Institution: University of Derby

Unit of Assessment: 7- Earth Systems and Environmental Science

1. Unit context and structure, research and impact strategy

1.1 Unit context

All staff within Unit of Assessment (UoA7) at the University of Derby are members of the Environmental Sustainability Research Centre (ESRC). They are a multi-disciplinary team of researchers who are well placed to make a significant contribution to global research in environmental sustainability, particularly in the context of UN Sustainable Development Goals 11 (Sustainable Cities and Communities), 13 (Climate Action), 14 (Life Below Water) and 15 (Life on Land).

Following REF2014, the opportunity for greater collaboration between the Biological Sciences Research Group and the Human and Physical Environments Research Group was recognised. The ESRC was created with the aim of fostering Environmental Science research and encouraging inter-disciplinarity. This was facilitated by institutional restructuring: staff with ecological expertise joined geosciences colleagues in the new School of Environmental Science. Eighteen of the 20 staff within this submission are from the School of Environmental Sciences with relevant researchers from other parts of the University included in UoA7; **Barnes** is from the School of Human Sciences, while **Okere** is from University of Derby Online Learning (UDOL).

The ESRC co-ordinates research related activities, such as regular research discussion meetings, research seminar series (every fortnight in each semester) and an annual ESRC conference, open to staff, postgraduate students and external colleagues. The work of the ESRC is underpinned by the concept of a sustainable and resilient planet. Research within the ESRC falls within three main themes: 1) **Biodiversity and ecosystems**, including research on animal behaviour, ecology and conservation; 2) **Sustainable resources**, including research on materials extraction, green energy, soils and resources for the carbon transition; 3) **Global resilience,** including research on environmental hazards, food security and climate change. Examples of key on-going research projects within each of the three themes are given in Section 1.3.

1.2 Research and impact strategy

1.2.1 The success of the objectives stated in REF 2014

In our submission to UoA7 in REF2014, we identified the following objectives:

Objective 1: To increase the number of researchers through appointing new staff who have a track record of publishing research. Our UoA7 submission in 2014 included 7.3 FTE category A staff; our current submission includes 19.6 FTE staff (including 3 who were submitted to UoA5 in 2014). The appointment of new research-active staff, together with increased support for research (see Section 2.1) has resulted in a rapidly increasing academic impact of ESRC researchers. This is demonstrated by the increase in citations from researchers allied to the ESRC over the last 7 years (Figure 1) and a 5-fold increase in the number of peer-reviewed primary journal articles published in 2019 in comparison to 2013.

Objective 2: To take a lead in collaborative projects with colleagues in the UK, Europe and further afield. The success of this objective is demonstrated by the wide range of projects with national and international collaborators detailed in the 'Research structure' (Section 1.3): all 19 key ongoing projects led by a University of Derby researcher involve national and/or international external collaboration. Furthermore 46/49 of the outputs for this UoA involve external collaboration.

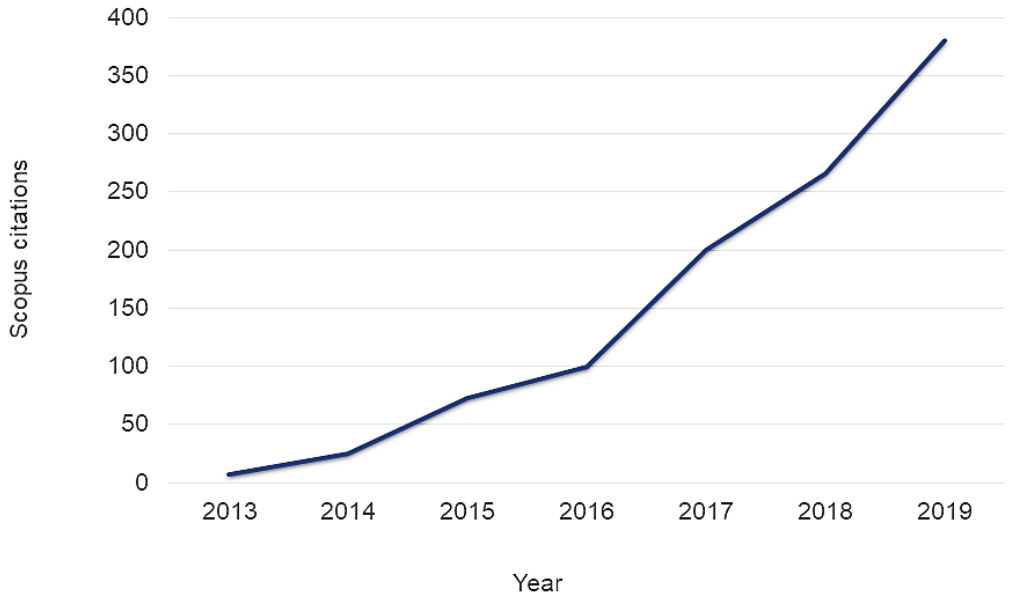

Figure 1: Annual number of citations (data from Scopus) of papers carrying the University of Derby address, authored by staff allied to the ESRC (note: self-citations are excluded, and data is not cumulative).

Objective 3: Working closely with faculty knowledge transfer and partnership managers to plan practicable ways to research impact. This led us to develop research projects that involved working with the potential beneficiaries of the impact from the outset. This is exemplified by: 1) the project examining the effects of climate change on coastal communities in West Africa (**Davies-Vollum**, **Raha**, see Section 1.3c), which involves close collaboration with local communities, the Ghana Forestry Commission and Ramsar network; 2) eDNA work (see REF3, 7-2) in collaboration with Surescreen Scientifics Ltd., the Zoological Society of London, the Environment Agency, the Freshwater Biological Association and Wildlife Trusts (**Sweet**, **Bulling**, **Burian**, **Ramsey**); and 3) research on the conservation and culturing of corals (see REF3, 7-1), which involves collaboration with Sea Life centres UK and Horniman Museum (**Sweet**, **Bulling**, **Röthig** & **Burian**). A further emerging area of impact is our new Cuckoo Tors long term ecological monitoring site (see Section 3.2). An additional part of our Impact Strategy was to facilitate the achievement and documentation of research impact by employing a dedicated Impact Researcher for this UoA.

