

Unit-level environment template (REF5b)

Institution: University of Portsmouth (UoP)

Unit of Assessment: B7 – Earth Systems and Environmental Sciences

1 Unit context and structure, research and impact strategy

1.1 Unit context and structure

Staff in this submission are drawn from the Schools of Biological Sciences (SBS; 10.9 FTE) and Environment, Geography and Geosciences (SEGG; 22.9 FTE). Our research spans fundamental discovery science to applied research that addresses problems of global societal relevance. During the census period, we have strengthened and broadened our staff base and grown our submission from 25.7 to 33.8 FTE, aligned with the University's ambitions for environmental sustainability and support for interdisciplinary working (REF5a, paragraph (p.) 9). We have also made significant investments in facilities, instrumentation and organisational infrastructure to support critical mass around six research groups (**Group Leads, appointed in REF period**):

- **Crustal Evolution** (CEG: *Darling, Fowler, Mottram, Parrish, Strachan, Storey*) has an international reputation for discovery science, focussed on the initiation of plate tectonics, geochronology of shock metamorphism, crustal evolution of the Moon and Mars, ore formation and geochronology of ductile and brittle deformation.
- **Environmental Processes and Impacts** (EPIG: *Fones, Hoque, Mills, Watts, Salta, Smith*) draws together expertise in aquatic geochemistry, hydrogeology, environmental radioactivity and environmental microbiology to address issues related to the impacts of climate change, contamination and pollution of the environment.
- **Palaeontology** (PG: *Cotton, Gale, Loydell, Martill, Minter*) uses fossil and sedimentological records to investigate past climates and environment and has built a reputation for research on vertebrate and invertebrate palaeontology, alongside micropalaeontology and ichnology. As well as having a high profile for science communication, the PG's stratigraphic expertise supports the hydrocarbon industry to improve source rock characterisation.
- **Marine Sciences** (MSG: *Cragg, Ford, Hale, Marley, Preston, Ragazzola, Reynolds, Shipway, Willis (former staff)*) focuses on marine biology and ecology, marine biogeochemistry, aquatic toxicology, climate change, marine protected areas, habitat restoration, and human impacts on the marine environment.
- **Natural Hazards** (NHG: *Benson, Gibson, Koor, Rust, Solana, Teeuw, Whitworth*) focuses on volcano-seismology and associated hazards and risks, neotectonics, landslides, disaster risk reduction and resilience, and has a particular strength in the use of low-cost geoinformatics in responding to, and preparing for, hazardous events.
- **Ecology and Evolution** (EEG: *Armbruster, Barrales, Bourgeois, Fruciano, Grinsted, Tallis*). Fundamental research in EEG underpins practical measures to understand biodiversity and

Unit-level environment template (REF5b)

ecosystem function, for example, the effect of climate change on terrestrial pollination stability, social evolution, community ecology, and host-parasite and plant-pollinator interactions.

1.2 Achievement of strategic aims for research and impact

Throughout the REF period, we have evaluated and updated our strategic aims, notably in School Vision Statements in 2017 and 2019. Achievement of these aims is summarised below:

1.2.1 Broadening our research strengths and developing new, related areas with societal relevance

We have strategically recruited new staff to enhance and complement our research strengths. For instance, *Mottram* and *Parrish* extend the geochronology capability of the CEG to include dating brittle deformation, *Cotton* extends PG research to micropalaeontology and the appointment of *Bourgeois*, *Fruciano* and *Ginsted* increases the breadth of population and behavioural ecology research in the EEG. In EPIG, *Salta* enhances our environmental microbiology research, particularly in biofilms, whilst *Hoque* adds hydrogeology expertise to our water quality and monitoring research. Our Marine Sciences Group (MSG) has seen the most significant expansion, reflecting its contribution to institutional priorities of ocean governance and plastic pollution (REF5a, 1.0). Recruitment of five staff (*Marley*, *Preston*, *Raggazola*, *Reynolds* and *Shipway*) enhances our strengths in marine ecology and evolution, microalgal taxonomy and marine biogeochemistry, enabling us to study interactions between human activity and the marine environment at the molecular, ecosystem and community levels.

We have also supported extant staff and invested in specialist instrumentation to establish our Natural Hazards Group (NHG). Their research focusses on areas with potential transformative impacts, such as disaster risk reduction, fugitive dust, smart ground investigation and geo-conservation, aligned with University 'Security and Risk', 'Sustainability and the Environment' and 'Future Technologies' Thematic Areas, and with the priorities of external funders.

In 2017, Faculty QR funding was invested in bioinformatics expertise and a bioinformatics-specific, high-performance computing cluster that has enhanced our capabilities in environmental genomics, relevant to our ecotoxicology, biofilms, evolutionary ecology and enzyme bioprospecting research programmes.

This growth across the Unit has contributed to our research vitality. Over the last 5 years, staff across the Unit have published 494 papers: of these, over 40% are in 'top 10% journals' (CiteScore) and 24% are classed as 'highly cited' (i.e. citation count in the top 10% for the subject area). The merging of the Department of Geography with the School of Earth and Environmental Sciences into SEGG in 2019 provides opportunities for further growth of research at the interface of society and the environment.

1.2.2 Investing in interdisciplinary research (IDR) to address global societal challenges

The Unit has an established record of accomplishment in interdisciplinary working. In the last assessment period, we created and led the UoP Environment Network that provided the foundation for the current 'Sustainability and the Environment' University Theme, to which we

Unit-level environment template (REF5b)

are key contributors. A strong element of the Unit's IDR has developed from within the MSG, focussed around enzymatic breakdown of complex natural and synthetic polymers, such as wood and plastic. *Cragg*, working with molecular and structural biologists in UoA3, previously characterised a unique crustacean cellulase impacting on biofuel production (*Proc Natl Acad Sci.* 2013; 110(25): 10189-10194). In this assessment period, supported by BBSRC funding and with the Ocean Genome Legacy Centre and US National Renewable Energy Laboratory (NREL), this team applied structure-guided protein engineering approaches to lignin-degrading enzymes whose products are valuable building blocks for the chemical industry. Recognising the research excellence in this group and the potential impact of enzyme innovation to address global environmental challenges, the University committed £6M to establish the Centre for Enzyme Innovation (CEI) that was further enhanced by a £5.8M Expanding Excellence in England award in 2019 (REF5a, p.6).

The CEI draws together our research excellence in marine zoology (*Cragg*, *Shipway*) and environmental microbiology (*Watts*), connecting it with broader environment research areas to drive growth in enzyme innovation, spanning a pipeline from discovery to application. *Cragg*, *Shipway* and *Watts* lead the bioprospecting programmes and Senior Research Fellows, Senior Research Associates, Specialist Technicians and postgraduate research students (PGRS) have been recruited to work across disciplinary interfaces. The CEI, with an immediate focus on plastic-degrading enzymes, recognition for research excellence and established national and international partnerships, is at the forefront of research to deliver solutions to the global plastic challenge. This IDR ethos and infrastructure has already supported *Cragg* to lead an international consortium (with *Ford*, *Salta* and *Watts* and Project Partners at the Nanyang Technological University and National University of Singapore) developing innovative microbial solutions to marine plastic pollution in South East Asia (NERC, £711k).

