to seasonal changes in the flow regime. Here, the focus will consider the model’s capability to capture flow-vegetation interactions within the 3D flow field for scenarios with low-abundances and high-abundances of in-stream vegetation.

Keywords: CFD modelling, climate change, flooding, gravel-bed rivers, macrophytes
Very small glaciers (<0.5 km$^2$) account for more than 80% of the total number of glaciers and more than 15% of the total glacier area in the European Alps. Although small in size, they are a relevant component of the Alpine cryosphere and widely considered as important indicators of climate change. Their sensitivity to global warming is particularly pronounced in maritime areas receiving high mean annual precipitation (MAP). The southeastern European Alps show one of the highest MAP totals in the entire Alpine chain, with up to 3300 mm (water equivalent) in the Julian Alps and a winter snow accumulation of approximately 7 m at 1800 m asl (averaged over the period 1972-2017). As a consequence, very small glaciers and ice/ firn patches are still present in that area at rather low altitudes (1830-2340 m asl).

This study seeks to better understand the impact of extreme events on short- to medium-term response of very small glaciers. First, we performed repeated geodetic and direct mass balance measurements on several glaciers during the period 2006-2016, and the results show more than 10% increase in ice volume in the studied decade. This is in accordance with several exceptional winter snow accumulations in the 2000s in the southeastern Alps, promoting a positive mass balance in the following years. This contrasts with a general trend for the European Alps of about a half of the glacier area loss in the period 1850-2000, and even accelerated ice loss after 1980. We then analysed synoptic meteorological conditions leading to the exceptional snowy winters in the 2000s, which appear to be related to the influence and modification of some climate indices. Although further summer warming is expected in the next decades, modification of storm tracks and higher occurrence of extreme events during winter might represent a crucial input in driving the evolution of small glacial remnants of this Alpine sector in the near future.

Keywords: European Alps, mass balance, very small glaciers, winter precipitation
Accurate quantification of sediment residence time is important for catchment management. Floodplains are large reservoirs of fine sediments (particles <2 mm in diameter) that can have deleterious impacts on water quality, especially if enriched with industrial contaminants. However, monitoring sediment storage and release is challenging, as estimated timeframes for turnover of floodplains commonly span several hundreds of years or more. Over this timescale, significant environmental changes, such as land use and hydroclimatic change, can arise and impact sediment erosion and deposition rates. Furthermore, different fluvial systems exhibit different sediment storage behaviour. For example, lateral channel migration may remain restricted to an active, recently (re)formed floodplain area in the centre of the valley floor and may take much longer to erode sediments closer to the valley edge. Other fluvial systems, however, may rework floodplains without this bias to younger surfaces.

We present a method to quantify residence times from CAESAR-Lisflood model runs. We use Geographic Information System tools to track the timing of deposition and erosion events on Digital Elevation Model valley floor cells over 1000 years, presenting the River Dane in northern England as an example. These data can be used to calculate floodplain sediment ages and residence times, with the result being a unique time series of sediment fluxes for every cell that has been occupied by the channel at least once. Potential data and methodological considerations are tested, including evaluating model outputs over different time steps (10, 20, 50 and 100 years), and altering input parameters to compare a forest cover scenario with a grass cover scenario. We also show that the majority of floodplain turnover in the selected reaches favours young surfaces, with more than 50% of the reworked floodplain area storing sediment for several decades, and other floodplain areas storing sediment for several centuries at least.

Keywords: residence time, age, sediment, floodplain
Coastal wetlands store large quantities of carbon and attenuate storm surges, and so loss of these ecosystems is the focus of numerous studies. Salt marshes respond to sea level variations and storm-driven erosion through biologically mediated accretion, but in many populated coastal areas drowning and retreat are observed, for example in the Mississippi Delta and the Venice Lagoon. Recent studies suggest that where sediment delivery to wetlands is not heavily modified by human activities, established marsh platforms can keep pace with relative sea level rise (RSLR). More importantly, accretion rates in excess of rates of RSLR have been observed in pioneer marsh zones, suggesting sediment supplies that are sufficient to avoid marsh drowning. Numerical models suggest that marsh stability is closely related to both the tidal amplitude and the position of the marsh surface relative to sea level.

Using new algorithms, we delineate multiple marsh platforms in the United States and North-West Europe based on repeat airborne lidar surveys. We then assess the position of these platforms within the tidal frame for different tidal amplitudes. We refine our analysis of wetland topographic change at sub-decadal timescales by relating elevation change to initial elevation for stable marsh platforms, but also for eroding and pioneer marsh zones. By combining high-resolution datasets and unsupervised classification methods, we are therefore able to quantify the mutual influence of tidal amplitude and marsh elevation on the vertical accretion of salt marshes.