A further development since REF2014 has been a greater emphasis on an open research environment. In line with the University's Research Strategy, it is a requirement that following acceptance, all research outputs generated are uploaded onto the University of Derby Online Research Archive, UDORA. All outputs in our submission, for example, are publicly available on UDORA. The ESRC has also provided funds to allow 'Gold' open access publishing in academic journals for approximately two papers each year for the past 4 years.

The University's Research Data Management Policy (REF5a, 2.1) aligns with and supports the Concordat on Open Research Data. A culture of open research data is something that is already established in many of the research disciplines that form part of our submission for UoA7; sharing of data sets is often a requirement of the journals in which staff have published. This is exemplified by the outputs of **Sweet** and **D. Elliott**, in which all nucleotide sequence data has been uploaded to GenBank.

A further development since REF2014 is an increasing emphasis on the use of responsible metrics. The University's Academic Board approved the University's Responsible Metrics Statement in 2019 (based on the Leiden Manifesto for Responsible Metrics) and the University

aims to sign the Declaration on Research Assessment (DORA) during 2021/22. Responsible Metrics Champions have been appointed in each School/College (**D. Elliott** is the Responsible Metrics Champion for UoA7 subject areas).

In line with the University's compliance with the Concordat for Research Integrity, there has also been an enhanced focus on research ethics. This is exemplified by the introduction of the digital Ethics Monitor system. All research projects from ESRC researchers and their postgraduate students must be approved by the College Research Ethics Committee, which meets 12 times per year and reports to the University Research Ethics Committee. Researchers are required to complete a new application via Ethics Monitor for each new research project. These are peer reviewed by members of the committee. All amendments must be resubmitted to, and approved by, the College Research Ethics Committee.

1.2.2 Research aims and objectives going forwards

To facilitate closer collaboration with colleagues from the Built Environment discipline and the Centre for Mineral Products, who have overlapping research interests in environmental sustainability (e.g., in the carbon neutral agenda and sustainable cities), a recent University restructuring (September 2020) now places colleagues from these disciplines with staff from the former School of Environmental Sciences, in the new School of the Built and Natural Environment. Going forward, the main themes of the ESRC have been extended to incorporate the sustainable built environment. The over-arching research aims for the new School are:

1. That the ESRC is known as a centre of excellence for environmental sustainability research.
2. Research activity is aligned to the School narrative of the "Lived Landscape" and the research themes of the ESRC.
3. The research environment and culture within the School are vibrant and collaborative (both internally and externally), supporting high quality and impactful research.

This will be achieved by the following broad objectives, agreed by the ESRC Steering Committee:

a) Establish key areas of research based on expertise, potential for development and alignment to ESRC research themes and School narrative.
b) Align research activity with University's Innovation and Research Strategic Priorities.
c) Link staff development with University-wide programmes e.g., the mentoring programmes for Early Career Researchers and Associate Professors (see REF5a, 3.4.2).
d) Increase the number of research active staff (note that the number of staff with significant responsibility for research (SRR), relevant to UoA7 is currently 20 out of 37 (54%), which already exceeds the University's strategic objective of 50% of staff with SRR by the next REF).
e) Link enterprise/ Knowledge Transfer Partnership (KTP) activities to research activities and expertise.
f) Enhance the equipment base using a prioritisation system focused on the needs of research priorities (and teaching).
g) Improve the research environment/culture.
h) Review the existing laboratory/field spaces that exist across multiple sites and use an integrated approach to consolidation and enhancement.
i) Diversify income streams (e.g. KTPs) and increase the number of bids submitted and thus research income.
j) Improve impact and quality of research (informed by responsible use of metrics), including the number of 3* and 4* papers.
k) Increase numbers of postgraduate research students.
l) Ensure that the existing and emerging curriculum is research informed.
m) Secure an inclusive research environment across the School using the ESRC as the vehicle for this.

1.3 Research structure

Key on-going research projects, together with their associated staff and external collaborators, associated with each of the three themes of the ESRC are described below:

A) Biodiversity and ecosystems:

- *Coral reef conservation* (**Sweet** & **Bulling**, **Röthig** & **Burian**, plus three PhD students). This research focusses on the development of novel strategies to save coral reefs on a global scale (see REF3, 7-1), such as the design and implementation of mesocosms capable of inducing broadcast spawning *ex situ*. This work is in collaboration with Horniman Museum U.K. and UK Sea Life centres U.K. (see Section 3.1 for details of funding sources).
- *The use and improved functionality of environmental DNA (eDNA) for surveying and monitoring freshwater organisms of conservation concern* (**Sweet**, **Bulling**, **Ramsey**, **Burian**, plus two PhD students). This research involves the development and validation of eDNA assays for a range of freshwater organisms (see REF3, 7-2). The research involves working directly with Surescreen Scientifics Ltd, the Zoological Society of London, the Environment Agency, the Freshwater Biological Association and Wildlife Trusts (see Section 3.1 for funding sources).
- *Freshwater mussel research* (**Ramsey** & **Davies-Vollum**, with two PhD students). This inter-disciplinary research (involving zoology and geosciences) supports the development of models to explore how ecosystem services might be enhanced by restoration of freshwater mussel populations. In addition, research in collaboration with the Freshwater Biological Association focusses on the conservation and ecology of the endangered freshwater pearl mussel (*Margaritifera margaritifera*).
- *Habitat connectivity and urban ecology* (**Ramsey**, **Norton**, **Bulling**, **Williams**). This multi-scale and interdisciplinary research focuses on understanding how cities can better support biodiverse communities and enhance people's engagement with nature and with pro-conservation actions. It includes collaboration with psychologists at the University (Sheffield, Kotera, UoA4), local partners (Derbyshire Wildlife Trust, Derby City Council), and researchers internationally (Chukyo University, Japan; Adnan Menderes University, Turkey; University of Melbourne, Australia) and nationally (Universities of Sheffield, Cranfield and Exeter).
- *Relationships between biodiversity, community stability and ecosystem services* (**Bulling**, **Burian**, **Norton**, **D. Elliott**). This research aims to assess the impact of different grassland management strategies on the relationship between above and below-ground diversity. This project is part of the ongoing collaboration between the University and Meynell Langely Estate, Derbyshire.
- *Diversity of animal mating systems* (**Huck**, **Vahed**). This research entails studies of genetic monogamy and its consequences in wild Azara's owl monkeys (*Aotus azarae*) in Northern Argenitina (**Huck**, in collaboration with Fernandez-Duque, Yale University) and studies of levels of polyandry and their evolutionary consequences in bushcrickets (**Vahed**, in collaboration with Barrientos, Instituto Tecnologico, Victoria, Mexico, Gilbert, University of Hull, Lehmann, Humboldt University, Berlin and Ritchie, University of St Andrews).
- *Effects of domestic cats on wildlife* (**Huck**, **Vahed**, with one PhD student). This study aims to identify any links between how much food a cat is fed, feline body mass index and predatory behaviours on small terrestrial vertebrates. The project also involves validation of the use of cat cameras to study the time-budget of domestic cats.
- *Conservation of endangered/ vulnerable Insects* (**Vahed**, in collaboration with Grzedzika, Polish Academy of Sciences). This research focusses on the ecology and conservation of Orthoptera (grasshoppers and crickets), e.g., the Scaly Cricket, *Pseudomogoplistes vicentae* in the UK and the Heath Bushcricket, *Gampsocleis glabra* in Poland.