1.2.3 Enhancing our organisational infrastructure to facilitate engagement with users of research

In 2015, the University introduced a workload allocation model (REF5a, p.2) that explicitly recognises time for networking, partnership development, advocacy and consultancy. In 2016, constituent Schools appointed designated (0.3 FTE) Associate Heads for Research and for Innovation, the latter to support non-academic collaboration and knowledge exchange. Events, training and support provided by Collaboration Managers in Faculty and central Research and Innovation Services (RIS) (REF5a, p.15) have developed researchers' skills and capacity to respond to collaborative opportunities with research users.

Within the Unit, we created two externally-facing 'research and consultancy entities', clustered around distinct areas of expertise and specialist instrumentation, to act as vehicles for external engagement and impact:

- the UoP Geological and Environmental Laboratories (UPGEL) that combine our capabilities and facilities in geochemistry and geochronology, soil and water environmental chemistry, rock mechanics, engineering geology, geotechnical engineering and passive sampling of the environment; and

Unit-level environment template (REF5b)

- our marine research station, the Institute of Marine Sciences (IMS), which supports research on the impact of climate change and environmental contaminants, such as pharmaceuticals, radioactivity and microplastics, on aquatic ecosystems, as well as the development of new products with improved environmental profiles.

In 2016, funding from the Solent LEP (£390k), matched by University funding, enabled us to recruit four Scientific Officers (SO), aligned with the IMS and UPGEL, to develop research-based projects with external partners and support knowledge exchange through research and training activities. Since then, and through UPGEL and the IMS, the Unit has carried out contract research and commercial testing for over 63 clients including national and international companies in the water, oil and gas, waste management, renewables, wood technology, construction and ground engineering sectors; environmental agencies and consultants; and research institutes. Our knowledge exchange income has increased from £63k in AY2013/14 to £290k in AY2019/20, and SO support has directly facilitated adoption of innovative tools, protocols and products underpinned by our research, as described in two of our Impact Case Studies, *UoP07Chemcatcher* and *UoP07Wood*.

1.2.4 Supporting staff to become research active

Our new Natural Hazards Group (NHG) is composed of staff who previously had a teaching or consultancy focus. In 2011, we created the Centre for Applied Geosciences (CAG) to establish cross-disciplinary critical mass and strengthen research culture to support these staff and others with a similar background. CAG developed a programme of mentoring, external speakers, theme/team meetings and created a strong ethos of collaboration on publications, grant applications and external profile. As a result of these initiatives, the quality of publications has improved, research income has grown from £107k in 2013/14 to £880k in 2019/20, and NHG staff are supervising PGRS, many of them externally funded. The NHG's research has particularly strong links with industry and makes a significant contribution to the South Coast Centre of Excellence in Satellite Applications (REF5a, p.17) in the practical deployment of data from Space.

1.3 Enabling and facilitating impact

We have employed a variety of mechanisms to support impact across the research lifecycle. As well as enhancing our infrastructure to support external engagement (1.2.3), researchers are supported through mentoring and training to develop "pathways to impact" for every project. Schools hold impact away-days and "Dragon's Den" style sessions with stakeholders, and staff attend workshops on networking, Intellectual Property (IP) and commercialisation, and on strategies to engage wider audiences, as part of the RIS Development Programme (RISDP, REF5a, p.33). Unit funding is also invested in "impact acceleration" awards for project costs, travel, attendance at meetings, stakeholder and dissemination events. These approaches supported the development of our Impact Case Studies, as well as wider impact across the Unit (4.2). For example, *Smith's* research in the Chernobyl Exclusion Zone (CEZ) builds on his decades-long collaborations with Ukrainian and Belarussian researchers and with the State Agency of Ukraine for Exclusion Zone Management (SAUEZM) and underpins a new CEZ water management strategy. The Unit funded analysis of crop and water samples to support vodka production from contaminated land (the ATOMIK grain spirit project) and stakeholder

Unit-level environment template (REF5b)

consultation events that led to the signing of an agreement for the transfer of abandoned land for re-settlement (*UoP07Chernobyl*). Between 2014 and 2018, *Fones* and *Mills* worked with water supply companies and environment agencies across the UK to develop and calibrate new variants of the Chemcatcher®, a device developed within the Unit for measuring mobile pollutants in water. Unit funding supported an SO to deliver training courses, deploy Chemcatcher® in the field and analyse data, and *Fones* and *Mills* to visit field sites, meet end users and advise on the use of Chemcatcher® in river catchment management strategies (*UoP07Chemcatcher*). Similarly, an SO at the IMS tested innovative wood protection treatments for agencies and companies across Europe. This provided confidence in the Portsmouth protocols for assessing wood resistance to marine borer attack, and facilitated refinement of the protocols for incorporation into commercial product development. Supported by Unit funding, *Cragg* also made field visits and attended key meetings to promote the incorporation of the Portsmouth protocol into European Standards for testing of wood and wood treatments for marine construction (*UoP07Wood*).

1.4 Approach to supporting interdisciplinary research (IDR)

Interdisciplinarity is embedded in our research in a number of ways. Research Group Leads encourage colleagues to develop and engage in collaborative research projects with other Portsmouth academics, who are invited to 'open laboratory days' and our seminar series. We have invested in facilities and instrumentation that support IDR (3.3) and provide seedcorn funding (up to £25K per project) for promising interdisciplinary collaborations. Examples include: *Gibson* and *Watts* working with criminologists and DSTL to establish a Taphonomy Facility; *Hoque* with computer scientists and data security experts to develop social networking technology to screen for arsenic in groundwater wells in Bangladesh; *Gibson* using hyperspectral sensing to monitor climate change with glaciologists; *Watts* with bioinformaticians and geoconservationists on innovative biofilms for heritage conservation; and *Watts*, *Hale* and *Preston* with civil engineers investigating microplastics in road run-off as vectors for virus transfer. These projects contribute to University Thematic Areas, 'Sustainability and the Environment', 'Future Technologies' and 'Health and Wellbeing', and we will continue to pump-prime a diverse IDR portfolio moving forward.

Researchers in our Unit also contribute to IDR centres and projects, linked to international networks. For example, the Centre for Blue Governance (CBG, REF5a, p.7) (*Ford*, Deputy Director) connects expertise across UoP in aquatic resources, management of coastal environment processes, and human and marine ecology. Collaborations developed through the CBG underpin MaCoBioS, an EU-funded project (*Cragg*, Col) investigating the impacts of climate change on critical marine coastal ecosystems, and research on the governance of deltas in Bangladesh involving *Ford*, *Hoque* (PI) and *Preston*. Funded by the 'Sustainability and the Environment' Theme, *Ford* and *Marley* are working on a project to tackle the problem of urban plastic pollution in Kenya and Bangladesh with UoP researchers from UoAs 14, 17, 20 and 33.

1.5 Research strategy to 2026

We have identified five objectives to build our global reach and reputation and deliver environmental and societal impact, aligned with the University Strategy 2020-25 (REF5a2.0). These objectives capitalise on our growth in research excellence and interdisciplinary working,

Unit-level environment template (REF5b)

and investment in infrastructure. All are underpinned by our commitment to staff development, support for PGRS and equality, diversity and inclusivity.

1.5.1 Continue to grow the vitality of our research, particularly where we have established a leading position and our research positively influences society.

Examples include: the development and application of novel geochronological and geochemical tools using advanced electron imaging and mass spectrometry; the fate and behaviour of plastics in the environment; cognate particulate pollution as the next emerging global environmental health crisis; and natural hazard risk management and reduction.