Keywords: coastal geomorphology, salt marsh, sea level rise, tidal amplitude

Social Media: @GchGoodwin
Geomorphological risks to coastal heritage: insights from Ynys Enlli, Wales, and Dunbeg fort, Ireland

H. Griffiths [1], L. Barker [2], A. Corns [3], G. Devlin [3], T. Driver [2], S. Davies [1], P. Robson [1], R. Shaw [3]


Projections of future climate change and sea level rise suggest that the effects of storm activity are likely to become more significant. This includes the geomorphological processes of coastal erosion and sand inundation, especially in exposed and remote coastal locations without coastal protection works. This means that the historic environments of these landscapes, which commonly include heritage sites of very significant historical, archaeological and cultural importance, are at risk of being permanently lost, damaged or buried. In order to prioritise sites for recording and interpretation, and to inform planning of potential protection measures, the nature and rate of geomorphological processes need to be better understood.

We present data from preliminary, desk-based work (historical maps, reports) and fieldwork (Differential Global Positioning System and Unmanned Aerial Vehicle surveys, rapid coastal zone assessments) undertaken as part of the CHERISH project at two such exposed, remote coastal sites: Ynys Enlli, located off the coast of Pen Llŷn, north Wales, and Dunbeg promontory fort, County Kerry, Ireland. Both are important early Christian sites and are currently experiencing erosion, which in the case of Enlli is exposing cremation burials and archaeological material, and in Dunbeg is causing structural damage. Previous work has shown that ~8 m of erosion has occurred at some sites on Enlli (1918-2014), and recent surveys have shown that this has erosion is continuing. At Dunbeg, historical rates have been faster (e.g. ~0.5 m/a from 1897-1915) but are likely to be faster in some sections owing to additional localised erosion by overland flow. These preliminary results suggest that erosion is likely to continue, resulting in further exposure and/or loss of important archaeological material. Integration of these data with data from surveys of other sites on both sides of the Irish Sea will enable identification of areas of coastline to prioritise for targeted recording and management.

Keywords: coastal erosion, heritage sites, historical change, management

Social Media: @HywelGriffiths
The geomorphological significance of mega-boulders in the Tamatert Valley, High Atlas, Morocco

M.G. Hann [1], J.C. Woodward [1], P.D. Hughes [1]

[1] Department of Geography, The University of Manchester, Manchester, UK

In the Tamatert Valley, near the village of Imlil (1800 m.a.s.l.) in the High Atlas of Morocco, a defining feature of the valley floor is a spread of enormous boulders pointing to the occurrence of a catastrophic geomorphological event (or events) in the recent geological past. The headwaters of this catchment were glaciated during the Pleistocene. Mega-boulders are present on the bed of the steep active channel and within exposed Quaternary fluvial and colluvial deposits. Fieldwork has been carried out to establish the spatial distribution, lithology, size, and geomorphological context of these boulders. Key aims are to determine their age, provenance, and the processes responsible for their transport and present disposition. The largest boulders are not derived from the local bedrock in the lower valley. The timing of emplacement will be established through optically stimulated luminescence dating of associated deposits and via cosmogenic dating of the boulders themselves. More broadly, the impact of such catastrophic geomorphological events is often key to a better understanding of landscape evolution and contemporary fluvial system behaviour in steep mountain settings and must therefore be an important part of fluvial geomorphological research in the Mediterranean and North Africa.

Keywords: fluvial, catastrophic events, Morocco, High Atlas, mega-boulders

Social Media: @Geomorph_Mad
Deciphering rates of erosion over geologic time is fundamental for understanding the interplay between climate, tectonic, and surface processes. River bed sediments are thought to provide a spatially integrated sample of erosion processes in the upstream catchment and are often used to generate catchment averaged erosion rates. Sampling the lithology and grain size of riverbed gravels on three alluvial fans in the Iglesia basin, Argentine Andes, we demonstrate a clear lithological control on clast size: the more resistant lithologies are concentrated in the coarsest fraction of river bed gravels. The more resistant lithologies are also under-represented in the riverbed gravels when compared to their exposure in their upstream catchments. We examine the steepness of fluvial channels in each catchment and evaluate the extent to which spatial variability in bedrock lithology and pulses of glaciation have modulated the lithology and size of sediment exported from the catchment. This work has significant implications for those applying cosmogenic radionuclide and thermochronology techniques on river bed gravels to estimate catchment averaged erosion rates.