B) Sustainable resources:

- *Soils and biocrusts* (**D. Elliott**, **Okere**, **Bulling** and one PhD student, in collaboration with: Thomas, Aberystwyth University, Bullard, Loughborough University, Field, Manchester Metropolitan University, Dougill, Leeds University, Cook, Leeds University, Nwaishi, Calgary, Canada, Strong, Canberra, Australia and Felde, Witzenhausen, Germany). By

identifying the structure and function of biocrust microbial communities in drylands and peatlands, the research contributes to informed land management relevant to sustainable goals such as maximising carbon storage, minimising greenhouse gas emissions, enhancing soil fertility, and prevention of dust storms.

- *Finding critical metal deposits, such as rare earth elements, associated with magmatic intrusions* (**Elliott**). Rare earth elements are imperative for green technology production aimed at reducing emissions causing climate change.
- *Sedimentological and geophysical analysis of the Mountain Aquifer system beneath Gaza* (**Phethean**). This project aims to find potential new sources of freshwater in the region and has important consequences for the current humanitarian crisis in Gaza and the sustainable management of water resources.
- *Understanding the distributions of microcontinents in the global oceans* (**Phethean**, in collaboration with Yuan, Computing and Data Science, University of Derby and Peace, McMaster University, Canada, plus one PhD student). Microcontinents are highly prospective sources of hydrocarbon resources and are commonly present around developing countries. This work has important implications for locating natural resources and the economic growth of developing countries.

C) Global resilience:

Our Global resilience research involves: **i) climate change** and **ii) global hazards**.

i) Climate change:

- *Ice-marginal processes in mountain environments* (**Tonkin**). This work highlights the value of new photogrammetric techniques for establishing past glacier change and reports on the development of modern glacial land systems during deglaciation. Research in SE Iceland is ongoing and a forthcoming investigation on the evolving thermal structure of high-Arctic glaciers as a response to climate change has recently received British Society for Geomorphology Early-Career Researcher (ECR) funding.
- *Alluvial fan response to Late Quaternary sea level and climate change, Crete* (**Pope**, in collaboration with Candy, Royal Holloway and colleague from the University of Zurich). This project seeks to estimate accurate long-term sea-level change in tectonically active areas. The research involves a novel field-based approach that combines novel techniques e.g., high-resolution dating geochronological frameworks, high-resolution field mapping, high-resolution analysis of field data (sediments and speleothems), the use of remotely sensed data and modelling.
- *Predicting the risk of damage to archaeological sites in the Mediterranean based on understanding past climate change* (**Pope**, in collaboration with colleagues from Emory University, USA, and the Ephorate of Antiquities and University of Athens, Greece). This multidisciplinary project (geology, geography, biology, history, archaeology) assesses the vulnerability of cultural heritage sites located in climatically sensitive locations, e.g., low-lying floodplains and coastal environments. Currently, research is being undertaken at a test site – the Sanctuary of the Great Gods, Samothrace.
- *Adaptations to climate and environmental change in coastal communities in Ghana* (**Davies-Vollum**, **Raha** and one PhD student, in collaboration with the Forestry Commission of Ghana and Ramsar). This inter-disciplinary project pulls together aspects of physical geomorphology and human geography with the lived experience of climate change. The Muni-Pomadze lagoon-barrier system in Ghana, is being used as a case study to understand past and current shoreline change and the impact it is having on the local community. The scope of the project has recently been extended to include a network of researchers studying lagoons and their communities in West Africa.

ii) Global hazards:

- *Understanding the timescales and processes of magmatic evolution, from small-sized monogenetic volcanoes (Oregon, Chile, Japan) to arc volcanoes (New Zealand, Chile) and super-volcanic systems (California)* (**Chamberlain** in collaboration with Conway, Geological Survey of Japan, Tamura and McIntosh, JAMSTEC and Wilson, VUW). To support further development of this research, **Chamberlain** was PI of a NERC Global

Partnership Seedcorn Fund grant (in collaboration with colleagues from the University of Leeds, GFZ Potsdam and SERNAGEOMIN). The grant has supported work aiming to link the fields of petrology, geophysics and mechanics of magma movement in the crust, to generate hypotheses of magmatic timescales related to specific upper crustal stress conditions.