1.5.2 Continue to embed IDR within our Unit by building on the opportunities offered by the merged SEGG and through the CEI, CBG and University Thematic Areas.

Our new research on microplastics, as environmental pollutants and as potential vectors for disease transfer, offers extensive opportunities for IDR and inter-sector collaboration. We will access cross-Unit expertise to extend our engagement with science-led policy development in our research on environmental and climate change, water quality, habitat restoration/conservation, sustainable development, and management of natural resources and waste materials.

1.5.3 Support mid-career and senior staff to grow critical mass within research groups through recruitment of PGRS and postdoctoral researchers, supported by external funding.

We will expand our mentoring provision, support staff to maximise publication and funding success via internal peer review and promote attendance on new University 'Reader to Professor' Leadership programmes. We will prioritise support for female leadership programmes, moving towards an improved gender-balance at all grades.

1.5.4 Maintain and enhance our infrastructure and instrumentation as the basis for developing new partnerships, embedding IDR and delivering impact.

We will develop our Electron Microscopy and Microanalysis Unit (3.3) as an international resource and to establish UK leadership in Moon and Mars sample return and analysis. We will expand our analytical capabilities further to enable correlative research programmes on complex geo-environmental challenges and will continue to use our environmental chemistry, rock mechanics, hyperspectral and marine science facilities as the basis for engagement with end users.

1.5.5 Maximise the benefits of our research, aiming for all research groups to develop 'case studies' of impact.

We will enhance our portfolio of engagement with key industries and stakeholders beyond HE through membership of the South Coast Satellite Applications Catapult, National Biofilms Innovation Centre and through our contributions to the CEI and CBG. We will support staff to identify potential links with beneficiaries through research mentoring and networking, and we will

Unit-level environment template (REF5b)

financially support high quality engagement opportunities, such as secondments, exchanges and events.

1.6 Open research, ethics and integrity

We are committed to an open research environment: 94% of our outputs have been published under open-access licences since 01/04/2016 and 100% of our in-scope REF2 outputs meet Research England's Open Access requirements. Datasets are deposited on University and external open-source repositories (e.g. National Geoscience Data Centre; EO Data Repository; Environmental Information Data Centre; Open Science Framework). Since 2018, 88% of the Unit's outputs have been assessed as compliant with the University's Research Data Management policy (REF5a, p.24). We share specialist data with relevant communities; for example, in GenBank, where we have deposited the transcriptomes of amphipods for use in ecotoxicology (*Ford*) and the mitochondrial genome of *Limnoria* as part of the international Gribble Genome project (*Cragg*). The Unit also facilitates primary research that supports open data; *Teeuw* and *Gibson* evaluated the use of open free- or low-cost geoinformatic systems (GIS) for resource and disaster management applications and were the first to highlight the problem of digital data poverty in sustainable development (*Int J Appl Earth Obs Geoinf.* 2016; 50: 1-9). Data from *Teeuw*'s UK Space Agency-funded 'CommonSensing' project is shared via [Open Data Cube](#).

The University Strategy commits us to the highest standards of academic, professional and research integrity. At School level, this is supported through quality assurance processes that ensure sound research design, participant safety and adherence to ethical codes, openness and transparency. Members of the Unit (*Benson, Minter*) sit on the Faculty Ethics Committee that oversees a mandatory review process in line with the University's commitments under the Concordat to Support Research Integrity, the UKRIO Code of Practice for Research, and DORA (REF5a, p.22); consideration includes ethics, integrity and due diligence in both environmental and human-participatory research.

2 People

Category A staff (FTE) in this submission comprise 8.3 Professors, 8.7 Readers / Principal Lecturers, 14.6 Senior Lecturers/Senior Research Fellows and 2.2 Lecturers/Research Fellows. By FTE, 33% are early career researchers (ECRs).

2.1 Staffing strategy and staff development

Our strategy is to strengthen areas of existing and potential international research excellence by developing the research profile of extant staff and by recruiting new staff with strategically relevant research expertise (1.2.1). Of our new appointments, ten staff (6F:4M) are ECRs, endorsing our commitments to staff development and to addressing historic gender imbalances within the Unit.

The University has held an HR Excellence in Research Award since 2013 and is a signatory to the Researcher Development Concordat (REF5a, p.41). Our staff development strategy aims to grow the capability and profile of our researchers through resourcing their time and providing a

Unit-level environment template (REF5b)

portfolio of support at all career stages. Since REF2014, we have introduced a workload model, streamlining administration and teaching activities to enhance staff efficiency and giving research goals greater priority. Research-active staff (those regularly publishing research articles) are allocated a minimum of 0.2 FTE for research, with additional time for grant-writing, externally-funded research and impact activities. Research Group Leads contribute to annual Performance and Development Reviews (PDR) that link individual and Unit-wide research objectives and identify development needs. New staff are integrated into the Unit's research environment through Research Group membership, an enhanced research workload allocation (0.2 FTE / Year1) and eligibility for research 'start-up funds'. Early- and mid-career staff have a senior mentor from within the Unit and workload hours are allocated to both mentor and mentee.

Early-career academic researchers (ECRs) continue to receive an extended research workload allocation (0.1 FTE / Year 2), have access to ring-fenced ECR funding and are preferentially considered for internally-funded PhD studentships as first supervisor, with additional supervisors to provide mentorship. Of 19 Unit-funded studentships in the census period, 11 were awarded to ECRs appointed since AY2012/13. Supported thus, *Hoque* generated field data on water quality in Myanmar and Bangladesh for publications and grant applications and *Raggazola* developed collaborations in the UK and Europe that have underpinned publications in *Nature Climate Change* and *PNAS*, and projects on the use of artificial coral reefs to mitigate the effects of climate change (Royal Society funded). In 2018, *Marley*, *Mottram*, *Preston* and *Reynolds* (4F) were awarded University ECR Fellowships that provide funding, bespoke training and mentoring to support research career development. As a result, *Marley* worked with high profile stakeholders (Plastic Oceans and GB Row Challenge) on marine acoustic monitoring, *Mottram* has secured funding from NERC for research on mineral deposits of the Canadian Cordillera [REF2/22994790], *Preston* is collaborating with Blue Marine Foundation, visited international oyster hatcheries and co-organised a European Native Oyster Restoration Alliance (NORA) workshop, and *Reynolds* is collaborating with the National Oceanography Centre, UK, and Woods Hole Oceanographic Institute, USA.

We have also targeted support to mid-career researchers to enhance their research profiles and develop their research leadership capabilities. For example, investment in *Darling* (appointed as an ECR in 2012) has included a bursaried PhD studentship, project costs, funding to support exchange visits with collaborators at Imperial College, London and in Ontario, and significant investment in electron microscopy and microanalytical instrumentation (3.3). This has facilitated subsequent publications in *Nature Astronomy*, *Nature Communications* and *Nature Geoscience* and STFC funding to establish UK leadership in radiometric dating of Mars. *Teeuw* received mentoring, bid writing support and workload allocation to develop collaborative, international projects and has secured awards to lead research programmes on illegal gold mining in Colombia, the impacts of Hurricane Maria in Dominica, and Risk Science in the UK Space Agency 'Common Sensing' project to enhance climate change resilience in Pacific Small Island Developing States.