Keywords: channel steepness, erosion, grain size, lithology

Social Media: @rmharries
At the global scale, Mars can be divided into heavily cratered southern highlands, and much smoother and largely featureless northern lowlands. The sharp transition between these distinct regions — called the ‘dichotomy boundary’ — hosts large areas of irregular mesas and buttes, known as fretted terrain. Frequently compared to the Earth’s drylands, Mars’s fretted terrain is distinguished by its association with ice-rich landforms and glacial/periglacial processes. The origin of the fretted terrains remains elusive, and a handle of the mechanisms and rates of glacial erosion and deposition will help us understand how the terrain evolved over geological time.

Here, we present a quantitative framework for comparing the morphology of fretted terrain of Mars with that of the drylands of Earth, using measures of their areal clustering, topographic roughness, intra-mesa valley-spacing and bifurcation ratios, planform boundary incision, and alcove morphometry. Application of these measures enables an assessment of the relative contribution of various processes that formed the fretted terrain, especially those linked to glacial ice. We use this framework to guide and characterise a 2D numerical model of the planform evolution of fretted terrain from a range of initial synthetic landscapes. This model is driven by cliff recession and seeded alcove growth, and we compare its simulation results against the real terrain observed on both Mars and Earth.

Keywords: analogues, drylands, glacial erosion, landscape evolution, Mars

Social Media: @adamjhepburn
**How can the Landlab modelling toolkit help in communicating geomorphology?**


Landlab is a cross-platform (Mac/PC/Unix), open source, modular, user-expandable toolkit for the modelling of Earth surface processes. It is written in Python, and is designed explicitly for: ease and speed of use; flexibility and adaptability of use cases; rapid prototyping; and combining processes in novel ways. Much effort has been put into making the install procedures as pain-free as possible, and the software is heavily documented both online and within the code. Together, all of these features make Landlab an ideal platform for the communication of geomorphic ideas, across all levels.

Here, we introduce the key features of Landlab and highlight several existing case studies where Landlab is already enhancing the communicating and teaching of geomorphology. For instance: (1) the integration of Landlab with Hydroshare community software tools enables easy sharing of Landlab model configurations and output as well as the ability to run Landlab without installing it; (2) Landlab has been used in computer labs to teach the basics of modelling of surface processes; and (3) exploitation of Notebook functionality in Python has allowed us to create suites of online tutorials aimed at both undergraduate students and potential research users of Landlab. We are very interested in further widening the utility of Landlab as an educational tool in the broadest sense, especially outside academic teaching, and would be keen to hear ideas from BSG attendees on how they could see Landlab being of use in the communication of geomorphology in other ways.

**Keywords:** landscape evolution, numerical modelling, science communication

**Social Media:** @Siccar_Point
Seagrass meadows are recognised as valuable assets to coastal fringe environments, with the ability to protect and stabilise coastlines, provide marine habitats, and contribute to blue carbon storage. These benefits are known to be strongly influenced by local hydrodynamic forcing, including waves and currents, which can have direct impacts on the local vegetation properties and sediment mobility. Wave hydrodynamics within vegetation canopies have previously been investigated through experimental research, although few studies assess flexibility as a variable.

This research aims to fill this gap in understanding and advance the knowledge concerning the influence of flexural rigidity of vegetation on local wave hydrodynamics, within and above a surrogate seagrass canopy, and in turn improve the understanding of associated influence on coastal geomorphology. Experiments were conducted in a wave flume dominated by progressive waves, with a surrogate seagrass canopy installed in the central section of the flume. In total eight different submerged canopies were tested, involving four different blade flexibilities (semi-rigid, low-flexibility, moderate-flexibility, and high-flexibility) at two canopy densities (142 and 566 shoots m²). For each canopy, three regular wave conditions were tested. A two component Laser-Doppler Anemometer (LDA), positioned in the centre of each canopy, provided high-resolution non-intrusive velocity profile measurements within and above the canopy. This approach allowed assessment of the effect of vegetation flexibility on vortex penetration into the canopy, and the flow and turbulence structure within the canopy. In addition, twin-wire resistive wave-gauges quantified the wave attenuation associated with different the vegetation flexibility and canopy density. This research provides, for the first time, a systematic study into the effects of vegetation flexibility on wave-induced flow and turbulence structures within seagrass canopies, which is difficult to measure in the field. The presentation will present detailed hydrodynamic data from this study, which in turn can improve parametrisations of large-scale coastal geomorphic models.

