Institution: Edge Hill University

Unit of Assessment: C14 Geography and Environmental Studies

1. Unit context and structure, research and impact strategy

UOA structure

Research activities in this UOA span the overarching theme of Global Environmental Change and represent all staff with significant responsibility for research within the Department of Geography and Geology. The Department has 10 such staff, all 1.0 FTE. While relatively small, the Department is highly collegial, and well-balanced with a blend of early-career, mid-career and senior researchers, fostering enthusiastic research collaboration. Also, the Department, like its parent University, is relatively young, bringing a creative and modern perspective to conceiving research and enabling impact. A diverse range of research topics is investigated; from historical reconstruction of long-term climate records, focusing on volcano and flood events, to present-day monitoring of physical environments, such as coastlines, wetlands and forests, and society's role in environmental change, including disaster recovery and palm oil consumption.

Research objectives

Key priorities identified in REF 2014 were to:

1. Enhance the UOA's profile by increasing the volume, quality and impact of international research activity.
2. Improve the vitality and sustainability of the UOA by growing the staff research community, embedding research at the heart of departmental life.
3. Increase external research funding applications to sustain research.
4. Grow the postgraduate research community.

It may be noted, in REF 2014 the constituency of the UOA was different, involving staff from both the Department of Geography and the Department of Biology, now a separate UOA. Nonetheless, these priorities have remained central to UOA research development.

1. The UOA's international standing has grown noticeably since 2014, boosted especially through substantially increased volume of high-quality research output. While in REF 2014, the (combined) UOA had a total pool of 29 papers suitable for REF submission (refereed journal papers etc.), in REF 2021 this number (for the Geography and Geology Department alone) stands at 86.

2. This gear-change in research productivity stems from both strategic appointment of new research-active staff and enhanced research support. This has led to a larger and stronger research-active staff base (for the Department, six submitted in REF 2014; now 10), thus reinforcing UOA sustainability. More directly, research has been embedded firmly in routine departmental life, encouraged via appointment of a new, research-active, Head of Department, and assisted by the creation of a new coordinating position, Research Leader. Also, a new research strategy has been formulated, embedding a research culture into all aspects of departmental life. For example, research business is now routinely supported (individual research mentors appointed, annual individual research plan reviews), monitored (quarterly departmental research meetings, annual departmental research away days) and encouraged (aspirations of two journal outputs per staff member per year, two departmental PhD completions per year).

3. As the staff base and volume of activity have grown, applications for external research funding have followed suit. In the present REF cycle, applications exceeding £2.5m have been made to major funding bodies such as European Research Council, Leverhulme Trust, Natural Environment Research Council (NERC), Newton Fund, Royal Society and Wellcome Trust; plus a host of small funders including British Ecology Society (BES), Manchester

Geographical Society, Natural England and Royal Geographical Society (RGS). This push towards external funding has been achieved through enhanced staff mentoring, with senior researchers providing valuable assistance for ECRs. Also, the University's excellent Research Investment Fund (RIF) has proved a vital stepping-stone for external grant applications, facilitating small pump-priming projects, but also providing valuable practice at grant writing and facilitating third-party review of proposals. In total, since 2014, six members of staff have secured 12 competitive internal grants worth £123k in total.

4. Internal schemes, plus strategic external collaborations, have also led to great success in growing the postgraduate research community. In REF 2014, the UOA had three PhD completions, but over the present REF cycle, departmental staff have been involved in supervising a total of 23 PhD students. Increasing the PGR community is crucial for future UOA growth, but this can be challenging under the current government PhD funding regime. Thus, to thrive, our strategy targeted the competitive internal University's Graduate Teaching Assistant scheme, winning ten studentships over the last six years. At the same time, staff members have pursued research collaborations leading to 12 external supervisory positions at eight UK and overseas universities.

Future research activities will follow objectives laid down in the new UOA Research Strategy. Our overarching research philosophy is captured in the precept of this strategy document: "Members of the department will undertake research with the fundamental goals of advancing knowledge and serving society, but also to fulfil personal research curiosity. Retaining the latter as a key driver of research activity ensures that research remains a pleasure, not a chore, from which all research benefits can flow." This unequivocal statement is intended to guarantee organic development of research, ensuring ongoing staff engagement and, thus, growth and sustainability.

The strategy precept is followed by a series of eight principal aims (e.g. "Foster a thriving research environment in which all academic staff members are research-active") and then a list of 16 procedures to achieve these aims (e.g. "Support individual staff research development through annual meetings with research mentors to discuss three-year research plans", "Manage teaching and administration workloads effectively to ensure all research-active staff have routine opportunity to progress research"). While using this general Research Strategy to frame our overall approach to research, to achieve desired progression over the next five years, **we have set four key priorities**:

1. Consolidate research activity to targeted Global Environmental Change sub-themes of, for instance, coastal geomorphology, peatland conservation, forest sustainability and geohazard response, to strengthen the depth of our research base. As a relatively small UOA, including diverse subject areas, some degree of coalescence is essential to grow research quality and reach.
2. Increase research income, thus growing overall research production, capacity and sustainability.
3. Strengthen interdisciplinary research collaborations, including exploiting internal mechanisms such as the new Data Science STEM Research Centre and the Institute for Social Responsibility (ISR), but also via external and international partnerships, to increase innovation within our investigations and the relevance of our findings.
4. Increase active engagement, including research co-production, with stakeholders and beneficiaries to embed societal benefit at the heart of our research activity.