Support for established researchers includes external mentoring, underwriting or extending postdoctoral appointments while grant renewals are pending, and support for international mobility. Two staff have benefitted from research sabbaticals in this census period. One supported *Strachan* to reinvigorate research collaborations at Curtin University, Australia, and St

Unit-level environment template (REF5b)

Francis Xavier University, Canada, following a decade as Head of School. Data generated underpinned 5 publications, including a contribution to 'Geologic Time Scale' 2020, and funding for time at the NERC Isotope Geosciences Laboratory. The second enabled *Cragg* to conduct mangrove fieldwork and develop collaborations with experts at the Nanyang Technological University (NTU) and National University of Singapore (NUS). *Cragg* was subsequently invited to contribute to the IUCN Mangrove Specialist Group, attend the 2019 MMM5 (global mangrove) conference in Singapore and currently leads an international consortium (with NTU and NUS) on marine plastic pollution in South East Asia. A sabbatical to *Darling* has been postponed due to Covid-19; this will consolidate collaborations in the USA and Canada and his emerging leadership in planetary and deep-crustal resources.

All staff have equal access to funding for staff development (study leave, sabbaticals, conference attendance) and a variety of internal funding opportunities (up to £25K per award). Workshops on funding, publishing, open research and dissemination are offered via the RISDP; this is supplemented by Research Group activities that include discussion groups, paper writing workshops, grant "hothouses", and a research seminar series that includes external speakers and provides staff and PGRS with opportunities for external collaboration and networking.

Postdoctoral research staff (7.1 FTE, 58%F) are members of Research Groups, mentored by permanent Unit members, and are supported to apply for internal and external funding and to present their research at national and international conferences. Research staff are represented through a Research Staff Forum, have an annual PDR and can access career development training and coaching via RISDP. During this REF period, two research staff (2F), *Preston* and *Reynolds*, have been appointed to permanent UoP academic positions and others have progressed to roles in academia (UWE, Bristol), research (CNRS, France) and governmental laboratories (CEFAS, UK).

The principal mechanism for enabling research and impact activities is workload allocation and we have a strong record of recognising and rewarding staff for research and impact leadership through promotion. The University's Policy on Promotion and Appointment to Reader and Professor includes a range of research and impact activities and recognises co-authorship of publications and income generation as Principal or Co-Investigator. Staff are encouraged to attend promotion workshops and applicants are offered mentoring and peer review support. Female staff are supported to undertake the Aurora and Springboard programmes: *Hale* and *Watts* have benefitted from these and now act as role models and mentors in the Unit and more broadly. In this assessment period, six staff (*Cragg*, *Fones*, *Ford*, *Martill*, *Storey*, *Strachan* – 6M) have been promoted to Professor and five (*Darling*, *Preston*, *Rust*, *Solana*, *Whitworth* - 2F:3M) to Reader. In September 2020, *Fowler*, *Teeuw* and *Watts* (1F:2M) were promoted to Professor and *Gibson* and *Koor* (2M) to Reader.

2.2 Support for, training and supervision of research students

PGRS are an integral part of the Unit and investment in their development is key to achieving our objectives. The relevance of our research to industry has attracted external sponsorship, either fully- or jointly-funded as CASE (BBSRC, NERC) and KTP studentships, from, for example, Aker BP, AstraZeneca, Blue Marine Foundation, DustScan, Environment Agency, EPI Ltd, South West Water and the Swiss Federal Institute of Aquatic Science and Technology. We

Unit-level environment template (REF5b)

have also secured international funding for PhD programmes, including the Brazilian CNPq and CAPES schemes (n=8), the Royal Thai Government Studentship Programme (n=5) and the Nigerian Government Petroleum Technology Development Fund (n=5), and have strategically invested internal QR resources (£700k) in stipends for 19 PhD studentships across all Research Groups. As a result, PGRS completions (23F:31M) have increased by 20% relative to REF2014; 70 students are currently registered on our doctoral programmes (PhD and Prof Doc), indicating the sustainability of this trajectory.

PGRS selection is based upon presentations and interviews of shortlisted candidates with the supervisor(s) and Research Group Lead, supported by a trained interviewer. PGRS supervisory teams typically consist of three staff, including external supervisors where they bring additional expertise. Supervisors are expected to have regular informal contact with their students and to hold monthly meetings for their research group. Progress in year 1 is formally monitored by a Major Review Report and presentation to a panel that includes two assessors independent of the supervisory team. Annual reviews with presentations to the same panel are held thereafter. Each School has a Research Degrees Coordinator responsible for the monitoring and development of PGRS. There are PGRS representatives on each Schools' Equality and Diversity, Research and Innovation and Faculty Research Degrees Committees.

The majority of training is tailored to specific projects but PGRS also attend at least 10 days of researcher development training each year, in line with Vitae recommendations. The University Graduate School Development Programme provides professional and generic skills training [REF5a, p.38] whilst the Unit provides specialist subject training, for example, on the use of microscopy and spectroscopy techniques, environmental modelling and statistics. Students are supported financially to attend national courses, such as the NERC Electron Microprobe course. All PGRS are active members of our Research Groups, through which they participate in 'Journal Clubs', discussions on thesis- and grant-writing, and peer support for developing research projects. As well as presenting in Research Groups, PGRS take part in School seminar series, an annual School Postgraduate Research Conference, University Festival of Doctoral Research, and 3-minute thesis presentations. A bursary is available for all PGRS to attend at least one international conference over the course of their studies.

Our Unit provides a range of additional development activities to improve our PGRS' employability. External networking is facilitated by supervisors' extensive collaborations and the Unit's engagement with key stakeholders. A PGRS placement scheme has supported students to spend time at academic and non-academic institutions where they learn techniques and methods to support their research and develop their networks. Recent destinations include: Greenwich University; University of Iceland; University of Vigo, Spain; Natural History Museum; Royal Ontario Museum, Toronto; Key Forensic Services Ltd; Ove Arup and Partners, London; Aker BP and Applied, Petroleum Technology, Norway. PGRS develop the impact of their research through working with our collaborators and have benefitted from opportunities with, for example, the Solent Oyster Restoration Project, the Environment Agency, Southern Inshore Fisheries Conservation Authority, Southern Water, The Wildlife Trust and the Solent Forum. Our PGRS contribute to impact activities (4.2) and public engagement (4.4) and all students involved in teaching are enrolled on the University Graduate Students Professional Development programme that is aligned to accreditation by the UK HEA.

Unit-level environment template (REF5b)

Our training and development portfolio prepares our PGRS to go onto a range of successful careers, including in research (e.g. Universities of Montpellier and Clermont-Ferrand, France; Southern Illinois, USA; Royal Ontario Museum and University of Quebec, Canada), academia (UWE, Gottingen), government agencies (Defence Science and Technology Laboratory; Nigerian Maritime Administration and Safety Agency, Thai Office of Atoms for Peace), charities (Blue Marine Foundation) and industry (Dustscan; CDM Smith, Germany; Atkins, UK; Zantiks, UK).

Our Unit also contributes to national research training as a core partner in the BBSRC South Coast Biosciences (SoCoBio) DTP and associate partner in the NERC INSPIRE DTP. UoP delivers a residential Science Communication Summer School for all SoCoBio PGRS and *Ford* co-supervises an INSPIRE PGRS with Southampton. Between 2017-2020, *Whitworth* led the [3DTeLC](#) project, with 13 European partners, that developed a suite of open-source 3D and VR materials that have enhanced the skills of over 100 geo-environmental PGRS in spatial analysis, informatics, mathematics, fieldwork, observation and image analysis.