Keywords: ecohydraulics, experimental modelling, hydrodynamics, vegetation

Social Media: @DynamicCoast
Deltas are home to hundreds of millions of people worldwide and form an important part of coastal environments. Due to their low elevation, many deltas are threatened by sea level rise as well as direct human influences on flow, sediment delivery and subsidence. River sediment grain size and cohesivity have been shown to be important factors in determining the erosion, deposition and stability regimes within a delta system, but the influence of the receiving basin substrate characteristics is poorly constrained. It has been shown that basin substrates composed of finer sediment lead to more incisive channels but the exact controls of substrate characteristics on delta morphodynamics have not been quantified.

This poster presents an investigation of the effects of receiving basin sediment grain size and cohesivity on the morphodynamics of deltas, especially the ability of distributary channels to migrate or avulse after incising into the substrate. Numerical experiments were conducted where the evolution of deltas was modelled in the Delft3D modelling suite. Fluvial discharge was varied between 102 and 105 m$^3$/s and basin floor cohesive sediment fraction was varied from 0 to 100%. In further modelling, the volume of sediment fluxed to the delta is systematically reduced from an initial state to assess the relative effects of sediment flux and basin substrate characteristics. Results suggest that increasing cohesive sediment fraction of the receiving basin substrate leads to lower numbers of bifurcations (a reduction of approximately two thirds between 13% and 87% cohesive sediment). Data on channel mobility were extracted from model outputs to explore how a higher cohesive sediment fraction in the substrate leads to a reduction in lateral movement of channels and how this affects the morphodynamic evolution of deltas. The results also show how a reduction in sediment input to the delta exacerbates the influence of the receiving basin characteristics.

Keywords: cohesive sediment, delta, modelling, morphodynamics

Social Media: @Delta_Josh
Late Holocene evolution of the Okavango River, Botswana

Z.T. Larkin [1], T.J. Ralph [1], S. Tooth [2,3], G.A.T. Duller [2], K. Fryirs [1], T. McCarthy [3]

[1] Department of Environmental Sciences, Macquarie University, Sydney, Australia; [2] Department of Geography and Earth Sciences, Aberystwyth University, Aberystwyth, UK; [3] School of Geosciences, University of the Witwatersrand, Johannesburg, South Africa

The Okavango Delta in the northern Kalahari Desert of Botswana is one of the largest and most dynamic wetland systems in Africa. Understanding the long-term evolution of the Okavango River and how it responds to external influences can help us to anticipate future trajectories of river adjustment due to climate and/or land use change. This research aims to investigate the timing and hydroclimatic drivers of enhanced flow in Holocene palaeochannels of the Panhandle region of the Delta, particularly by comparing the morphology and discharges of palaeochannels with the modern-day channels.

Palaeochannels in the Panhandle are up to 5-10 times the size of the modern channels and were active ~4 ka during a wet period that was also characterised by regional lake development. Increased Atlantic Ocean-sourced rainfall over the catchment due to an intensification or expansion of the Congo Air Boundary during the mid-Holocene is likely responsible for the enhanced flow. These large palaeochannels were actively laterally migrating (rates of at least 6 m/a). The modern channels are much smaller and only slowly laterally migrating but are prone to avulsion (abrupt channel relocation) leading to redistribution of water and sediment through a complex arrangement of intersecting channels. The complex relationships between climate and hydrology, discharge, and river character (morphology) and behaviour (laterally migrating versus avulsive) provide a template for understanding how future climatic and/or land use changes may influence the Okavango River.

Keywords: drylands, geochronology, optically stimulated luminescence, river behaviour
Engaging the public and other stakeholders with geomorphology can be challenging (Gregory et al., 2014; Tooth et al., 2016). As practising artists with an interest in geography, landscape and geomorphology, we use the visual arts to find ways to make geomorphology more accessible to the wider public. We ran a short project with three stakeholders in the landscape, who walked along the River Ystwyth while recording their perceptions of how the landscape has changed using photographs and words. The three participants had differing perceptions of landscape in both emotional and practical terms and in the physical way in which they engaged with the land. Each worked with a visual artist who responded to their images and words with rapid art works. The images and words gathered form a multi-layered document of the Ystwyth valley. We have overlaid visual and word-based feedback from participants and artists onto a map of the Ystwyth valley to form a visually arresting image that seeks to share information as simply as possible. This River Ystwyth pilot project is part of a larger project to explore how self-reported ethnography and the visual arts can reflect a changing relationship with the landscape, as the landscape itself changes.