<u>Research impact</u>
In light of priority 1, any new research endeavour must consider potential impact and beneficiaries at the outset, providing a clear statement on expected outcomes. All staff undergo annual research planning meetings to review progress and identify future priorities, and these

meetings require a clear statement on research impact, including a review of impact-achieved work and potential impact related to future work.

Our approach towards research collaboration has shifted over the current REF cycle, with far greater emphasis on early engagement and co-production of research with the stakeholder community, rather than separation of academic research followed by stakeholder dissemination and engagement. Examples of this practice include **Aplin**'s research on '**Increasing palm oil sustainability to conserve Malaysia's tropical peatland (case study 1)** – where key stakeholders from the Malaysian government's Forestry Department and the land management NGO, Global Environment Center, engaged extensively with the research undertaken and co-authored journal papers. Other examples of research co-production in the UOA include **Jones. A**'s work on flood hazard assessment, where research outputs have been co-authored with the major user organisation, the Environment Agency.

Delgado Fernández is bringing stakeholders into research debates via a series of knowledge exchange projects and workshops. For instance, in current research on **Coastal dune evolution and management (case study 2**) – workshops on 'Coastal Dune Dynamics and Evolution' (2018) and 'Coastal Resilience and Adaptation' (2019), involved stakeholder organisations including National Trust, Natural England and Sefton Council. Indeed, this activity has seen **Delgado Fernández** invited by the National Trust to take the formal role of 'Critical Friend' and to sit on their Stakeholder Group, thus providing direct guidance on their coastal management operations. She also collaborates with coastal management agencies in Gran Canaria, Spain, engaging with government bodies to improve management of the Maspalomas dune field. **Moses** leads the Newton-funded Thai Coast project, developed in collaboration with the Thailand Government's Department for Marine and Coastal Resources, ensuring the research outcomes align with their policy needs around better understanding of coastal vulnerability.

The UOA has bid successfully to the University's competitive Impact and Knowledge Exchange Fund (IKEF), with **Delgado Fernández** receiving support to facilitate the extension and realisation of impact from her body of work on coastal management in Sefton. Broader University support has included bespoke UOA research impact training courses by the Research Impact Manager as part of departmental research away days, plus targeted events such as a panel discussion on 'Bringing an interdisciplinary perspective in making your research impactful: a round table conversation' at which **Aplin** was an invited speaker.

<u>Interdisciplinarity</u>

Geography lends itself to interdisciplinarity, and UOA research activity involves many such examples of research collaboration, both within the Department and further afield with external partners and disciplines. In one project, **Aplin** and **Delgado Fernández** have developed an interdisciplinary collaboration to exploit geospatial methodologies (**Aplin**) for coastal investigation (**Delgado Fernández**). This project, supported by NERC, extends further to include University co-investigators from Biology (ecology of coastal habitats) and Computer Science (deep learning analysis), plus external collaborators (University of Nottingham, Ulster University) and beneficiaries (National Trust, Natural England, Sefton Council). **Jones, A.** is part of an interdisciplinary project entitled 'Science, society and environment in the First Millennium CE' led by Durham University's Institute of Advanced Studies (IAS). **Moses**'s Thai Coast project integrates climate science, geomorphology, socio-economics, health and wellbeing science, and geo-information technology to improve understanding of hydro-meteorological hazard occurrence on Thailand's coastal zone and the ways in which governance and institutional arrangements mitigate their impact.

The UOA is pursuing various routes to extend interdisciplinary activity. The Department has strong research links with Biology, including new interdisciplinary projects, supported by the University, on 'Satellite mapping of mosquito habitats' and 'Cabo Verde Hypersaline environments'. Recently, the University founded a new Data Science STEM Research Centre,

and Geography and Geology is one of three main contributors, the other two being Biology and Computer Science. This has quickly yielded new interdisciplinary projects and a growing community of co-supervised PhD projects such as 'Development of an adaptive quality of service to enable spatial and temporal measurement of environmental factors' and 'Modelling the distribution of Miombo woodland using satellite remote-sensed data'. The University's ISR provides an interdisciplinary platform to integrate various interests and perspectives on human wellbeing and policy. Geography is contributing to relevant ISR themes, in particular sustainability, where **Aplin** is Co-Director of SustainNET, the University's new sustainability network, and contributed to the inaugural 'Sustainability in the Region' knowledge exchange event in 2019.

Open research

The Department is committed to developing and pursuing open research. We have made several successful applications to the University's Open Access Fund to support publication of work in strategically important areas, such as research involving countries on the ODA list where local beneficiaries may not have access to the latest resources due to publisher paywalls. Of 81 refereed journal papers published by UOA staff since 2014, 78 are OA compliant, of which 29 are gold OA. At the recent Open Research Week (hosted by EHU, Liverpool and John Moores universities), our GTA, Kwame Awuah, participated in a session regarding DORA and equity, and acted as a panellist responding to points raised in the talk by Stephen Curry, Chair of DORA.