- *Understanding active magmatism on Ascension Island* (**Chamberlain** in collaboration with Barclay, UEA, Preece, Swansea University, Brown, Durham University). This research integrates geochemical analyses and physical volcanology to understand where and how magmas evolve in young oceanic crust, with implications for the composition and style of future eruptive activity on the island.
- *Plate tectonic and geophysical modelling to understand lithospheric controls on plate motions and the build-up of stress in the tectonic plates* (**Phethean**, in collaboration with Yuan, Computing, University of Derby and Peace, McMaster University, Canada, plus one PhD student). This inter-disciplinary project brings together Geologists and Computer Scientists from the UK and Canada and has important implications for stress transfer in the crust and earthquake generation.

2. People

2.1 Staff, staffing strategy and staff development

The ESRC/School of Environmental Sciences works in line with the University's Equality and Diversity Policy to support and promote equality and diversity. Consistent with the broader University strategy of working towards Athena Swan certification, the ESRC actively seeks to encourage and support those who are from under-represented groups and Early Career Researchers. This is reflected by the establishment of the School-level Equality, Diversity and Inclusion working group which works closely with the ESRC. Staff data in relation to diversity and inclusion are presented in Table 2.1.

Table 2.1: Percentage of full time equivalent (FTE) academic staff based on gender (note no staff identified as gender neutral), ethnicity (Black and Minority Ethnic) and declared disability

	Totals (FTE)	Gender		Ethnicity			Disability	
		Female	Male	BAME	Non-BAME	Refused/ Unknown	Declared disability	No declared Disability
Category A Eligible	**831.6**	**50%**	**50%**	**24%**	**75%**	**<1%**	**3%**	**97%**
UoA7	**19.6**	**39%**	**61%**	**15%**	**85%**	**0%**	**0%**	**100%**

Six of the submitted staff (31%) are ECRs. Nineteen of the staff are full time and one part time. Sixteen of the submitted staff (80%) are on permanent contracts. Twenty out of 37 staff (54%) in UoA7 were identified as having SRR, which is over the University average of 30%.

Our staffing strategy followed research objective 1 identified in the last REF: 'To increase the number of researchers through appointing new staff who have a track record of publishing research'. Recent appointments of permanent staff to the School have also been made based on the individual's potential to contribute to one or more of the existing key research themes within the ESRC. For example, the appointment of **Chamberlain** as a permanent lecturer in 2017 strengthened the theme of 'Global hazards', the appointment of **Tonkin** (hired in 2016 and made permanent in 2018) strengthened the theme of 'climate change', while two new appointments for permanent lecturers made in February 2019 (**Phethean** and **H. Elliott**) strengthened the theme 'Sustainable resources'. In addition, one of our post-doctoral researchers on a fixed-term contract (**Norton**) was appointed as a permanent lecturer in January 2020, enhancing the theme 'Biodiversity and Ecosystems'. Three of these new appointments were female and all have SRR, helping to improve the gender balance in the discipline area and this UoA.

Strategic funding was provided through the ESRC to employ independent researchers on fixed-term contracts to move significant areas of collaborative research forward: **Norton** has worked with **Ramsey** on habitat connections and urban ecology, **Burian** worked with **Bulling,** in collaboration with colleagues in the School of Electronics, Computing and Mathematics to use new developments in network analysis to provide a greater understanding of ecological systems and with **Sweet** on eDNA techniques for species surveying, while **Röthig** worked with **Sweet** on coral reef conservation.

The research environment has also been enhanced by the conferment (in 2018) of two 'Visiting Research Fellows' (**Adetunji** and **Johnson**), together with an Emeritus Professor (**Rollinson**). **Adetunji** has expertise in the application of Mossbauer spectrometry to a range of geological and environmental areas, **Johnson** has expertise in the application of sclerochronology to understanding past climates and **Rollinson** has expertise in the early geological history of the earth.

Newly appointed academic staff are offered support to develop their research profile. Staff with SRR are provided with research objectives during the annual development and performance review meeting with their line manager. The following staff development opportunities linked to research are also available:

- Our staff engage in the University's Researcher Development Programme (REF5a, 3.4). Staff are also encouraged to attend and contribute to the annual University Research and Knowledge Exchange Conference.
- Our ECRs are required to participate in the University's ECR forum and to take advantage of the support and funding offered. **Phethean**, for example, obtained funding from this source that enabled him to present at two international conferences.
- Our ECRs and Associate Professors are appointed a mentor, in line with the University's mentoring system.
- The University have provided seed-corn funding for pilot projects with the view to facilitating a full Global Challenges Research Fund (GCRF) bid. ESRC researchers have successfully applied to this fund (e.g., **Phethean**, supporting fieldwork in Gaza; **Ramsey**, supporting visits to collaborators in Costa Rica, **Davies-Vollum**, supporting fieldwork and workshops and building collaborations in West Africa and **Raha**, supporting a meeting at the University of Calcutta to develop a project on waste management in Calcutta).
- An internal peer-review process has been established for all external funding applications (for details, see the institutional level environment statement).
- The ESRC has hosted writing retreats, such as a 5-day residential retreat in June 2019 which was attended by seven staff including three ECRs. This event facilitated the production of six published papers.
- Promotion/conferment opportunities are available linked to research: one Professor (**Vahed**) and three Associate Professors (**Sweet**, **D. Elliott** and **Pope**) have been appointed within the ESRC during the REF period.
- The ESRC has an annual call for competitive application to support focussed research projects/pump priming for grant applications, administered by the Research Centre head. In 2019, priority was given to supporting ECRs. Projects that have received such support include **Raha**'s work on the effect of climate change on coastal communities in Ghana, **Okere**'s work on remediation of oil-contaminated land in Nigeria, and **Norton**'s research on nature connectedness amongst different ethnic groups in Derby. In addition, support from the School and the ESRC is available to staff to attend conferences and research meetings.

In line with the University's commitment to a research-informed curriculum and TEF Gold status, all staff in the submission are actively involved in teaching on undergraduate and postgraduate courses. Undergraduate programmes to which staff contribute include: BSc (Hons) Geology, Geography, Geology and Environmental Hazards, Geography and Environmental Hazards, Biology, Zoology, together with foundation years in the same. Staff also contribute to MSc Conservation Biology, MSc Environmental Assessment and Control, MSc Geo-Energy, plus an

online MSc in Environmental Management, administered by University of Derby Online Learning (UDOL).