References:

Keywords: images, landscape change, perceptions, public engagement, words

Is this a Welsh Landscape (after R.S. Thomas)? Perceptions of the changing Welsh landscape

R. Lewington, C. Newsham

Engaging the public and other stakeholders with geomorphology can be challenging (Gregory et al., 2014; Tooth et al., 2016). As practising artists with an interest in geography, landscape and geomorphology, we use the visual arts to find ways to make geomorphology more accessible to the wider public. We ran a short project with three stakeholders in the landscape, who walked along the River Ystwyth while recording their perceptions of how the landscape has changed using photographs and words. The three participants had differing perceptions of landscape in both emotional and practical terms and in the physical way in which they engaged with the land. Each worked with a visual artist who responded to their images and words with rapid art works. The images and words gathered form a multi-layered document of the Ystwyth valley. We have overlaid visual and word-based feedback from participants and artists onto a map of the Ystwyth valley to form a visually arresting image that seeks to share information as simply as possible. This River Ystwyth pilot project is part of a larger project to explore how self-reported ethnography and the visual arts can reflect a changing relationship with the landscape, as the landscape itself changes.

References:

Keywords: images, landscape change, perceptions, public engagement, words
Wetland classification has become a primary tool to characterise and inventorise wetland landscapes, but wetlands are difficult to classify because they straddle the terrestrial and aquatic boundary and occur in a variety of topographic and hydroclimatic settings. Presently, many ecological wetland classification schemes are focused on the ‘hydrogeomorphic’ unit, which attempts to account for the physical setting of a wetland. However, in many cases landforms are defined in topographic terms (e.g. flats, slopes) rather than geomorphological terms (e.g. oxbow, floodplain), and no attempt is made to characterise the process-form relationships of wetland landforms. The current misrepresentation of product geomorphology (i.e. topography rather than landforms) and underrepresentation of process geomorphology (i.e. lacking process-landform relationships) means that many current wetland classification schemes represent an inaccurate and static attempt to characterize geomorphologically dynamic wetland landscapes.

Here, we use examples from wetlands in the drylands of Africa, Australia, and North America to identify the capacity for adjustment (form and timescale of adjustment) of wetland landforms and we relate this capacity to the geomorphological concepts of landform sensitivity and sediment connectivity. We highlight how geomorphological insights into process-landform relationships and timescales of landform adjustment can add value to wetland classification efforts with important implications for wetland management and ecosystem service delivery. We submit that geomorphology has a much larger role to play in wetland characterization and can reinforce existing wetland classification schemes. More participation by the geomorphology community in wetland science and more awareness by the ecology community in recognising and characterising wetlands as dynamic landscapes will facilitate more effective wetland research and management.

Keywords: geomorphic adjustment, landform dynamics, management, wetland classification
Meltwater from Himalayan glaciers provides a vital resource for irrigation, sanitation and hydropower for millions of people in the Hindu-Kush Himalaya. Despite a recent increase in investigations into supraglacial hydrological features and processes of debris-covered glaciers, very little is known about how water is conveyed or stored beneath the glacier surface. Here, we report the results of fluorescent dye-tracing to investigate the englacial and subglacial drainage of the high-elevation, debris-covered Khumbu Glacier, Nepal, during the 2018 pre-monsoon season. We carried out six preliminary dye tests near the terminus, and a further ten long-range tests across the 9 km long ablation zone (ranging from 80 m to 7 km upglacier from the fluorometers located at the glacier terminus). Resulting dye breakthrough curves show that a subsurface hydrological network drains water to the terminus from up to 7 km upglacier, although the water does not appear to route through the linked supraglacial pond chain system. Water transport was slow (dye transit velocities varied between ~0.01 and 0.07 m/s), indicating an inefficient and convoluted drainage system, as perhaps associated with the early pre-monsoon timing of the dye tests. Close to the terminus, meltwater was stored in near-surface englacial reservoirs located between supraglacial ponds, providing transit delays of several hours. Such characteristics differentiate the hydrological features of debris-covered glaciers from those of clean-ice glaciers, indicating a need for further research into their distinct subsurface hydrology.

Keywords: dye tracing, glacier, hydrology, Himalaya, debris cover

Social Media: @Katie_Miles_851
Gully-landslide interactions: an ecogeomorphological investigation

I.E. Osumgborogwu [1], J. Wainwright [1], L. Turnbull-Lloyd [1]

[1] Department of Geography, Durham University, Durham, UK

Gully erosion and landsliding are geomorphic processes that contribute to landscape evolution yet they become hazardous when they interact with human activities. Some landslide events occur as a result of extreme gullying (gully-induced landslides); in turn the irregular surfaces created by landslide scars encourage concentration of runoff, thus increasing runoff erosivity and subsequent initiation of new gullies. This feedback between gully-induced landslides and landslide-induced gullies creates complex landforms that pose challenges to land management.