The UOA is committed to full research transparency, and staff routinely deposit research data on open access repositories, including the Edge Hill Research Data Repository, following FAIR principles (findable, accessible, interoperable, re-usable). **Egan** has deposited data retrieved from sediment cores of Moss Lake, Washington, USA, related to her 2016 *Quaternary Science Reviews* paper; and **Delgado Fernández** has made data available from a field experiment at Devil's Hole, Merseyside, UK, published in *Journal of Geophysical Research* in 2018. In addition to the Edge Hill repository, other public repositories are used in line with subject standards, and according to funder and publisher requirements. **Jones, C.** has submitted over 50 fire activity records from her woodland fire history research to the Global Palaeofire Working Group which provides free access to a global fire record database for research and public use; and JE has shared a series of her Moss Lake data sets on Pangaea open access data repository. UOA staff are also involved in major initiatives to facilitate and promote public access to science data. **Moses** is coastal change work package co-lead in European Marine Observation and Data Network (EMODNet), the 'gateway to marine data in Europe', which aims to collate, harmonise and release data for the purposes of policy making and planning.

Staff are widely engaged in development and exploitation of open source software and tools for their research and to enable wider exploitation and reuse by the research and user communities. For instance, **Cortés** and **Delgado Fernández** use C programming language and R software environment respectively for geochemical and coastal modelling; and **Egan** and **Jones,C.** use Past (statistical software), Psimpoll (for creating pollen/diatom diagrams) and OxCal (for age depth modelling) for palaeo reconstruction research.

Research integrity

The UOA conducts its research with openness and integrity, paying careful heed to all ethical, legal and professional considerations. Integrity is built into our approach, with respect for the people and places who are integral to our work. Any and all research endeavours are subject, at the outset, to full ethical review, first via a Department Research Ethics Committee, and then through the University's Science or Social Sciences Research Ethics Committee. Naturally, this includes consideration of all international frameworks for research ethics such as the Nagoya protocol. For instance, **Aplin**'s University QR Global Challenges Research Fund (GCRF) projects on mosquito habitat mapping in Africa were reviewed rigorously to determine Nagoya requirements. All UOA staff have attended training courses on aspects of

research integrity, including GDPR, research ethics, research governance, copyright, and equality and diversity. We believe that our approach to responsible metrics, not using indicators as a proxy for quality, to underpin recruitment and promotion, or to allocate resources, also reflects our integrity and the University's adherence to DORA. Training staff to understand the uses and abuses of metrics is part of our approach to ethical conduct.

UOA staff engage with professional practice on research integrity via learned society activity. For instance, five members of staff are Fellows of the Royal Geographical Society (RGS) and receive updates on research conduct, ethical standards and so on; likewise, **Moses** and **Taylor** are Fellows of the Geological Society of London (GSL). **Aplin** has contributed to the Remote Sensing and Photogrammetry Society's Awards and Professional Standards Committee, and **Egan** is financial signatory for the British Diatom Society.

2. People

Staffing strategy

There have been three main aspects to staffing strategy in the UOA. First, we have sought to grow the number and advance the careers of staff with significant responsibility for research, and one way this has been achieved is by attracting and appointing excellent researchers. In the REF cycle, seven new academic appointments have been made, all of whom are being submitted to REF 2021. Second, we have developed a well-balanced community in terms of research experience, with an appropriate mixture of early-career, mid-career and senior researchers. This has been achieved via a careful combination of appointments (two professors, one senior lecturer, four lecturers) and promotion (one professor, three senior lecturers). Third, we have appointed new staff with research expertise in specific areas, such as process geomorphology, geohazard vulnerability and geospatial science, to complement and strengthen our research base. All but one of the academic appointments are permanent, showing a strong investment commitment from the University and enabling long-term planning for the UOA.

Staff development

Within a range of staff development measures in the UOA, we have targeted two main points over the REF cycle. First, we have strengthened support for individual researchers significantly, especially via active research mentoring. All staff are allocated a research mentor and the mentoring process includes both formal and informal mechanisms to provide the desired level of support for each individual case. Formal annual research-plan meetings are held between each staff member and their mentor; this is particularly useful for providing guidance on long-term strategy. Informal, ad hoc mentoring support is available as required, for instance to comment on draft conference presentations, journal papers and grant proposals. Second, in line with our overall young researcher demographic (at the start of the REF cycle), we have focused especially on the research development needs of ECRs (see below).

In addition to the University's Researcher Development Programme, which provides targeted training opportunities for both ECR (e.g. Boost your Research Profile) and experienced researchers (e.g. Developments in the Research Funding Landscape), the Department provides generous support for external, subject-specific training. In this regard, UOA staff have received advanced training on differential GPS and drone imaging, and attended specialist training programmes such as the NERC Airborne Research Facility (ARF) workshop. Excellent University and departmental support is also provided for conference attendance, giving staff valuable opportunities to present their research and elicit useful feedback, as well as develop research networks.

UOA staff development success can be seen over the REF cycle by the impressive record of internal promotion. Three members of staff have been promoted from lecturer to senior lecturer, and one member of staff has been promoted successively from lecturer to reader and then professor. **Egan** has progressed from ECR in 2015 to senior lecturer in 2019, and made a significant contribution to departmental research life as part of the internal UOA REF steering group (details below). Similarly, **Delgado Fernández** and **Rowson** were ECRs submitted in

REF 2014 and have rapidly developed as researchers (with **Delgado Fernández** promoted to professor in 2018). **Delgado Fernández** won the University's inaugural ECR Conference Poster Prize, which was won again by **Egan in** 2017. **Rowson**, after completing postgraduate supervisor training and enrolling his first PhD student, has moved on rapidly to assume the crucial role of PGR Director and is now leading strategic development of our postgraduate community.