2.3 Equality and Diversity

The University is a signatory to the Race Equality Charter, a Stonewall Diversity Champion, Disability Confident employer, and holds an Institutional Athena Swan Bronze Award. All staff undertake mandatory training including Bullying & Harassment, Unconscious Bias, and Equality, Diversity & Inclusion (EDI). Both constituent Schools have an Equality and Diversity Group and an EDI lead (0.1 FTE) who oversees the promotion of equality and diversity, from the point of staff recruitment onwards. SBS holds a Departmental Athena SWAN Bronze Award and the recently-established SEGG will submit in November 2021. We are committed to foster an inclusive environment for all; 73% of eligible Category A staff are included in this submission and the overall profile of our Unit broadly reflects that of academic and research staff in the discipline (Table 1). 18% of our Unit work part-time and 1% are on fixed-term contracts.

Table 1: Unit Profile and demographics

Indicator	Proportion of Cat A staff		Doctoral degrees awarded
	Sector	Unit	
Gender (Female)	36% ¹	35%	43%
Ethnicity (BAME ²)	4% ¹	10%	15%
Declared disability	3% ¹	1%	12%
Age (36-55)	50% ¹	61%	n/a

1-Earth, marine, environmental sciences [Advance HE, 2020](#); 2-Reported as Black, Asian and Minority Ethnic

We have made significant progress towards a Unit diversity profile representative of sector norms; of the thirteen staff appointed into academic positions, eight are women. We have increased the proportion of female staff in our submission from 20% to 35% and staff reported

Unit-level environment template (REF5b)

as of 'BAME' ethnic origin from 0% to 10%. Nevertheless, the gender profile by career stage reflects ongoing EDI issues within the Unit, and in STEM subjects more broadly. Women are well-represented at Lecturer/Senior Lecturer (53%F) levels but there is underrepresentation at senior grades (30%F Reader/Principal Lecturer; 0%F Professorial). We will address this as a priority going forward. This will include taking actions to secure Athena Swan Awards (Silver SBS; Bronze, SEGG) and supporting more of our female staff to apply for sabbaticals, participate in the HE Aurora Leadership Programme and to access bespoke coaching and mentoring offered by the University and externally. To support female staff with publication and grant-writing, we have held off-site, residential workshops that have provided time and space to make substantial progress on manuscripts and research bids, as well as helping to develop peer support and networking; we will continue these moving forward.

Research seminars and essential meetings are scheduled within core hours and 11 staff currently have flexible working patterns to accommodate caring responsibilities. The University has guidance for staff and managers on maternity, paternity, shared parental and adoption leave; two members of staff have returned from maternity leave, one to fractional contract positions that allowed for career progression. Funding is available to support research re-engagement after periods of extended absence and *Ford* has hosted a Daphne Jackson Fellow. We have supported a member of staff with a declared disability to access funding through the Access to Work Programme for specialist equipment to support their research.

REF submission: All staff involved in Unit REF decision-making attended an 'Equality and Diversity in the REF' workshop (Advance HE, October 2019). Outputs were reviewed and selected according to the UoP Code of Practice. An EIA has confirmed that REF2 outputs reflect the profile of submitted staff for gender (28%F), ethnicity (8% BAME), disability (4%), contract (7% fixed term, 19% part-time) and career stage (32% ECR).

3 Income, infrastructure and facilities

3.1 Research funding and strategies for generating income

During this assessment period, our income strategy has focused on supporting a wider group of staff to submit to a broader range of funders. Staff share their research ideas with mentors and Research Group members at the earliest opportunity, gaining advice from experienced colleagues at the point where feedback can be most effective. Grant writing is supported through workload allowance, funding and bid-writing workshops. Competitive external bid applications are reviewed within the Unit (small grants) and through the University's Peer Review College (larger grants, REF5a, p.56). Our investments in staff development and external engagement have extended our collaborations and raised the profile of our researchers to support income generation.

These mechanisms have been highly effective; 68% of submitted staff have contributed to income generation as PI and, since REF2014, our total research income has grown by 48% (from £2.73M to £4.04M). We have also secured funding from increasingly diverse sources (54 individual funders) including: UK research councils (e.g. BBSRC, ESRC, NERC and STFC);

Unit-level environment template (REF5b)

trusts and charities, such as the Blue Marine Foundation, Leverhulme; the European Commission; UK government bodies; and industry in the UK and overseas.

Our UKRI income base has seen the most significant growth (from £1.45M to £2.48M), reflecting the increased societal relevance of our research. Nine staff (*Fones, Ford, Hale, Mottram, Parrish, Smith, Storey, Teeuw, Watts*) have held NERC awards and the breadth of our NERC-funded projects demonstrates our profile in aquatic geochemistry, macronutrient and carbon cycling (*Fones, Hale and Watts*), environmental monitoring and risk assessment (*Ford, Smith*), geochronology (*Mottram, Storey*), geochemical analysis (*Parrish*) and remote sensing for disaster preparedness mapping (*Teeuw*). *Cragg* has received near-continuous BBSRC funding for projects investigating enzymatic degradation of lignocellulose for fermentative production of biofuels and platform chemicals, and was a Co-I on a BBSRC strategic LoLa, as part of the BBSRC Sustainable Bioenergy Centre (£2.8M, £568k to UoP). We have also been supported by the STFC (awards to *Darling* to establish the UoP2 Mars Consortium and to *Smith* to develop methods to assess cataract development in fish exposed to radiation) and the ESRC for participatory research with communities along the Choco River, Colombia (*Teeuw* (Co-I)).

Our income from government bodies has also grown significantly, from 4% to 11% of our portfolio. Projects include enhancing the natural capital of the Solent (Environment Agency, £60k) and using satellite imagery to detect illegal gold mining in Colombia (£3.3M, £60k to UoP) and to improve the resilience of Small Island Developing States (SIDS) to climate change and natural disasters (£471k), funded by the UK Space Agency.

Our current grant portfolio includes over 90 projects supported by over 40 funders, indicating the vitality and sustainability of our funding base. Recent awards to *Cragg* to tackle marine plastic pollution and to *Ford*, as UK lead on the cross-Channel project, REDPOL, to develop methods to support changes in the environmental regulation of endocrine disrupting chemicals (€2.8M, £310k to UoP), respond directly to key environmental challenges. We will continue to ensure our research agendas align with the priorities of a wide range of funders and will further extend our collaborations with end users to support research translation and impact.

3.2 Organisational infrastructure supporting research and impact

Research and impact are supported across the Unit at School level. The School Research and Innovation Committee (SRIC) identifies research priorities, agrees the strategic distribution of investment (e.g. in studentships and small grants), considers EDI issues, manages research integrity and monitors delivery against KPIs and the Research Concordat. Current membership includes Associate Heads Research and Innovation, Research Group Leads, the Research Degrees Coordinator and representatives of ECRs and research staff. The SRICs report to the School Management Groups and Faculty RIC. The REF Unit Coordinator (*Storey*) is a member of the Faculty and University REF Steering Committees. Research Groups operate a peer-support system at the early stages of research design to improve project rigour and quality of publications and bids. In addition to Unit-specific support, staff in the Faculty and central RIS team (REF5a, p.56-57) provide support for bid development (including finance and co-ordination of internal reviews), developing pathways to, and evidencing of impact, research ethics

Unit-level environment template (REF5b)

applications, post-award administration of funded research projects and commercialisation (IP, patenting and contracts).