This work aims to study the ecogeomorphological processes of gully-landslide interactions, to ascertain the controls of these processes and local and regional drivers, as well as the resultant hazards of these interactions. Our conceptual framework shows known drivers of gully-landslide interactions and forms the basis for the present work. The Orlu Senatorial Zone of southeast Nigeria, a densely populated and extremely gullied region will be studied. We will use combinations of repeat satellite imageries available from the Nigeria Space Research and Development Agency spanning a 10 year period, high resolution Digital Elevation Models of the study sites over a 10 year interval, rainfall data available from the Nigeria Meteorological Agency for a 10 year period, and direct field measurements. Using output from analysis of these data, we will quantify parameters such as rainfall, land use/land cover and vegetation change that relate to and produce different overviews of how ecogeomorphic factors influence gully-landslide interactions. We will present results in relation to spatial variation and human interactions with the environment. Consequently, we will be able to identify relevant processes and variables that control spatial dynamics of gully-landslide interactions in an ecogeomorphic system. Conclusions will be drawn to support our conceptual framework, and to guide future work and research on gully evolution. This study will improve understanding of gully-landslide linkages and management of gullied environments.

Keywords: ecogeomorphology, geomorphic hazard, gully erosion, gully-induced landsliding, gully-landslide interactions
Constraining landscape response times to tectonic forcing

C. Pont [1], A. Whittaker [1], G. Roberts [1]


Constraining landscape response times in regions of active tectonics provides crucial insights for using topography to infer active fault slip rate histories and for determining histories of landscape evolution. Rivers play a central role in physically transmitting tectonic signals to landscapes via incision. In particular, the speed at which fluvial knickpoints retreat upstream fundamentally controls timescales over which landscapes record a tectonic perturbation. However, constraints and controls on these rates remain sparse.

Here, we present a synthesis of published data on knickpoint retreat rates upstream of active faults for bedrock catchments in Turkey, Italy and Greece where good constraints on climate and fault slip histories exist. These data suggest landscape response times differ markedly across regions: knickpoint retreat rates vary by more than 10 times across different catchment areas, ranging from 0.3 mm/a to 27.6 mm/a. However, bigger catchments areas are, in theory, expected to drive a faster signal through the fluvial system. Even when accounting for differences in catchment size, knickpoint speeds still varied by a factor of greater than 6 and the residual signal shows no correlation with the magnitude of fault throw rates. Consequently, landscape response times to tectonics varies significantly between regions even when faults are slipping at the same rate. We hypothesise that rock strength and resistance to erosion could be one driver of this effect.

Initial fieldwork from rivers crossing active normal faults in Calabria, Italy, shows that rock mass strength varies significantly upstream, allowing us to evaluate the extent to which this effect controls knickpoint migration in time and space.

Keywords: knickpoints, rivers, rock strength, tectonics
Matching stakeholder concerns and scientific data for floodplain wetland management: a rapid assessment approach

T.J. Ralph [1], P. Harvey [1]

[1] Department of Environmental Sciences, Macquarie University, NSW 2109, Australia

Stakeholder and community consultation can be a powerful tool to help identify environmental issues and site-specific areas of contemporary and historical concern. Matching stakeholder observations and concerns with environmental issues and threatening processes identified by scientific studies can be problematic, however, due to misaligned spatial and temporal scales of consideration and sometimes competing outcomes (e.g. conservation versus publication). Ecosystem health in the Macquarie Marshes (a large Ramsar-listed wetland system in New South Wales, Australia) is often contested, and key threatening processes such as water (un)availability and channel erosion are not ubiquitous, meaning that it is difficult to ascertain the full extent of deleterious change in the wetlands based on stakeholder accounts or historical research. We assessed known hotspots of channel change using a rapid assessment technique to determine whether anecdotal and scientific information matched at multiple sites within a connected system. We developed a prioritised list of sites for further detailed investigation that accurately reflects the concerns of key stakeholders. Together with ongoing stakeholder engagement, rapid assessment allows a broad-scale, targeted approach to erosion and sediment management and development of common goals to promote water and wetland conservation.