ECR support

The UOA has developed an eight-point strategy to provide rounded support for ECR development:

1. Annual meetings are held between each individual ECR and their research mentor to discuss rolling three-year research plans;
2. ECR research goals are set and monitored annually by the Head of Department through the annual performance and development review (PDR) process;
3. Quarterly research meetings and annual research away days provide opportunities for targeted ECR progress updates and development;
4. Teaching and administration workloads are managed effectively to ensure ECRs have routine opportunity to progress research;
5. ECRs are supported to undertake relevant research training through courses, workshops and other training activities;
6. ECRs are encouraged to attend conferences, workshops and other research events for presentation, feedback and networking;
7. ECRs are given priority access to internal research funding schemes to conduct pump-priming research projects;
8. Peer support and ad hoc mentoring is available for ECR research development as and when required.

Strenuous efforts are made to integrate new ECRs into the Department's research culture. ECRs are allocated a research mentor on arrival and, where possible, brought in as partners on research grants or PhD supervision. For instance, **Dickinson** is leading a University GCRF project, supported by co-investigator **Moses**, to explore how coastal communities in Thailand can manage risks around climate change; and he is also co-supervisor for a PhD student, also researching coastal development, in Ghana. To accelerate discussions over potential research collaboration both within and beyond the Department, ECRs are also routinely invited to present their research in a research seminar soon after joining the Department.

Postdoctoral researchers are an important component of a dynamic research community and they are given strong support to develop research skills, in some cases taking independent responsibility for research. The UOA appointed a PDRA (Christopher Marston) during the REF cycle, who made a significant contribution during his four-year tenure. He was initially appointed to support research in geospatial environmental analysis, but was then encouraged to take ownership of new research projects, submitting competitive bids as a co-investigator, and ultimately leading research on University GCRF projects related to malaria risk mapping.

Research students

Growing our postgraduate research community is a central plank of current research strategy and we have had significant growth over the REF cycle, showing our commitment to producing the next generation of researchers. By REF 2014, the UOA had its first three part-time PhD students – following the University gaining research degree awarding powers in 2008. Since 2014, the UOA has recruited ten full-time PhD students, as well as providing co-supervision of a student registered in Computer Science. Members of the UOA have also co-supervised 12 students registered at other institutions, including four NERC-funded students.

The University provides a full PGR research training programme through the first semester of enrolment. Further subject-specific training is provided via the UOA, usually involving supervisor or technician input, and each student is given an individual training programme, tailored to their project, often involving external training provision. For instance, students have attended NERC ARF's data processing workshop at Plymouth Marine Laboratory and the CoastTools International Summer School at the Universidade Do Algarve, Portugal. Some doctoral training courses are provided by UOA staff members for external as well as internal students, with **Rowson** delivering courses on 'Modelling gas fluxes' for students from Edge Hill as well as MMU, Southampton and York. PhD students undergo three viva voce examinations – registration, progress and final – two of which involve external examiners, ensuring high standards and creating networking opportunities, and also providing excellent preparation for the third (final) PhD viva.

Good funding resources are provided to MRes and PhD students by both the University and the Department. The University operates a PGR Bursary Fund to support activities including conference presentation, fieldwork and specialist training. Bursaries are matched by departmental funding. UOA PhD students have made good use of this fund, including presentations at the BES annual conference, International Union for Quaternary Research (INQUA) congress and the European Geosciences Union (EGU). Beyond the bursary fund, resources are provided according to need identified at project inception and costed into the annual departmental budget, and this can involve very generous input from the University. To illustrate the point, £7,200 was provided to purchase satellite imagery in support of a doctoral research project into savannah grazing lawn dynamics, and £3500 was provided for a student to undertake fieldwork on biological invasion in Chile's temperate forests.

The UOA provides strong support for career preparation, especially for onward academic (PDRA etc.) positions which have been the favoured option for most of our students to date. As well as strong support for conference presentation, involving abstract writing and co-authoring presentations and papers, students are encouraged to write up results for full journal paper submission, and there are many notable successes here with articles in *Ecological Indicators*, *Science of the Total Environment* and *Remote Sensing*, all ahead of PhD completion. Students are also expected to deliver oral presentations on research progress at the University's annual STEM PG Forum and, in their final year of research, to give full research seminars in the departmental seminar series. In recent times, we have developed a particular emphasis on creating opportunities for PhD students to engage in impact activities, an important aspect of our employability strategy. Therefore, PhD students are invited to contribute to public awareness activities such as Liverpool Year of Environment in 2019, where they supervised an exhibit on coastal management, engaging widely with a curious and varied public audience. Many of our students come from under-represented groups and we continue to support them after they have graduated, including on-going access to University training opportunities.

<u>Equality and diversity</u>
The UOA is a diverse and international community with a staff gender split of 60:40 female/male, and staff members coming from Chile, New Zealand and Spain, as well as the UK. Gender equality is of particular significance. This commitment to women's equality is embedded within active UOA research, with **Delgado Fernández** co-authoring a paper on 'Steps to improve gender diversity in coastal geoscience and engineering' in *Palgrave Communications*, a *Nature* group journal. This paper stems from **Delgado Fernández**'s involvement as a founder member of the Women in Coastal Sciences and Engineering Network. The HoD is also female; with two senior women in a small team, we provide role models for ECRs and students who are developing a career in science.

Our PGR community has also been diverse and inclusive. The gender split of our PhD students has been relatively even, with a 40:60 female/male ratio. Our students' nationalities are again well-balanced, with a home/EU/overseas breakdown of 50:10:40. We are particularly pleased to welcome research students from Africa – various staff members have

active research interests in sub-Saharan Africa – with students from Ghana, Nigeria and Zimbabwe. In terms of ethnicity, 30% of our PGR community are people of colour, the remainder white. We also have a high proportion of mature PhD students, and the majority of our home students have come from non-traditional socio-economic backgrounds.