3.3 Specialist infrastructure and facilities

Our distinctive research profile is underpinned by outstanding facilities and instrumentation, acquired through external grants and significant (£2.3M) internal capital investment in strategically important areas, such as advanced electron microscope imaging, environmental and geochemical analysis, and enzyme innovation. All staff and PGRS have equal access to infrastructure and instrumentation, irrespective of seniority, Research Group affiliation or availability of external income. Research and impact across the Unit is supported by Scientific Officers (1.2.3) and 6.5 FTE technical staff (46%F), managed by School Technical Managers. Technical staff are members of Research Groups, have access to funding for conference attendance and specialist training, contribute to publications, and are supported to achieve additional qualifications. Two of our technical staff have received bursary funding to support part-time PhDs.

3.3.1 Facilities

The CEI has benefitted from significant strategic University and external investment. As well as investment in staff and PGRS, a £1.1M estate refurbishment created new laboratories (including Category 2) that facilitate interdisciplinary working and embed the CEI in the scientific research community. The Solent LEP has recently invested £1M in our enzyme innovation work to create a bio-recycling development facility that will enhance our capability to engage directly with industry and will support research translation and regional economic growth.

The Institute of Marine Sciences (IMS) is situated at the mouth of Langstone Harbour, Portsmouth, and provides direct access to the Solent European Marine Site and coastal habitats across the Solent. The Aquatic Centre houses a 320 m² controlled environment aquarium and seawater system, experimental rooms and quarantine facilities. The IMS hosts England's first oyster hatchery, established in partnership with the Blue Marine Foundation and underpinning our involvement in the Solent Oyster Restoration Project. We have invested in a new research vessel (£110k) and a floating research platform (£47k), moored in the Langstone waters that are rich in bio-fouling organisms. The platform is used for exposure trials and a range of *in situ* research and monitoring. The IMS supports research collaborations and commercial projects with, for example, Blue Marine Foundation, CEFAS, QinetiQ, the Building Research Establishment, Thales, Balmoral Offshore Engineering, Kebony AS, and the Research Council of Norway. Innovative laboratory protocols to assess marine borer activity, developed at the IMS by *Cragg* and *Shipway*, have been used to develop wood protection products with enhanced efficacy and improved environmental profiles (*UoP07Wood*).

3.3.2 Specialist instrumentation

During this assessment period, we have invested £630k in enhancing the Unit's imaging and analysis capabilities and consolidating these within the [Electron Microscopy and Microanalysis Unit](#) (EMMU), led by *Darling*. EMMU instrumentation underpins research within the CEG (REF2/7107496/20471622), across Unit Research Groups and IDR with, for example, structural

Unit-level environment template (REF5b)

biologists, materials and biomechanical engineers and heritage conservators in other UoAs. LA-ICP-MS instrumentation includes a Nu Plasma multiple-collector ICP-MS, Analytik Jena PlasmaQuant Elite quadrupole ICP-MS and an ASI Resolution Excimer 193nm laser. Scanning electron microscopy (SEM) capabilities have been enhanced with two Zeiss Evo MA10 SEMs, one with LaB6 source and Oxford Instruments solid-state EDS and EBSD detectors for advanced imaging, chemical and crystallographic analysis at the micro- to nano-scale, and the other with Tungsten source for imaging palaeontological and biological specimens. In 2020, we invested in a Tescan FEG source SEM to support IDR on enzyme innovation and microplastics as part of the CEI. The EMMU also provides bespoke services to academia (e.g. University of Brighton) and industry (e.g. Chemostrat). A new Zeiss Axio Lab optical microscope and an AHRC-funded Zeiss Smart Zoom 5 digital microscope (£100k, *Darling*) further enhances our imaging and analysis capabilities. Reflecting expertise and reputation developed over the census period, in January 2021, we were awarded NERC capital funding (£955k) to install the first tandem LA-LIBS femtosecond laser system in a European University. As well as linking physical and biological processes and accelerating our work on the environmental fate and behaviour of minerals, contaminants, plastics and dust, this will be a national resource and will underpin extensive future collaborations.

Our Rock Mechanics Laboratory (RML) integrates engineering geology, applied rock mechanics and fluid-driven seismicity in unstable rock masses, ranging from volcanoes to hydrocarbon reservoirs. The RML houses an 600kN INSTRON hydraulic press, upgraded Sanchez Triaxial and Instron Uniaxial Rigs (£500k), 100 MPa rock deformation/physics ensemble, and a 12 channel Acoustic Emission system capable of recording 1Tb of data to disk per hour for investigating fracture damage in real-time, akin to field-scale seismic monitoring. A 3D visualisation suite (£19k) supports *Whitworth's* '3DTeLC' project developing virtual reality models of natural hazards for PGRS training and outreach (*Bull Volcanol.* 2020; 82(5): 38). We have also established a new Remote and Hyperspectral Sensing Laboratory (£154k) that uses lab-based and portable systems to calibrate the remote sensing and field imaging of a wide range of materials via NIR satellite capture. These investments have grown the vitality of research in the NHG, underpinned high quality papers (REF2/16045450) and important industrial collaborations, and attracted funded PGRS.

To support expansion of our micropalaeontology research, we have invested in dedicated laboratories for sample preparation in a controlled environment, including a hydrofluoric acid hood for dissolving silicate rock matrices. Broader palaeontology research is facilitated by shared access to advanced imaging facilities in the Zeiss Global Centre (ZGC). The ZGC, located in the Faculty of Technology, houses X-ray 3D microscopes (Versa 510 and Versa 520) enabling high-resolution tomography and chemical mapping for imaging and elemental analysis of fossils. Our Environmental Chemicals Analysis Laboratory has benefitted from purchase of a Quattro nutrient analyser and a SpectroBlue ICP-OES, supporting geochemical analysis in marine and sediment-water systems. We have also upgraded our greenhouse facilities, to include mobile benches, automatic watering and day-length control lighting systems, which have enabled simulated commercial tomato production as part of the European Horti-BlueC project (*Tallis, Ford*).

Unit-level environment template (REF5b)

Our facilities and instrumentation are accessible to wider academia and industry via the [University Research Portal](#) and equipment sharing databases, such as [Equipment.data](#) and [Konfer](#). We will continue to invest in infrastructure, ensuring that future enhancement is driven by our strategic priorities and maximises the opportunities for shared resource use.

Our researchers also access world-class research facilities that complement those in the Unit. Researchers have secured competitive, peer-reviewed time at national facilities (equivalent to £234k in this REF period), such as the NERC Ion Micro-probe Facility (*Darling, Storey*), Biomolecular Analysis Facility (*Ford*) and National Environmental Isotope Facility (*Darling, Strachan, Parrish*); Diamond Light Source (*Smith*); European Synchrotron Radiation Facility (*Storey, Darling*); Atom Probe, Canadian Centre of Electron Microscopy; and Ion Microprobe, Canadian Centre for Isotopic Microanalysis (*Darling*).