2.2 Research students

We recognise the importance of developing a vibrant community of post-graduate researchers (PGR) to enhance the wider research culture of the School. We have grown our PGR numbers from four in the last REF period associated with UoA7 to a community of 25 PGR students allied to staff in this UoA in the current REF period. Fourteen of these students have now been awarded a PhD. The University's/School's commitment to this process has been demonstrated through the provision of seven PGR studentships. Part-funding for two of these studentships was obtained by collaboration with local businesses (e.g., Surescreen Scientifics Ltd, see REF3, 7-2) and support for three further studentships was provided by Horniman Museum and the Sea-life centres (UK).

We provide a fully supportive and intellectually stimulating environment to enable our PGR students to realise their full potential as researchers (see REF5a, 3.4.5):

- PGR students are supported by supervisory teams of up to three supervisors, led by the director of studies.
- Staff new to PGR supervision are required to take the University's PGR supervisor course and all supervisors are expected to attend PGR Supervision Good Practice sessions.
- To provide further support, each PGR student meets with an experienced researcher (who is not a part of their supervisory team) for a Progression Review meeting every 6 months to discuss development of their project and progress with their dissemination plans.
- In line with standard University PGR student regulations, each student completes a full research proposal and ethics document within three months (six months in the case of part time students) of initial registration, has regular meetings with the whole supervisory team and submits a Confirmation/Transfer of Registration report with a viva at 12 months (or longer in the case or part-time students). The progress of PGR research students is monitored at quarterly College Research Committee meetings. Every 12 months, the student and supervisors produce an annual report on progress which needs to be approved by the College Research Committee prior to re-enrolment.
- The monitoring of student progress is also facilitated by the digital PhD Manager' system, which documents supervisory meetings and supports student milestones and progression monitoring.
- PGR students have access to the central support from Student Wellbeing. If they experience ill health or other difficulties during their studies, it is possible to arrange a suspension of registration/authorised break from studies for them for up to a year and to transfer them to part-time upon their return. In the REF period, two PGR students (supervised by **Huck** and **Vahed**) experienced ill health and took these options.
- Office space, desk and a PC are provided in the new Researcher Office. PGR students from the ESRC share this space with those from other research centres within the College of Life and Natural Sciences, together with post-doctoral researchers, making them feel part of a vibrant research community. This facility is adjacent to academic offices for staff within the School of Environmental Sciences and a shared social space/kitchen.
- New PGR students are provided with a programme of induction events, consisting of activities and workshops organised centrally and by the College, supported by members of the University Professorial Council (UPC).
- Our PGR students are required to participate fully in the University's PhD training programme. This training is allied to the Researcher Development Framework (RDF), developed by Vitae (of which the University is a member). The training consists of opportunities provided centrally for all students and bespoke training provided by Colleges that are tailored to discipline areas, e.g. bespoke training sessions on statistical methods (run by **Bulling**).
- PGR students within the School are encouraged to participate actively in the weekly Journal club, along with academic staff.
- PGR student representatives attend the College Research Committee meetings. Post-doctoral researchers are also represented at these committee meetings.

- PGR students are expected to attend, and contribute talks to, the Environmental Sustainability Research Centre's Research seminar series, attend fortnightly ESRC meetings and centrally organised events, such as inaugural lectures.
- UoD PGR students organise their own annual research conference.
- PGR students are encouraged to take part in the annual 3MT competition, the first round of which is based within the College of Life and Natural Sciences. Students from the ESRC have gone on to win University and regional level 3MT events (e.g., Zapitis, Director of Studies: **Ramsey** and Koomson, Director of Studies: **Davies-Vollum**). Koomson was entered in the National 3MT final in 2020.

The results of the 2020 Postgraduate Research Experience Survey for the College of Life and Natural Sciences (in which the School of Environmental Sciences and ESRC were situated) were very positive, with an overall satisfaction score of 82%. Areas such as supervision, resources, progression and assessment and research skills all had over 80% positive responses.

3. Income, infrastructure and facilities

3.1 Research income

3.1.1 Internal research income

As a demonstration of their commitment to increasing the level and profile of research at the University of Derby, the University provided pump-priming funds (approximately GBP140K per year for 4 years) to help launch the ESRC in 2016, providing support for employing researchers, PGR students and targeted project support (for examples of these, see Section 1 and 2).

3.1.2 External research income

The total external income for UoA7 for the REF period was GBP276.7K (Table 3.1). Research on coral diseases and the aquatic culturing of corals (**Sweet**, **Burian**, **Bulling**, **Röthig**); has been supported by funding from the Gordon and Betty Moore Foundation (US based charity) (GBP28.8K), The Waltham Foundation (UK based charity) (GBP8K), The University of Reunion (GBP2.6K), together with GBP15K from an EU Consolidator Grant administered by the University of Newcastle. Sea Life (UK based charity) provided approximately GBP26K towards the running costs of the new Aquatic Research Facility and approximately GBP200K worth of equipment for this facility. In addition, a newly designed bespoke coral spawning system (value GBP30K) was donated by the Coral Spawning Lab.

Research on eDNA (**Sweet**, **Burian**, **Ramsey**) has been part-funded by Surescreen Scientifics Ltd (UK based industry) (GBP89.8 K), which included two part-funded PhD studentships, plus GBP7.5K from the Zoological Society of London.

A NERC Global Partnership Seed-corn Fund grant (GBP93K- the first for the University of Derby) is supporting research on Volcanism (**Chamberlain**). **Ramsey** secured GBP3K (as part of an NSF funded project focussing on pollinators and ecosystem services) to develop research links with colleagues at Colorado State University. **Tonkin** was awarded GBP3K from the British Society for Geomorphology to support research on past and contemporary glacial change.