Keywords: erosion assessment, channel change, integrated management, wetlands in drylands
Water and mud? Communicating and visualising wetland geomorphology for non-specialist stakeholder engagement

T.J. Ralph [1], M.C. Rupic [2]

[1] Department of Environmental Sciences, Macquarie University, Sydney, NSW 2109, Australia; [2] Department of Geography and Environment, University of Hawai‘i at Mānoa, Honolulu, Hawaii, USA

Wetlands exhibit a range of geomorphological responses to external controls as well as to internal forms and processes. Yet when engaging with non-specialist stakeholders, complex biophysical responses and feedbacks in wetlands tend to be simplified to focus on water (i.e. presence/absence, flow regimes, inundation patterns, extreme events) and/or mud (i.e. soil/sediment type, deposition, erosion, nutrient/contaminant load). Here, we develop and present an infographic to demonstrate the interactions between water and mud in wetlands, and to tease out some of the more complex processes such as erosion, sedimentation and channel change in an appropriate format for non-specialist stakeholders. We address how changes in the location, extent and integrity of channels within wetlands can lead to significant changes in inundation and aquatic ecosystem responses, as well as to flow-on effects for biota, habitats and agricultural productivity. Targeted and appropriate communication and visualisation of geomorphological issues is needed to move collectively towards the development of long-term strategies for holistic and adaptive management, conservation and sustainable use of wetlands.

Keywords: avulsion, channel change, integrated management, wetlands in drylands

Social Media: @timjralph
Supraglacial lakes play an important role in the response of debris-covered glaciers to climate change, both in terms of water storage and ablation rates. Regions with high proportions of glacial lakes and associated ice cliffs strongly enhance ablation rates. Although low gradients and low ice velocities have been shown to partially control supraglacial lake formation, additional controls are less well constrained. We propose that glacier evolution and pre-existing ice structures play a significant role in the location of supraglacial lake formation and potential drainage. Ground Penetrating Radar (GPR) reflection surveys were undertaken on the Miage Glacier, the largest debris-covered glacier in the European Alps, located on the southwest flank of Mont Blanc. A total of four supraglacial lakes and an ice-marginal lake were bathymetrically surveyed during summer field seasons in 2017 and 2018, prior to and after GPR data collection. This study aims to provide an insight into subsurface structural controls on the location, formation and evolution of supraglacial lakes. GPR data were collected using a Mala ProEx 100 MHz rough terrain antenna (RTA) in March 2018. A total of six GPR transects across the glacier covered a total distance of ~5.2 km. Data were processed in ReflexW using standard processing steps (including time zero and topographic correction). Two way travel time of returned signals resulted in depth penetrations of up to ~40 m. Internal structures are consistent with high debris concentrations entrained within the ice. Internal water was identified within a number of transects interpreted to be crevasses or meltwater features. GPR on the Miage Glacier has provided an insight into the internal structure of the glacier. Further analysis of such structures in relation to the presence of supraglacial lakes is required.

Keywords: debris-covered glaciers, ground penetrating radar, ice structures, supraglacial lakes

Social Media: @AnneStefaniak
Biologically cohesive extracellular polymeric substances (EPS) are commonly associated with the pervasive secretion of marine benthic and pelagic microorganisms such as diatoms and microphytobenthos, and are estimated to represent 40% of the total marine organic carbon pool. To date, EPS research has focussed on the fluvial-intertidal zones and deep marine processes where EPS is shown to contribute to bedform and seafloor sediment stability through the formation of a cohesive matrix, where bonds between sediment particles are created when activated by moisture. However, the presence of these 'biopolymers' have not been investigated in coastal fringe environments, such as soft cliff sediments and shorelines, which are exposed to diurnal wetting and drying cycles associated with tides and longer term climatic events.

This study offers a novel, and timely insight, drawing in previous understanding of the processes driving coastal erosion with modern sedimentary processes through a series of field and laboratory-based investigations. Here, we quantify how the production of EPS may vary between different geologies (notably, boulder clay, Kimmeridge clay and chalk) along the East Yorkshire coastline. Using historical Light Detection and Ranging (LiDAR) and satellite imagery from the study sites, we then demonstrate how EPS content manifests itself in varying rates of coastal retreat, and how this varies with cliff material grain size and location on the cliff (active versus stable areas). Furthermore, through the use of low temperature scanning electron microscopy (LTSEM) analysis we will develop a more detailed classification of EPS from a sedimentological perspective through the visual representation of the internal fabric within the sediment matrix. This work will inform a series of laboratory experiments aimed at emphasising the spatial distribution of growth and decay of biopolymers along the shoreface. We expect that the outcome of this study will have important implications for the understanding and future modelling of coastal erosion under predicted climate variability.

Keywords: coastal sediments, EPS, erosion, seasonality

Social Media: @SerenaTeasdale
In this study, we present results from a baseline characterisation of a degraded peat site several hectares in size that is located on farmland east of the Peak District. This site has been identified for Natural Flood Management (NFM) intervention managed by Sheffield and Rotherham Wildlife Trust (SRWT). Co-ordinated NFM, which integrates a range of land management practices, is gaining traction as a valuable part of catchment-scale flood resilience in the UK. One emerging feature of NFM is the significant role of non-specialist organisations such as community groups in the selection and implementation of projects following generic rule-based guidelines. Geomorphologically, hydrologically and ecologically, every site is different and specific site conditions may drastically alter outcomes of NFM interventions from those predicted. This is the source of considerable uncertainty in catchment-scale NFM design and presents a significant obstacle to wider adoption of NFM as a reliable alternative to traditional ‘hard’ flood engineering.