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

4.1 Research collaborations, networks and partnerships

Our strategic focus on supporting collaborations to enhance the quality of our research and income generation is evidenced by 84% of our publications in this REF period being with international or national co-authors (SciVal). Collaboration with academic partners is facilitated by financial support, sabbaticals, mentoring and annual PDRs, where staff are encouraged to develop their academic profile through visiting positions, research networks and roles in professional bodies. Flexible allocations of funding for travel and placements have supported visiting researcher positions in the UK (e.g. Aberdeen, Cambridge, Durham, Edinburgh, Leeds, Southampton, Surrey) and overseas (e.g. University of the Algarve, ETH Zurich, Curtin University, St Francis Xavier University, Lee Kong Chian Natural History Museum, NTU and NUS). A partnership agreement with Brazilian universities, the Federal University of Ouro Preto and State Universities of Rio de Janeiro and Sao Paulo, has facilitated staff and student exchanges, joint publications and PGR studentships.

Our participation in funded research consortia promotes open science, produces rigorous research outputs and contributes to international impact. Examples include:

- *Cragg* was a Co-I on the 'Marine wood borer enzyme discovery' research project (2014 - 2019), a component of the £24M BBSRC Sustainable Bioenergy Centre, with HEI partners in the UK (Cambridge, York - lead), Europe (Copenhagen, Norway, Vienna), the USA (Ocean Genome Legacy Centre, Northeastern University, Boston), and Singapore. The project revealed the complex molecular mechanisms of wood digestion in marine wood borers and identified new enzymes and processes for production of biofuels and platform chemicals. *Cragg* has extended these international collaborations, to include the US NREL, to synthesise the understanding of how organisms across the '[Tree of Life](#)' deconstruct enzyme-recalcitrant, but globally-dominant, vascular plant biomass and develop a major new perspective on the global flow of carbon from vascular plants into the oceans ([Annual Review of Marine Science, 2020](#)).

Unit-level environment template (REF5b)

- *Smith and Ford* co-led the 'TRansfer Exposure Effects' (TREE) consortium with the Universities of Nottingham, Salford, Stirling, West of England and the NERC Centre of Ecology and Hydrology. TREE was the largest coordinated study on radiation exposure and effects undertaken within the Chernobyl Exclusion Zone and was awarded Times Higher Education Research Project of the Year in 2016.
- *Darling* leads the UoP2 Mars Consortium that brings together internationally leading expertise at Portsmouth and Plymouth Universities and the Royal Ontario Museum to study the crustal evolution of Mars.
- *Mottram* has developed a multi-partner collaboration with Laurentian University, gold exploration companies and the Yukon, Canadian and Israel Geological Surveys, resulting in a paper in *Geology* on U-Pb carbonate and K-Ar illite fault dating (REF2/22994790).
- *Storey* led a collaboration with the Universities of Bristol, Helsinki and Southampton that has provided new insights into the way that plate tectonics have shaped the Earth.

4.2 Engagement with users of research to deliver societal, economic and environmental impacts

Our researchers engage with end users through a number of routes, including:

- **Using our specialist instrumentation to undertake collaborative and contract research.** For example, the Rock Mechanics Laboratory facilitated a partnership with EPI Ltd, a geophysics consultancy, attracting a NERC iCASE studentship and delivering publications (*JGR Solid Earth* 2019; 124: 9562-9579). Similarly, the Remote and Hyperspectral Sensing Laboratory underpins partnerships with the quarry industry and Northern Ireland Health and Safety Executive on the rapid detection of erionite and other potentially asbestiform materials (*Fowler and Gibson*). The IMS has supported a suite of testing work on novel wood treatments, enzyme-enabled treatments to accelerate degradation of horse bedding and biofouling control treatments. The EMMU hosts and maintains the Mary Rose Trust's SEM facilities; recent AHRC funding will enable correlative digital microscopy of some of the most important UK maritime heritage collections.
- **Working directly with industry partners.** This includes with DustscanAQ to improve air quality and identify 'nuisance' sources by monitoring and characterising industrial fugitive dusts (*Fowler, Smith and Whitworth*); supporting oil and gas exploration by Aker BP through characterising chalk hard grounds (*Fowler, Gale and Koor*); developing innovative wood treatments for marine construction with Kebony AS (*UoP07Wood*); and working with Southern Water to improve the management of Langstone Harbour by assessing marine litter and water quality (*Hale, Watts*).
- **Building partnerships through national and international networks.** The UoP is a member of the National Biofilms Innovation Centre through which *Watts* secured £50k to work with Historic England and the Isle of Wight Council on innovative methods of biofilm control that are being used to preserve the Newport Villa Roman mosaics. *Solana* and *Teeuw* are members of the UKRI-funded Caribbean Resilience and Recovery Knowledge

Unit-level environment template (REF5b)

Network that brings researchers, policymakers and practitioners together to work with SIDS that were most affected by the 2017 hurricanes and are struggling to 'build back better'. In 2017, *Preston* co-founded the [UK & Ireland Native Oyster Network](#) (with the Zoological Society of London) comprising 21 members, including universities, NGOs and seafood industry organisations. The network is engaged with 8 restoration projects and 13 fishery production companies. *Preston* also leads the UoP contribution to the Solent Oyster Restoration project that has restored 69,000 native oysters to the Solent.

- **Working with national and international government agencies responsible for environmental monitoring and management.** For example, working with universities and research institutes in the UK, France, Belgium and Netherlands to identify endocrine disrupter compounds in the environment (*Ford*); with the Swiss Oekotoxzentrum centre to develop biomarkers for sewage effluent exposure (*Ford*); with SAUEZM on a new water management strategy in the Chernobyl Exclusion Zone (*UoP07Chernobyl*); with water agencies and conservation trusts in the UK and Ireland on improved river catchment management (*UoP07Chemcatcher*); with materials testing agencies across Europe to incorporate the Portsmouth marine borer activity protocol into international standards (*UoP07Wood*); and with the United Nations, governments of Fiji, the Solomon Islands and Vanuatu and environmental consultancy companies on satellite remote sensing tools for enhanced climate resilience (*Teeuw*).
- **Policy influencing through publications and invited presentations.** Research on communication during volcanic crises (*Solana*, *Teeuw*) contributed to the 2017 Science and Technology Roadmap of the Sendai Framework for Disaster Risk Reduction (DRR) that highlighted the need for low cost, open-source GIS and shifted the focus from managing disasters to reducing risks. In 2018, *Solana* was an invited expert member of the Dominica post-Hurricane Maria review of Community Disaster Plans and *Teeuw* presented a summary of remote sensing applications for hurricane DRR to 50 diplomats, policy makers and NGO technical experts at a Canning House event on Natural Disasters in Latin America and the Caribbean.
- **Delivering professional training programmes.** *Teeuw* and *Solana*'s expertise in the use of geoinformatics, disaster preparedness mapping and risk communication has been incorporated into the SimEx training series, a multi-agency simulated disaster event response exercise, aligned with the UN Simulation and Training Network. Hosted annually by the UoP and Hampshire Fire and Rescue Service since 2015, participants from over 50 emergency services, first-responder and humanitarian organisations, including RedR UK, Red Cross, MapAction and UNITAR, use SimEx to test and improve their emergency procedures and training.