Table 3.1: Total external research income for UoA7 in the REF period and percentage of income from different funding sources (not including 'in kind' income).

Total	UK Research Councils	UK Charities	UK Government and Industry	EU	Non-EU
GBP276.7K	**33.6%**	**16.1%**	**32.5%**	**5.4%**	**12.4%**

3.2 Provision of specialist facilities and equipment

The ESRC has benefitted from ongoing investment in research infrastructure by the University of Derby. The following key estates developments have supported staff research since REF 2014:

- The Aquatic Research Facility. Launched in 2015, this facility was part-funded by Sea Life Centres, UK (see Section 3.1.2). An additional GBP250K of funding was provided by the University of Derby. The aim of the facility is to conduct research on all aspects of aquatic ecology, from freshwater to marine, with a focus on improving welfare, breeding and to assist with species conservation.
- New long-term ecological research site at Cuckoo Tors, Buxton. ESRC researchers are in the process of establishing this 58-acre University-owned upland site as a landscape ecology research facility focussed on long-term experiments, especially around restoration ecology and sustainable land management. The site was introduced to the ecological community in March 2019 in a keynote talk by **D. Elliott** at a meeting of the Ecological Continuity Trust and British Ecological Society. The Cuckoo Tors site has been registered as a 'node' in the global collaborative Dragnet project. A steering group has been established for the Cuckoo Tors project, including relevant stakeholders, such as the Environment Agency, Peak District national park, Nestle, Moors for the Future and the Derbyshire Wildlife Trust.
- Upgrading of the Glasshouse, providing different climatic zones with the existing facility.
- Upgrading of the Insectary to provide more closely controlled temperature and humidity.
- New Analytical Laboratory and Molecular Research Laboratory, providing an additional research-focussed facility.
- New student research laboratory.
- New Researcher office, providing office accommodation for PhD students and researchers within the College of Life and Natural Sciences, with adjacent staff kitchen/social space shared with academic staff.

Key pieces of equipment obtained within the period include: a new Scanning Electron Microscope (TESCAN VEGA 3) with back scatter detector, cathodoiluminescence (CL) and X max 20 (x-ray) detector, a qPCR machine, a Beckman-Coulter LS 13 320 laser particle size analyser, RD1100 ground-penetrating radar, Pulse EKKO Pro ground-penetrating radar with Emlid Reach RS+ GNSS receiver, Topcon Falcon 8 (UAV), DJI Inspire 1 Pro (UAV) and Topcon GLS-1500 laser scanner.

New equipment relating to the Cuckoo Tors research site includes a suite of environmental monitoring sensors (including temperature, CO2, water table, incident and reflected light - all well replicated with at least 6 for the site), logging equipment (Campbell CR1000X), and networking equipment for real-time online monitoring of the site. For carbon dioxide measurements a PP-Systems EGM5 was acquired with extensive peripherals, and 3x Eosense eosGP solid state sensors for long-term in-soil monitoring.

Researchers have access to specialist research laboratories located at the main University site. These include the Aquatic Research Facility, Insectary, Glasshouse, Analytical and Molecular Research Laboratories and Geotechnics laboratory. The latter includes rock-cutting and thin/polished Section laboratories with a specialist technician. Researchers also have access to an extensive map collection (and a Geosciences-trained map technician). We subscribe to the Edina GB Digimap service giving all staff and students full and unlimited access to all digital OS mapping (past and current), BGS geological mapping, Get Mapping PLC 25cm orthorectified aerial imagery (1998-2016) and CEH Land Cover Mapping (past and current). The recent development of the new School of the Built and Natural Environment has facilitated improved access of ESRC staff to civil engineering and surveying technical spaces and equipment. Researchers can undertake mineral separation, mineral magnetic work, and cathode luminescence analysis. Researchers can also use a Bartington MS2 susceptibility meter, MS2B dual frequency susceptibility sensor and MS2F field probe (e.g., to characterize the mineral magnetic properties of soils and sediments). Staff also have full access to Atomic Absorption Spectroscopy.

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

4.1 Research networks and collaborations

Details of key collaborators for individual research projects within the Environmental Sustainability Research Centre are given in Section 1.3 of this document. Below are highlighted some of the larger collaborative networks with which ESRC members are actively involved:

Sweet founded the BMMO (Beneficial Microorganisms of Marine Organisms http://bmmo.microbe.net/) in collaboration with Peixoto (University of Rio de Janeiro) in 2017 and now co-chairs the network. The aim of the BMMO is to answer key questions on the interactions of marine hosts and their associated microbiomes, with an emphasis in coral reef conservation. The BMMO consists of a growing network of interdisciplinary sub-groups from around the world (Australia, Brazil, United Arab Emirates, Germany, USA and the UK). The network has organised two International workshops in Leipzig (August 2018) and Rio de Janeiro (October 2018), funded by a grant from the EU program INCOBRA.

D. Elliott is an active member of the international 'Biocrust' research network. He engages regularly in Biocrust meetings, such as Biocrust4: the 4th international workshop on biological soil crusts, University of Queensland, Australia, August 2019.

D. Elliott is also actively involved with GEO-BON: Group on Earth Observation – Biological Observation Network https://geobon.org/. He is involved in several of the working groups, e.g., the "Ecosystem Structure" group – details at https://geobon.org/ebvs/working-groups/ecosystem-structure/ .

Ramsey is on the steering group of an NSF-funded research Network (3D Naturalists, focussed on pollinators and ecosystem services) with colleagues at Colorado State University and several other N. and C. American institutions. This has involved exchange visits between staff at Derby (**Ramsey**) and staff and students at institutions in the USA.

Davies-Vollum has built an international collaborative research network (12 researchers) focusing on impacts of climate change on the coast in less economically developed countries, with a focus on West Africa. This includes researchers from University of Derby, University of Nottingham, Bishop Grosseteste University and University of Portsmouth, Vaunuatu, Fiji, Nigeria, Benin and Ghana, including the Forestry Commission of Ghana and Ramsar. The first workshop was held in May 2019 and a second took place (online) in March 2020. The Network recently submitted a GCRF networking bid to support the development of the network in West Africa (**Davies-Vollum**, co PI with Colleague from Ghana).