We used transect-based soil sampling, ecological survey and dipwell installation to characterise soil and water retention across the site, supplemented by detailed Unmanned Aerial Vehicle (UAV) orthophotography, Digital Elevation Modelling, and continuous monitoring of streamflow using time lapse day/night digital imaging. Initial results indicate a complex hydrological environment with intricate, multi-pathway connectivity between surface and subsurface flows, and evidence of progressive dessication and headward erosion of deeply incising streams. The proposed NFM management, tree-planting, would likely significantly exacerbate these processes by further lowering the water table, leading to the loss of the remaining raised sphagnum bogs and their associated water-holding capacity. A significant consideration in our study design is the potential for long-term monitoring of the site by community volunteers from the SRWT. We evaluate the use of laser-range measurement of ping-pong ball floats as an alternative to dipmeters for dipwell measurements, and extraction of detailed hydrographs from digital images of water stage at the stream measurement point.

Keywords: citizen science, hydrology, Natural Flood Management, peatland, Unmanned Aerial Vehicle

Social Media: @drjonbridge
Wetlands play an important role in water and sediment dynamics in the Tsitsa River catchment, South Africa. They are most common along lower gradient reaches in the upper to mid catchment and typically occur as ‘unchannelled valley-bottom’, ‘channelled valley-bottom’ and ‘floodplain’ wetlands. Construction of two large, multipurpose dams has been proposed for the lower catchment, but high sediment delivery from upstream threatens the longevity of the impounded reservoirs. Wetland gully and channel incision has increased landscape sediment connectivity, so current catchment management efforts are focused on restoring wetland sediment trapping potential (buffering function) to curtail future reservoir sedimentation. While rehabilitation schemes are ongoing in the upper catchment, there is a need to broaden these schemes to lower in the catchment where wetlands have larger catchment areas. Given that resources for wetland rehabilitation are limited, it is important to prioritize management efforts for those wetlands that: 1) have relatively high sediment trapping potential; and 2) are capable of being rehabilitated sustainably with little cost.

Here, we use geomorphological insights to address this management prioritization issue. We have undertaken a catchment-wide wetland assessment in terms of their landscape setting, geological controls, spatial extent, degree of incision and sediment input. Wetland slope, upstream catchment area, and degree of incision were identified as the key factors, suggesting that moderate to low gradient wetlands in mid-catchment positions with limited incision should be the main focus. Low cost, sustainable management options for wetland rehabilitation need to be designed, preferably measures that promote good vegetative cover (e.g. grazing management and reed bed establishment) to maximise sediment trapping potential.

Keywords: channel incision, gully, management, sediment connectivity, wetland
The volume and characteristics of sediment supplied from catchments controls depositional stratigraphy. However, to date, few studies have constrained Holocene sediment budgets released into tectonically active basins over a regional scale. We address this challenge in the Gulf of Corinth, Greece, one of the most rapidly extending rifts worldwide, where we have excellent constraints on the climatic, tectonic and lithological boundary conditions. We visited the river mouths of 49 catchments feeding into the Gulf, which drain 83% of the rift by area. At each site, we measured channel hydraulic geometries and we characterised the grain size distribution of sediment exported from these rivers by Wolman point counting and in-situ sieving. In total, we measured ~17 000 clasts and processed 3 tonnes of sediment. The grain size distributions show a marked increase from east to west on the southern coast of the Gulf. The coarse-fraction grain sizes range from 20 to 110 mm, with 50% of values less than 40 mm. Simple geomorphic parameters such as catchment area and relief have little control on the grain size exported. However, the strong westerly gradient in tectonic extension rate and the type of bedrock lithology cropping out exert a first-order control on the sediment calibre measured. We estimated the bankfull shear stress and transport capacity for each river, and our calculations show that median grain sizes are transported in bedload at bankfull discharge; sand-grade particles are transported as mixed load or suspended load. Finally, we derived the full Holocene bedload sediment budget for the Gulf by combining our grain size data with catchment sediment flux estimates, calibrated to known Holocene sediment volumes in the basin. This is the first time such a budget has been derived, and we demonstrate that sediment export is highly intermittent in time and space.

Keywords: basins, grain size, intermittency, rivers, sediment budgets

Social Media: @DrAlexWhittaker