People with personal circumstances are provided valuable support by University long-term leave arrangements. For instance, staff members returning from extended periods of absence, including maternity leave and sickness, are prioritised in RIF-funded research support such as teaching replacement and research leave. Part-time staff arrangements are intended to help individuals develop careers in line with individual aspirations, and fixed-term staff receive support towards gaining future employment. A notable success here is a PDRA, who progressed directly from Edge Hill to a senior research position at the UK Centre for Ecology and Hydrology.

Career progression and promotion at the University is structured to ensure protected groups are given full and fair opportunity. Where staff members have had a period of extended leave, such as maternity leave, any corresponding reduction of research activity is not considered a barrier to promotion on research track. In one case, a colleague who had a period of maternity leave was promoted soon after her return. Research leadership roles are allocated in the UOA in a consciously inclusive way. For instance, when appointing REF co-leads, clearly it was important to have senior researchers, but a decision was taken to ensure that this involved an even gender balance, with one female and one male representative. Further, a REF steering group was formed and, again, an even gender balance was determined (2F:2M), but also an even nationality balance was decided upon (two international, two UK) to ensure all backgrounds were represented. Finally, deliberately, an ECR was included (later promoted to senior lecturer), to ensure all views were aired and to create opportunity for personal development. UOA REF preparations involved extensive internal peer review of all candidate outputs (>80) and all departmental staff were included in this process, giving everyone opportunity for professional development and direct buy-in to the REF process. We are pleased that our submission to REF2 largely reflects our staff profile.

3. Income, infrastructure and facilities

Research funding

The UOA's primary goal here is to increase research income to ensure onward sustainability of research. While there will be greater aspirations for income generation from all staff with significant responsibility for research, plans will be tailored for individuals according to career stage. Initially, ECRs are supported to prepare entry-level small grant applications; mid-career researchers will be encouraged to bid for medium sized grants and develop research networks as a means of inclusion as co-investigators in larger projects; and senior researchers will be expected to lead major research grant proposals. The first step to grow income is to focus on bid development; we have seen an increase in the volume of bids over the REF cycle with more staff engaging in grant writing.

To achieve our aspirations for greater research income, we have developed an effective research mentoring programme, with (new) senior research staff providing tailored guidance to ECRs. We have organised a series of training activities related to grant applications, such as during dedicated Departmental Research Away Days, involving both internal and external presenters. We also have developed a clear grant-proposal application procedure, involving opportunity for internal, and where appropriate external, review; and involving presentation run-throughs, mock grant-panel interviews etc. We now expect to exploit the experience gained over the recent REF cycle, creating further opportunities for training from experienced external parties such as representatives from research councils and charities, and horizon-scanning funding opportunities to ensure our research activities are developing in alignment with national and international research (and funding) priorities, particularly around sustainability and climate change.

Another strategy in this REF cycle has been to exploit competitive internal funding schemes to both secure pump-priming research funding and gain valuable experience, especially for ECRs, in the grant preparation process. As noted in section 1, we have had considerable success with the University's RIF scheme, and also with the IKEF and Open Access schemes.

We have had some notable external research funding success over the REF cycle, **Moses's** £500k Thai Coast project, awarded from the Newton Fund (NERC, ESRC, TRF); **Aplin**'s Royal Society-funded project on monitoring aerosol pollution; **Delgado Fernández**'s Natural England grant for investigating coastal dune blowouts; and **Jones, A.**'s IAS Fellowship (Durham University) to investigate historic human-environment relationships.

We have actively sought major research grants, including **Delgado Fernández**'s £1.5m European Research Council starter grant application on coastal dune dynamics (where she reached interview stage); **Jones, A.**'s and **Cortés**'s standard NERC grants bids on palaeofloods and volcanic arcs respectively; Marston and **Aplin's** Wellcome Trust and Royal Society fellowship applications on malaria hazard mapping; and **Moses**'s recent Newton Trust impact scheme application on citizen science for coastal governance in Thailand. In addition, to grow initial capacity in research income generation, and given the youthful and compact character of our UOA, we have deliberately targeted small and medium-sized grants. This has met with enthusiastic engagement from our staff, with all members actively involved in grant application, including **Egan**'s Royal Society research grant application on Holocene climate variability; **Delgado Fernández**'s and **Aplin**'s Leverhulme Trust fellowship bids on coastal geomorphology and drone-based forest monitoring respectively; **Dickinson**'s British Academy small-grant application on the impacts of over-research in the disaster landscape and UKRI COVID-19 open call application on community impacts and mobilization in previously disaster-affected areas; and **Cortés**'s NERC Ion Micro-Probe Analysis Facility bid for his work on analysing volatile content in volcanic melt inclusion crystals.

A range of small-medium awards have been secured, such as **Rowson**'s bid to the North West Geographic Society for field equipment in a long-term peat bog conservation initiative, and **Jones, C.**'s grant from Manchester Geographical Society to conduct woodland fire history analysis. Travel funding awards include **Egan**'s ECR bid to attend INQUA 2019, **Jones, A.**'s award to attend PAGES Floods Working Group workshop, and **Aplin**'s fully-funded invitation from the European Space Agency to participate in an expert workshop on defining essential biodiversity variables in Zurich in 2018. As well as staff, PhD students are supported to seek external funding and the UOA has had notable successes here, including fieldwork and outreach awards from the Royal Geographical Society (RGS) and British Geomorphological Society respectively.