Chamberlain was PI of a NERC Global Partnership Seedcorn Fund grant. This has allowed close collaboration between herself and colleagues from the University of Leeds, GFZ Potsdam and SERNAGEOMIN, Chile on projects linking the fields of petrology, geophysics and mechanics of magma movement in the crust.

4.2 Contribution to the economy and society

4.2.1 Contributions to the economy

The Centre's research on e-DNA techniques for exploring species distribution has provided a contribution to the economy and industry: the White-clawed and Signal crayfish eDNA assay was released as a commercial service in 2018 by Surescreen Scientifics Ltd. (see REF3, 7-2).

4.2.2 Public outreach and media

4.2.2.1 Public outreach

Vahed took part in the Wellcome-Sanger Institute's 25 genomes project (2017) as a 'species champion' for the scaly cricket and engaged in a series of live online events with school children from around the UK and Europe.

Vahed was an invited speaker and panel member in a discussion on the importance of conserving insects as part of the 'New Networks for Nature' conference, York, November 2019. The talk was attended by 240 people, who were primarily non-academics.

Davies-Vollum provided expert advice on geological collections at Leeds Museum in 2015. She has also worked with the National Coal Mining Museum and was lead author on an article on the geology of the mine at the museum (published 2016).

ESRC staff including **Vahed** and **Sweet** worked with their PG and UG students to select specimens for display and author for Derby Museum's new award- winning Nature Gallery, 'Notice Nature Feel the Joy', which opened in 2016.

ESRC researchers (**Norton**, **Röthig, Burian**, **Williams, H. Elliott**) have run four public-focussed 'Climate change awareness seminars' (from October 2019-Jan 2020) in Derby, funded through the Vice Chancellor's 'Ideas Forum'. These were attended by up to 110 participants per workshop, with an age range from 8 to 80. Each event involved an open discussion session following specific talks.

Tonkin contributed a section to 'Interact: stories of Arctic science' (published 2015), a book that aimed to increase public understanding of arctic science.

Norton is engaged in disseminating global conservation and biodiversity research to a diverse audience of local church communities. This has led to a bid for a research project involving University ESRC students working in local churches. **Norton** is also working with the City Council and the charity *Trees for Derby* to develop an ecosystem service-based map of where tree planting would be most effective.

Sweet designed and runs a website disseminating coral disease research to aquarium curators and hobbyists http://aquariumcoraldiseases.weebly.com. He has hosted workshops on coral diseases as part of 'Corals in your Aquarium', hosted by the Zoological Society of London and the Horniman Museum and Gardens. He also gave presentations at the 'European Research Nights' (Great North Museum, Newcastle, Natural History Museum, London) 2018 and has been involved with the creation of bespoke museum exhibits (Coral Reef exhibit at the Natural History Museum, 2017, Project Coral exhibit at the Horniman Museum and Gardens, 2015-ongoing, and Jelly World exhibit at Sealife London, 2017 ongoing).

Sweet and **Bulling** run short courses in the Indian Ocean which are open to local people, for example, the "Coral Reef Ecology Field Course". The Course has been taking place in Maldives from 2014 (9 courses up to date) involving in total 88 attendees, of which 16 have been Maldivian Nationals (see REF3, 7-1).

Sweet and ESRC PhD student Stelfox initiated in 2013 a UK registered charity (The Olive Ridley Project, ORP http://oliveridleyproject.org/meet-the-team/ Registered No 1165905; Sweet is a trustee for the charity), tackling the issue of turtle entanglement in discarded fishing nets. In February 2017, ORP opened the first Marine Turtle Rescue centre in Maldives, which brings together the work of citizen scientists, volunteers, environmentalists, marine biologists and veterinarians. The charity is present in several social media platforms (Instagram; 8.9K followers), Facebook (19K followers) and has also its own Youtube site (21 videos and 397K views).

4.2.2.2 ESRC staff in the media

ESRC staff regularly provide scientific input into BBC Radio Derby.

Huck's research on the use of animal-borne cameras for video-tracking domestic cats was featured in the Science Magazine, which led to radio interviews for the "Science Friday" programme and by URadio (Constant Wonder). She was interviewed for a forthcoming documentary by the Canadian company Markham Street Films (made in partnership with TV Ontario) entitled, 'Free Roaming: The Secret Outdoor Lives of Domestic Cats'.

Vahed was filmed with Chris Packham for a documentary on garden wildlife 'The British Back Garden: Life and Death on your Lawn' (Windfall films for BBC4 and National Geographic channel,

summer 2017). Vahed appeared in a documentary on spiders, 'Spider House' (Windfall films for BBC4 and National Geographic Channel, October 2014, also featured on the popular Channel 4 show "Gogglebox"). Vahed was interviewed by ITV Channel Islands in April 2019 on his work on the conservation of the Scaly Cricket.

Davies-Vollum and **Tonkin** were featured in a 'Time for Geography' documentary on shorelines (sand dunes) for use by GCSE and A level Geography students in 2018. This was awarded a highly commended in the Geographical Association Publisher's awards in 2019.

4.3 Contribution to the research base
In addition, to the activities listed below, all staff regularly present papers at national and international conferences and review papers for a wide range of scientific journals.

4.3.1 Conferences, seminars and workshops organised
Sweet: organised the 11th DNA Working Group Conference in November 2018: 'eDNA: putting practice into policy', University of Derby; member of the organising committee for the European Coral Reef symposium, Oxford, UK, December 2017; organised a symposium on 'Immunology Techniques Used for Studying Corals', International Coral reef Symposium, Hawaii, USA, 2016; organised a symposium entitled 'Ciliated diseases in Corals', Ecology and Evolution of Marine Parasites and Diseases, Texel, Netherlands, 2014.

