Institution: University of Bristol
Unit of Assessment: 14: Geography and Environmental Studies
1. Unit context and structure, research and impact strategy

Overview

The School of Geographical Sciences is a thriving, world-leading centre for integrated research in environmental systems, society, and their interactions. Through a combination of physical, life and social scientists, humanities scholars, and mathematicians, we address some of the biggest intellectual and practical problems of the 21st century such as climate change, urbanisation, health and well-being, poverty and development, biodiversity loss and the ongoing crises in water, energy, and food security.

Major successes over the REF period are evidenced by a broad range of measures:

- More than 1785* research publications (>5 per FTE per year), including 20 books and 131 book chapters, with 8200 external co-authors/collaborators from >4800 different organisations, receiving >29000 citations.
- Increased the number of prestigious NERC Independent Research Fellows and Royal Society University Research fellows from 3 to 8*.
- Expanded our staffing to deliver greater strength, cohesion, and breadth of research, through recruitments from ECR to professorial levels, tripling (from 2 to 7*) the number of female professors and halving the number of fixed term category A staff.
- Doubled the number of our PhD awards to nearly 100 and leadership of 3 UKRI DTPs/CDTs and two EU ITNs.
- Research income has grown by 65% to >£25m*. Per annum (pa) income grew from £3.1 to £3.6m*. We lead 3 UKRI Large Grant programmes and have diversified funding sources and the researchers receiving funding, doubling Human Geography research income to £0.7m pa.
- Impact is embedded throughout our research culture, generating >£537k of direct funding and >£2m of in-kind impact funding from government, business, and charities.
- Staff research has been recognised with multiple awards, including 5 Academy of Social Sciences Fellowships, 3 Royal Society Wolfson Research Merit Awards, 2 AGU Fellowships, the Royal Geographical Society's Murchison Award and Victoria Medal, and a CBE.

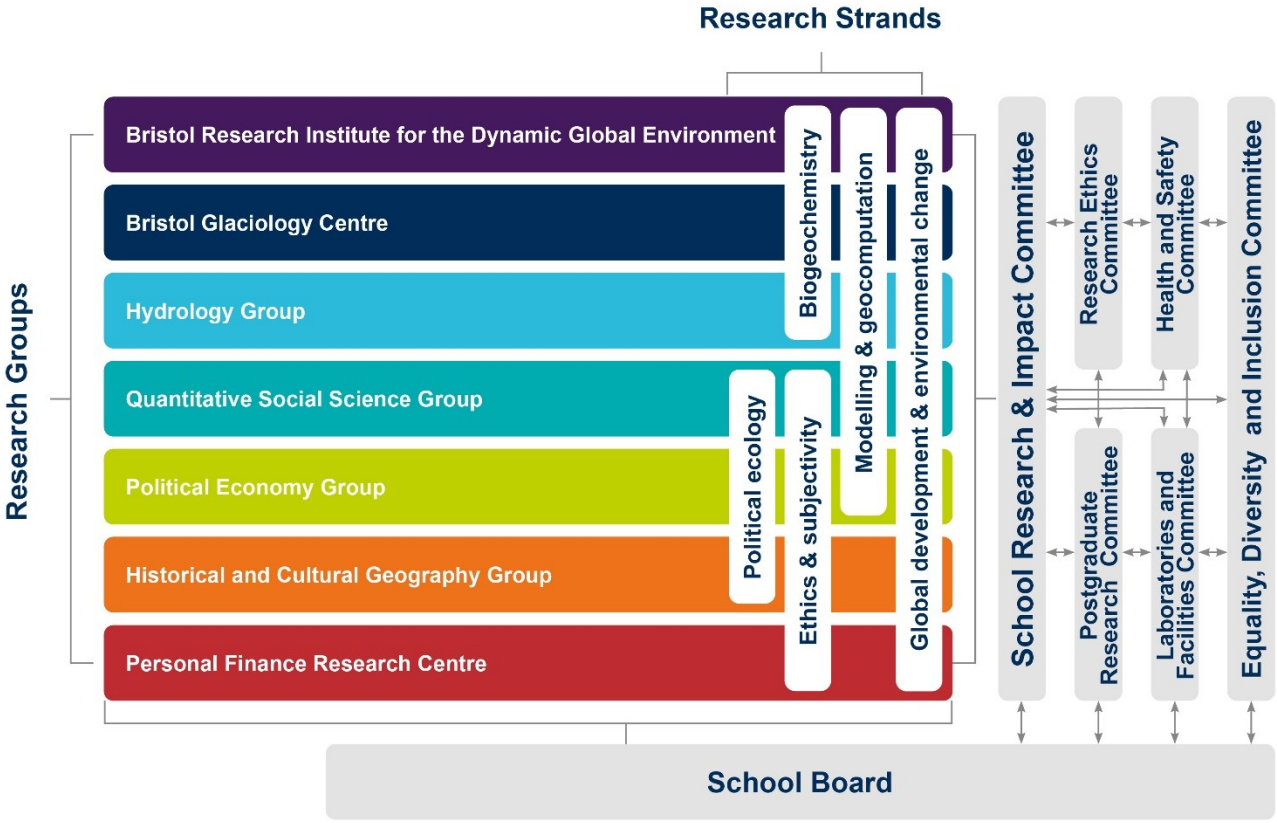
Our ambition is to develop new fundamental knowledge that radically transforms our understanding of the world and to create exciting new approaches to social science-physical science debates, translating and exchanging our new findings with the broadest range of stakeholders.