There are direct links from research funding to high quality research outputs, including **Aplin**'s Malaysia peat swamp forest research activity, funded from his RGS Ralph Brown Expedition Award, as well as associated NERC ARF data and DTP studentship awards, which has yielded five journal papers in *Nature Communications*, *Remote Sensing*, *Geoderma* and *Frontiers in Forests and Global Change*. **Delgado Fernández**'s Natural England project led to outputs in *Journal of Geophysical Research*, *Physical Geography* and *Science of the Total Environment*. Similarly, there are direct links from funded research to impact, such as **Aplin**'s contribution to Roundtable on Sustainable Palm Oil manuals on environmental management practices stemming from the tropical peatland work.

<u>Organisational infrastructure</u>

In the REF cycle, the UOA has reorganised its research through a new overarching research theme, Global Environmental Change. The University has invested heavily in the development of this theme through strategic appointments, including two professors, one senior lecturer and one lecturer. Other organisational advancements include development of, and contribution to, collaborative research groups. **Delgado Fernández** founded the Coastal Studies Lab (CSL), a collective of local and

international researchers in coastal erosion dynamics and management, focusing on Sefton Coast as a natural laboratory. Similarly, following appointment to the University in 2015, **Aplin** founded the Northwest Earth Observation Network (NEON), a regional academic group of remote sensing researchers which acts together to pursue and promote remote sensing research and exploitation. NEON won a conference support grant to hold a series of events related to Earth Observation for Habitat Monitoring at the 2016 British Ecological Society's Annual Conference in Liverpool. At University level, the UOA is a key contributor to new research collectives, including the Data Science STEM Research Centre and ISR's SustainNET, outlined in section 1.

Operational infrastructure

In the previous REF cycle, the Department moved into a new building, providing excellent new space for research. At that time, research infrastructure was limited, both in terms of dedicated space and equipment. Thus, in the current cycle, we have prioritized new investment in laboratory facilities and equipment. The UOA has benefitted from significant investment by the University to develop a modern and advanced research facility, enabling field and laboratory analysis across the GEC theme. A suite of science laboratories has been constructed at an investment of £1.2m, including a Physical Geography Research Laboratory with connected Analytical Laboratory; an Environmental Analysis Laboratory along with two storage rooms including large freezer sample storage; and a Geo-engineering Laboratory and associated Clean Laboratory. The building also houses two high specification computer labs, supplied with industry standard statistical, GIS and image processing software packages.

The laboratories are overseen by two highly skilled, full-time technicians, both of whom are members of the Institute of Science and Technology. Support is provided for all aspects of laboratory research analysis as well as field data collection. Further excellent research support is provided by our newly appointed Departmental Administrative Manager – elected FRGS since appointment – who works with the HoD to develop the strategic direction of the Department and has rolled out a new communications strategy for reporting research activity.

Equipment investment has also been substantial in the REF cycle. As well as fitting out the laboratories with all standard research equipment and consumables, specialist research equipment has been purchased to meet staff research needs. In total, £427k has been spent on research equipment and data, including a £64k ion chromatograph, £61k geo-engineering equipment (rock crusher, grinder, pelletizer), £44k terrestrial laser scanner, £40k XRF analyser and £56k on geological thin sections.

Collaborative infrastructure

The UOA is benefitting significantly from the new in-house research facilities, but we have worked strategically to develop research networks and gain access to external facilities to increase overall research capability. We have seen success in competitive bids to major UK research facilities, including **Aplin**'s NERC ARF award on dune field evolution, as well as a companion award from NERC Field Spectroscopy Facility for specialist sun photometry equipment to aid fieldwork and image calibration. **Moses** won a NERC High Performance Computing resource allocation, related to her Newton-funded Thai Coast project; and **Delgado Fernández** was co-investigator on a NERC Geophysical Facility award to investigate storm impacts on coastal dunes using ground penetrating radar.

Overseas, various UOA staff are beneficiaries of access to research infrastructure to pursue specific research activities. **Aplin** has a registered project with South Africa National Parks which provides a park fee waiver and access to laboratories, equipment, game guards and accommodation at Kruger National Park. **Moses** benefits from research support at Mahidol University via the Thai Coast project. In Chile, **Cortés** receives support from the National Forest Corporation to work in Villarrica volcanoes; and also in Chile, **Aplin**'s collaboration with Universidad de la Frontera (UFRO) provides free office and laboratory space for his research

team, plus field transport, equipment including use of UFRO's drone system and accommodation.

Department staff are widely involved in collaborative research with other HEIs and research partners around the UK, and this includes valuable access to specific research infrastructure. **Taylor** has access to facilities in the University of Manchester's Rock Deformation Laboratory via her collaboration with colleagues in the Basin Analysis Group**. Rowson** benefits from greenhouse space in Manchester Metropolitan University's (MMU) laboratories, where his PhD students store samples and run greenhouse experiments. In return, we contribute usefully to MMU research activity by providing our Department's ultraportable infrared gas analyser. **Delgado Fernández** has well established research collaborations with institutions in Northern Ireland. For instance, the Coastal and Marine Research group at the University of Ulster has a world-leading collection of 3D ultrasonic anemometers, sand traps, and data loggers, worth >£100K, which she has used in field experiments along the Sefton Coast, as part of her Natural England project.