The proportion of our research income from projects with at least one named non-academic partner has grown from 53% in 2013/14 to 89% in 2019/20, and 11% of our submitted outputs are co-authored with non-academic partners. Involvement of end users in the design and implementation of our research ensures that it has clear societal relevance and that we are well-positioned to respond to emerging priorities and challenges. This is evidenced by our research programmes to address the problems of plastic pollution and waste management, air quality, contamination of water and soils, and developing and living in marginal environments, especially

Unit-level environment template (REF5b)

in parts of the world subject to multi-geohazards. Users and beneficiaries of our research also provide access to field sites (e.g. the CEZ (*Smith*), mangrove swamps in South East Asia and high-intensity marine borer sites across Europe (*Cragg*)), and to exchange and placement opportunities for staff and PGRS (2.2). Established partnerships have supported bids for new instrumentation (e.g. new digital microscopes with the Mary Rose Trust (*Darling*) and an LA-LIBS femtosecond laser system with the NERC BGS (*Storey*)) that enhances our infrastructure and enables us to make a significant contribution to the UK research resource base.

4.3 Contributions to, and recognition by, our disciplines

Contributions to the wider scientific community are recognised in workload allocations and are an important vehicle for extending intellectual leadership to our disciplines. Editorship positions include Editor in Chief or Associate Editor (*Fones, Continental Shelf Research; Ford, Frontiers in Marine Science, PeerJ, Toxics; Parrish, Precambrian Research; Watts, Environmental Microbiome*); Special Issue Editor (*Ford, Aquatic Toxicology; Hoque, Remote Sensing; Mottram, Geochronology; Salta, Journal of Marine Science and Engineering*); and Science Editor (*Strachan, Geological Society of America Bulletin*). Researchers in the Unit have provided expert review for the European Commission, national (BBSRC, EPSRC, NERC and STFC) and international funding agencies in fifteen countries. They have also served on committees of diverse funding bodies: NERC (*Benson, Fones, Ford, Parrish, Storey*); British Council Newton Funding (*Darling, Watts*), European Commission (*Watts - H2020 MCSA-IF, MCSA-ITN, ERA Chair Evaluations, EU-LIF*); Czech Science Foundation (*Bourgeois*); Hong Kong Research Grants Council (*Bourgeois*); French Priority Research Programme on Antibiotic Resistance (*Watts*); Spanish Ministry of Science and Innovation (*Barrales*); Commonwealth Science Conference Grants Committee (*Armbruster*); Polish National Science Foundation (*Storey*); and the Norwegian Research Council Earth Sciences Grant Panel (*Parrish*).

Staff have hosted international conferences at Portsmouth e.g. Engineering Geology 50 Conference, 2017 (*Koor*) and International Seminar on Radiation Effects on Wildlife, 2019 (*Smith*), and have chaired or convened sessions at international workshops and conferences. These include: Goldschmidt (*Darling, Sept, 2013; Mottram, 2017-2019*); EURO-Conference in Rock Physics and Geomechanics (*Benson, 2015*); RSPSoc and AGI briefing on Satellite remote sensing for disaster risk reduction and insurance (*Teeuw, 2016*); 29th SETAC meeting (*Ford, Chair, 2019*); Behavioural Toxicology in Regulation Workshop, UBA, Germany (*Ford, 2019*); Fifth International Conference on the Effects of Noise on Aquatic Life (*Marley, 2019*); NORA Conference (*Preston, 2019*); and Marine Bioremediation, International Marine Biotechnology Conference (*Watts, 2019*).

Approximately 20 staff sit on committees of a diverse range of national and international professional organisations and special interest groups. These include the UK, Geological Society of London (*Benson, Mottram, Teeuw, Strachan*); UK Rock Deformation Network (*Benson, Chair*); UK Coordinating Group on Environmental Radiation (*Smith*); Water Sciences Forum of the Royal Society of Chemistry (*Fones*); General Council of Mineralogical Society of Great Britain and Ireland (*Darling*); NERC Isotope Geosciences Facilities Steering Committee (*Parrish*); NERC Ion Microprobe Facility Steering Committee (*Storey, Chair*); Metamorphic Studies Group (*Mottram, Chair*); Association of Geotechnical Specialists (*Koor*); and the Quantitative Ecology Special Interest Group of the British Ecological Society (*Marley*).

Unit-level environment template (REF5b)

Internationally, staff have made important contributions to influential bodies, including the Mangrove Specialist Group of the International Union for the Conservation of Nature (*Cragg*), International Marine Biotechnology Association (*Watts*) and the European Society for Marine Biotechnology (*Salta*). *Watts* was an advisor for the Microbiology Society 'Microbiome Policy Report' (2017). *Darling, Gale, Storey* and *Strachan* are co-authors on the 'Geological Time Scale 2020', evidencing our international reputation for geology and stratigraphy. In recognition of his distinguished contributions to geosciences, *Strachan* was elected as a Fellow of the Geological Society of America in 2020.

4.4 Engagement with diverse communities and publics

We are passionate about engaging the public with our research and employ a variety of mechanisms to do this. Our staff work with the University's press office and the media in general. Over the last three years, *Martill's* research on new pterosaur species, fossils of the oldest mammals related to mankind, and evidence of aquatic dinosaurs has been reported in nearly 2,000 news articles and broadcast clips. Similarly, *Smith's* research on wildlife in the CEZ has had media reach of over 100 million and inspired Sir David Attenborough to visit Chernobyl in the final scene of 'Our Planet', Netflix's most successful documentary series, with 25 million viewers in its first month. Moreover, *Smith's* ATOMIK grain spirit project, which produces vodka from grain grown within the CEZ, has gained significant international media attention (e.g. BBC News, CNN, Times of India, Xinhua) and is benefitting local communities through the social enterprise Chernobyl Spirit Company. *Shipway's* discovery of a new genus and species of rock-eating shipworm, undertaken with Philippine Mollusk Symbiont International Biodiversity Collaborative Group, was reported internationally (e.g. New York Times) and was ranked in the [top 50 global science stories of 2019 by Discover magazine](#).

Our staff and PGRS engage with our local community through participation in activities such as Pint of Science Week, outreach events at Portsmouth's Victorious Music Festival, Portsmouth Green Drinks, Cafe Scientifique, U3A, and through delivering STEM sessions across primary schools in the area. With their strong emphasis on Science in Society, Palaeontology PGRS also act as STEMNet ambassadors in local schools and deliver talks and events at the 'Dinosaur Isle' Museum, Isle of Wight. We have used "citizen-science" projects to promote engagement and change public awareness. For example, *Preston's* 'Photograph an oyster' project, undertaken through the Native Oyster Network, encouraged members of the public to photograph living native oysters around the UK coastline to raise awareness of native oyster reef habitats and the importance of oysters within ecosystem services, and to change public perception of oysters as a seafood dish. More broadly, *Preston's* work on the regeneration of native oyster stocks has received significant national media coverage, including on BBC television programmes 'Coast' (2016) and 'Countryfile' (2018). *Marley* has used sightings reported by members of the public to map the location of marine mammals in the waters surrounding the Isle of Wight. *Ford* and *Marley* have partnered with the 2,000 mile '[GB Row challenge](#)' to measure microplastics and pollutants in the water and create the first underwater noise pollution map of the UK. *Ford's* work on the negative consequences of antidepressant contamination to aquatic wildlife has been widely reported in national (e.g. *The Daily Telegraph* and *The Daily Mail*), and international (e.g. *Fox News*, *National Geographic*) media. A collaboration with performance artist, Paul Henry, in

Unit-level environment template (REF5b)

2017 led to [‘Shrimp Dance’](#), a series of performances and discussions as part of Scottish Mental Health Arts & Film Festival, supported by Creative Scotland.