Our ethos is to ensure that staff are world leading researchers or on track to become so, that knowledge is co-produced through our partner networks, and that our work produces highly impactful research outputs, eliciting societal, operational, and environmental change.

**All data are for the REF2021 census period, and comparisons are to our REF2014 data.*

1.1 Research Structure and Management

Since REF2014, our organisational structure has been refreshed with a strengthening of research groups and the formation of new, cross-cutting research 'strands' in dynamic new areas of our continually evolving discipline (Figure 1).



(**Figure 1:** School Research Structure and Management.)

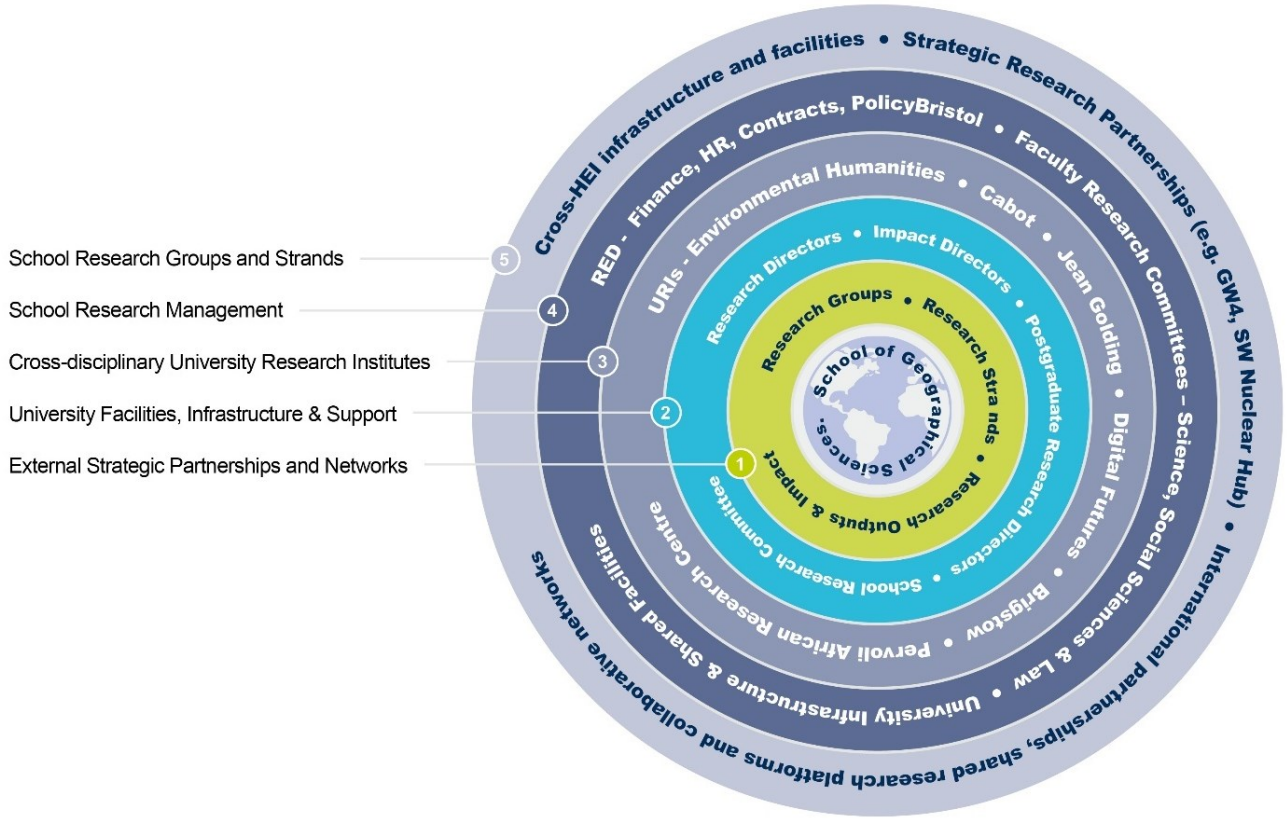
Research strands were developed to meet our REF2014 objective of growing interdisciplinary research within the School. These represent clusters of collaborative research activity, involving staff from several research groups, Schools and Faculties. They allow us to rapidly innovate and lead new developments in cross-disciplinary research. Evidence of their success includes 10 new interdisciplinary PhD students linked to the Biogeochemistry strand, and multiple GCRF-funded projects (section 3.1).