4. Collaboration and contribution to the research base, economy and society

Research collaborations

Further developing external research networks and collaborations has been a key strategy in the current REF period as a means to supplement in-house research resources, thus ensuring onward sustainability of research. ECRs are encouraged to engage with leading international researchers, and to help facilitate this they benefit from internal support to attend conferences, contribute to learned society committees etc. **Egan** was supported by University RIF funding to progress her tephrochronology research agenda in the USA, and fieldwork plus conference networking has led to strategic research collaborations with Louisiana State University and the University of Cambridge, both on complementary interdisciplinary research projects and in support of PhD students. Senior researchers have well-established research collaborations and are encouraged especially to take a lead on initiating new, large-scale collaborations, such as **Moses**'s Thai Coast project, IDF's CSL and PA's NEON.

UOA staff are engaged widely in national and international collaborations with HEIs and other research organisations, and with research beneficiaries**. Cortés** has well established research collaborations on petrology and geological mapping with the Chilean Geological Survey and the Geological Survey of Malawi, leading to world-leading research outputs in, for example, *Nature Communications* and *Volcanica*. **Dickinson** also has strong collaborations in Chile, working with disaster risk reduction experts to explore intersectional vulnerabilities amongst residents living in informal housing at Pontificia Universidad Católica de Chile, as well as collaborators in Ecuador, USA and UK. **Aplin**'s work on tropical peatland involves extensive collaborations with 50+ international partners and has led to agenda setting reviews on research priorities for peatland field research and oil palm sustainability. Nationally**, Rowson** collaborates extensively with other UK HEIs on his peatland conservation research, including via a series of major funded projects (e.g. from NERC and Leverhulme) with Durham, Manchester, York and Manchester Metropolitan Universities.

The UOA engages actively in academic exchange with collaborator organisations. A series of international researchers have spent time with us on collaborative projects, including both experienced practitioners such as Dr Adison Altamirano from UFRO, Chile, a leading forest ecology expert in South America, and Professor Jeff Ollerhead from Mount Allison University, Canada, an expert on marsh dynamics and coastal restoration; and ECRs such as Dr Pei Liu from Henan Polytechnic University, China, an expert in machine-learning classification methodologies who spent a year-long sabbatical at the University, and coastal scientists Carolina Peña Alonso and Leví García Romero from the Universidad de Las Palmas de Gran Canaria, Spain.

Research impact

As noted in section 1, our underlying research impact strategy in this REF period has been to engage with stakeholders and beneficiaries earlier in the research process, and in particular to seek opportunities for genuine research co-production with these partners. The UOA's two ICSs on 'Increasing palm oil sustainability to conserve Malaysia's tropical peatland' and 'Coastal dune evolution and management' demonstrate notable successes here.

Generally, staff engage widely with research stakeholders and beneficiaries at all stages of the research process. **Moses**'s Thai Coast project includes stakeholder workshops to assess views on existing risks from, and governance of, hydrometeorological hazards. Participants have included eight government bodies including Provincial Offices of Disaster Prevention and Mitigation, Fisheries, and Public Health. To further develop knowledge exchange opportunities from the UOA's coastal research activities, **Delgado Fernández**, **Jones, A.** and **Dickinson** secured competitive internal research funding for international research and networking activities, including a major multi-part event at Edge Hill involving research workshop, field trip and business meetings, plus separate stakeholder workshops. These events involved participants from Canada, Ireland, Spain, Thailand and the UK, and included a mixture of researchers and managers.

Moses has high-level European responsibilities on helping develop maritime policy via the European Commission Directorate-General for Maritime Affairs and Fisheries' Marine Observation and Data Expert Group (MODEG), as the principal advisor on coastal geomorphology. MODEG provides input and feedback to the Commission's strategic objective for an integrated maritime policy through EMODnet.

The UOA considers public communication a key responsibility of the research community and contributes widely to broad public discourses around climate change and other contemporary environmental topics. The Department has developed a structured programme of public outreach including rolling social media updates, webpage news feed, podcasts, in-house public lectures, specialist knowledge exchange workshops, external public interest group presentations, major public science exhibitions and broadcast media interviews. This is a step-change from the occasional, ad hoc public engagement activities in the previous REF cycle.

As well as national and international engagement, the UOA is especially committed to engaging with interested parties – commercial organisations, schools, the public – at the local level, and has an established public lecture series attracting audiences from around the region. Staff members speak widely on their research at public interest group meetings, such as **Delgado Fernández**'s regular talks around coastal change to Southport Scientific Society; **Jones, C.**'s presentation on woodland palaeoecology to Preston Society Birdwatching and Natural History; and **Jones. A**'s public lecture at Van Mildert College in Durham on extreme flooding. **Aplin** has been invited to make various prominent research talks to public and professional audiences, including his appearance on RGS's Monday Night Lecture series to discuss 'Where's the swamp gone for peat's sake?'; plus his session for UNICEF HQ's Webinar Series on Data Collection (developed in response to worldwide COVID lockdown constraints on routine field data collection activities), delivering a talk on remote sensing data sources to over 125 UNICEF staff in 40 countries. Further afield, **Moses** delivered an invited talk to the Northern Ireland GA on coastal resilience and vulnerability in Europe and SE Asia; and **Cortés** delivered a geochemistry workshop for ECRs in the Chilean Geological Survey. The UOA has contributed exhibits to significant public science events, such as NERC's 'Into the blue' in Manchester in 2016, Lancashire Science Festival in 2018 and Liverpool Year of Environment in 2019.