Vahed: co-organised and chaired a symposium (with G. Lehmann, Humboldt University, Berlin) on 'Sexual Selection in the Orthoptera', International Congress of Orthopterology, Agadir, Morocco, March 2019; co-organised and chaired a symposium (with S. Lewis, Tufts University, USA) entitled 'Nuptial Gifts, Diversity and Evolution', Ento '13: Royal Entomological Society), University of St. Andrews September 2013.

Phethean: Co-convened the following conference sessions at AGU Fall Meeting, San Francisco, California, USA 2019: 'The North Atlantic Realm from Neoproterozoic to Cenozoic: Orogens Old and New I'; 'The North Atlantic Realm from Neoproterozoic to Cenozoic: Orogens Old and New II Posters'. Co-convened the following session at EGU 2020: 'Structural inheritance and evolving rift kinematics in transform and oblique rift systems: A comparison of global examples.'

D. Elliott: convened a workshop on 'Peatlands and Freshwater Wetlands', 6th World Conference on Ecological Restoration (Society for Ecological Restoration), Manchester 2015.

Davies-Vollum: convened a workshop on Sedimentology education, British Sedimentological Research group Annual Meeting, Keele University 2015; convened GCRF workshops in 2019 and 2020 on coastal change in LEDCs with UK and international participants (by Skype).

ESRC: host the annual Green Spaces Event (each November). This provides an opportunity for local environmentalists to discuss and celebrate their work and for the ESRC to share its research. ESRC hosted, with Derbyshire Wildlife Trust, the 'Bee Summit' – to discuss the pollinator crisis and bring together different agencies to support bee and pollinator initiatives, June 2016. The ESRC also run an annual conference in June each year, which includes external speakers and delegates.

Chamberlain: convened a session at JpGU-AGU joint meeting 2020: 'Timescales of magmatism: from genesis to eruption.'

Okere: Convened a workshop entitled 'Developing Skills for a Sustainable Economy'. June 2018; Lagos, Port Harcourt and Abuja Nigeria

4.3.2 Keynote/ plenary lectures
Chamberlain: Chapman Conference on Merging Geophysical, Petrochronologic and Modelling Perspectives of Large Silicic Magma Systems, Chile 2018; **Vahed:** First European Congress on Orthoptera Conservation, University of Trier, Germany, March 2016; **Rollinson**: Goldschmidt Conference, Paris 2017; **D. Elliott**: Joint meeting of the Ecological Continuity Trust and British Ecological Society, Buxton, U.K. 2019; **Okere:** The International Student's Conference for Africa, Lancaster April 2019.

4.3.3 Editorial boards, journal editorship and guest editorship

Sweet is an Associate Editor for *Frontiers in Marine Science* and edited a special edition on Coral Reefs in the Anthropocene for this journal; **Rollinson**: Editorial Board of *Geology Today*; **Williams**: Associate Editor for *Journal of Applied Animal Research*; **Davies-Vollum**: Editorial Board, *Proceedings of Yorkshire Geological Society*; **Chamberlain**: Associate Editor for *Volcanica*; **Phethean**: Guest Editor for a *Solid Earth* special issue: 'The spectrum of obliquity: from orthogonal rifts to transform tectonics in continental and oceanic settings'.

4.3.4 Peer review of grant applications

Sweet: NERC, BBSRC, Leverhulme, MRC, ZSL Edge fellowships, NSF (USA); **Johnson**: Croatian science foundation, German Research Foundation; **D. Elliott**: NERC, Medical Research Council, Israel Science Foundation, Welsh Government; **Vahed**: BBSRC, Royal Commission (1851 Research Fellowship), Association of Commonwealth Universities Commonwealth Scholarship Commission, Association for the Study of Animal Behaviour project grants; **Huck**: International Primatological Society, Leaky Foundation; **Davies-Vollum**: EU Cost Actions, **Ramsey**: National Geographic, Society for Conservation Biology (Conservation Training Grant applications), **Chamberlain**: Graduate Women in Science (x2), NSF (USA).

4.3.5 External examining of PhDs

ESRC researchers who have externally examined PhDs within the period include: **Vahed** (7: University of Stirling, University of Aberystwyth, University of Auckland, New Zealand, University of Cambridge, Anglia Ruskin University, University of Nottingham, Deakin University, Australia); **Sweet** (3: Swansea University, King Abdullah University of Science and Technology, James Cook University, Australia); **Rollinson** (6: Royal Holloway, University of London, University of Keele, University of Leicester, Trinity College Dublin, University of Oxford, University of Stockholm); **Barnes** (4: University of Lincoln, University of Winchester and two at Swansea University).

4.3.6 Roles on external scientific committees, societies and other organisations

Ramsey: member of the Education Committee (European Section) for the Society for Conservation Biology; **Davies-Vollum**: joined the Universities Geoscience UK committee in 2016 and became executive secretary in 2018: **H. Elliott:** member of the education and membership board committee for the Women In Mining Society; **Huck:** member of the International Primatological Society's Research Committee; **Vahed:** member of the IUCN's "Grasshopper" specialist group and contributed information to the new European red list of Orthoptera, published in 2016; **Chamberlain:** member of the committee of the East Midlands Regional Group of the Geological Society of London; **D. Elliott:** invited expert (2019, on-going) in workshops of the NERC climate resilience research programme project: "Towards a microbial process-based understanding of the resilience of UK peatland systems", also a member of several working groups for the Group on Earth Observations Biological Observation Network (GEO-BON), contributing to the development of Essential Biodiversity Variables; **Sweet:** member of the Reef Conservation UK committee from 2013-2018 and is a member of the research committee for BIAZA (British and Irish Association for Zoos and Aquariums), corresponding secretary for the International Society of Reef Studies (2018 onwards) and is working with the IUCN on updating the red list of tropical corals.

4.3.7 Prizes

Röthig: received the Ruth Gates Memorial Award from the International Coral Reef Society in 2019 in recognition of outstanding early career research on the conservation of coral reefs; **Sweet** was awarded the Frontiers SpotLight Prize in 2019, along with his co-editors, for editing *"The Coral Reefs in the Anthropocene"* special issue for the journal.