Contributions to research base

The UOA views wider (beyond individual research activities) contributions to the research base as a key element of advancing fundamental disciplinary knowledge, so all staff with significant responsibility for research are encouraged to engage in broad academic service activities. In particular, UOA staff are active in learned-society activities, grant reviewing, editorial roles and conference organisation.

There is wide, often leadership, engagement from UOA staff with learned societies and other national and international research committees, for instance the American Geophysical Union, BES, British Society for Geomorphology, EGU, International Association for Geomorphology, International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), and Quaternary Research Association. Five staff members are Fellows of the RGS and two of the GSL; **Aplin** is an active Member, former Chair, of the Remote Sensing and Photogrammetry Society (RSPSoc); **Moses** is a Member, former Honorary Treasurer, of the British Society for Geomorphology; and **Egan** is a Member of the International Society for Diatom Research, and current financial signatory for the British Diatom Meeting.

Departmental staff members contribute widely to national and international grants committees. **Moses** is a member of NERC's Peer Review College; while **Aplin** was a panel member on NERC's Centre for Doctoral Training on Smart and Autonomous Sensors, as well as routinely undertaking Standard Grant reviews. **Aplin** has also reviewed research proposals for the Israeli Ministry of Science and Technology, and is a member of review panels for the RGS and BES. Both **Cortés** and **Jones, A.** review grant applications for the National Committee for Scientific and Technological Research (equivalent to NERC) in Chile, and **Cortés** also acts as reviewer for the National Science Foundation in the USA and New Zealand's Energy Commission. **Delgado Fernández** reviews grants for various organizations including the Australian Research Council, the Oregon Sea Grant scheme, Xi'an Jiaotong-Liverpool University and NWO Applied and Engineering Sciences (the Dutch Research Council). The UOA's professoriate – **Aplin**, **Delgado Fernández** and **Moses** – are also experienced PhD external examiners, between them undertaking 16 doctoral exams in the current REF period, both here in the UK and in Australia, Belgium, Italy, Netherlands and Spain.

All UOA staff contribute widely through journal paper reviewing, and senior staff also undertake various prestigious editorial roles. **Moses** holds the senior role of Assistant Scientific Editor in engineering geology for the *Quarterly Journal of Engineering Geology and Hydrogeology*. **Aplin** is on the Editorial Boards of *ISPRS Journal of Photogrammetry and Remote Sensing*, the second top remote sensing journal by impact factor, and *Frontiers in Remote Sensing*, *Land*, *Sensors* and *Remote Sensing Applications: Society and Environment*. **Delgado Fernández** is guest editor for *Earth Surface Processes and Landforms*.

In terms of conference organisation, **Aplin** has been appointed to various international conference series' Scientific Programme Committees, including biennial Geographic Object Based Image Analysis (ITC Netherlands 2016, Montpellier 2018), Spatial Accuracy (Montpellier 2016, Beijing 2018), and Earth Observation and Remote Sensing Applications (Guangzhou 2016, Xi'an 2018), and RSPSoc Annual Conferences (Nottingham 2016, ICL 2017) and the NERC-hosted National Earth Observation Conference (Birmingham 2018). **Delgado Fernández** has also been instrumental in coastal science conference organisation, leading thematic sessions on Coastal Morphodynamics at EGU in 2016 and 2017. **Aplin** won funding to organise a thematic session on habitat mapping at the 2016 British Ecology Society meeting in Liverpool, also attaching to this a related Annual Lecture and Conversazione for RSPSoc.

Various UOA staff have delivered notable conference presentations, by invitation. **Cortés** delivered invited presentations at the 2017 IAVCEI General Assembly in Portland, Oregon and the 2019 Icelandic Volcanism Workshop at Lancaster University; and **Moses** was invited to develop and co-chair a session on Rock Coasts in the Anthropocene at the International Rock Coast Conference. **Delgado Fernández** was invited to speak at the International Conference in Aeolian Research in 2018 in Bordeaux, and the Geological Society of America in 2019 in Phoenix; and **Aplin** was invited to deliver oral presentations at thematic conference sessions, including EGU 2016 in Vienna and Living Planet Symposium 2019 in Milan. **Egan** was invited to present in a session during the INQUA 2019 congress and also won the best poster prize from among 500+ contenders at INQUA 2015; and **Rowson** was invited to present at MacCap and NERC's Peat and Microbes conferences at the University of Manchester.

Finally, research is at the heart of the Department's learning and teaching ethos, with our undergraduate students treated as junior researchers and involved with staff research activities and findings. This embedding of research into the learning curriculum keeps research at the forefront of departmental life, reinforcing UOA vitality and sustainability. Undergraduates are introduced to staff research from the outset of their degrees, for instance via the year 1 Environmental Issues module, where staff members deliver research-lite seminars followed by interactive learning. Between degree years, we recruit UG students as paid summer research assistants, funded through the University's excellent Student Opportunity Fund, and also via Nuffield Research Placements where we have recruited six students over the last three years. In year 3, students attend the departmental research seminar series, selecting one for assessed review, and of course also complete a research dissertation, often linked to staff research agendas. In some cases, student achievements have fed back into the Department's research agenda; for instance, an outstanding undergraduate dissertation on palm oil sustainability was subsequently published in the *International Journal of Remote Sensing* and identified further research beneficiaries in Malaysia.