Research groups provide the research "home" and provide the management units for our research activity and have national and international visibility. All staff and students belong to one group, and groups gradually evolve in response to our strategic aims and developments. Leadership rotates every 4 years, with groups meeting regularly via seminars, reading groups, strategy meetings, and social activities, providing peer-to-peer mentoring, training, and support for all members.

Our **School Research Committee** manages research within the school. Chaired by our co-directors of research for physical and human geography, it includes our Impact and Postgraduate Research Directors and Research Group Leads. This committee develops and oversees delivery of our research strategy, sets priorities for investment, liaises with our *School Health and Safety*

(H&S), Research Ethics, Laboratories and Facilities, and *Equality, Diversity, and Inclusion (EDI)* committees, and feeds into *School Board* and *Faculty Committees*. It advises on staff appointments, promotes research, impact, and knowledge exchange opportunities, manages Research Away Days, and delivers targeted training, mentoring and support.

Our **Research Environment** is nested within a series of Faculty, University, strategic regional and international structures, providing a rich environment that supports and encourages research and impact delivery from the individual scholar to multi-national research collaborations and strategic stakeholder partnerships, at all career stages (Figure 2). Staff lead and participate in cross-disciplinary *University Research Institutes and Centres (URIs/URCs)* and are supported by the *Research, Enterprise, and Development (RED) group*, and *Faculty Research Committees*. Strategic regional and international partnerships then provide further opportunities for multilateral research collaboration and impact, as elaborated in our **Institution Environment Statement: REF5a.**



(**Figure 2:** University Research Environment and Strategic Regional and International Networks.)

1.1.1 Research Group Highlights since REF2014 and Future Strategic Research Aims (All research highlights are linked to REF2021 research outputs)

Bristol Research Initiative for the Dynamic Global Environment (BRIDGE): focuses on past, present, and future Earth system through modelling, geochemical, phylogenetic evolution, and remotely sensed data. *Highlights***:** (1) improved estimates of climate sensitivity from paleo data, (2) established the origins of photosynthetic eukaryotes from low salinity habitats, (3) improved understanding of recent methane and CFC trends. *Future aims*: (a) develop globally important geochemical inventories; (b) link microbial communities' evolution to past environmental change;

(c) improve translation of model outputs for stakeholders; (d) inform future climate by applying state-of-the-art Earth system models to the past.

Bristol Glaciology Centre*:* uses fieldwork, remote sensing, modelling, and experimental approaches to investigate physical and biogeochemical processes in glacial environments. *Highlights***:** (1) major revision of Antarctic ice loss due to marine ice-cliff instability, (2) ice sheets as major source of iron, silica and phosphorous to oceans, (3) ice sheet contributions to future sea-level rise from structured expert judgment. *Future aims***:** (a) develop new techniques to monitor present-day and project future ice sheet and sea level trends; (b) understand the stability of the Greenland and Antarctic ice sheets; (c) quantify the impacts of glacial biogeochemical processes in shaping the evolution of complex life and regulating global biogeochemical cycles.

Hydrology Group*:* research global-scale flood risk, dryland hydro-climatology, and aquatic biogeochemistry through monitoring, experimentation, and modelling. *Highlights***:** (1) first high-resolution global flood hazard model, (2) major agricultural changes required to mitigate eutrophication under climate change, (3) proof that climate is a first order control on drainage basin evolution. *Future aims*: (a) deliver enhanced tools for flood prediction, risk assessment and mitigation; (b) determine the impacts of climate change on water and food security; (c) conduct cross-disciplinary research on the key drivers of water quality degradation and biodiversity loss; (d) strengthen translation of research to better inform water policy and management.

Quantitative Spatial Science: addresses social, political, economic, and environmental questions through sophisticated quantitative research methods. *Highlights***:** (1) investigation of urban geography and protest mobilisation in Africa, (2) understanding intersectionality using multilevel modelling, (3) developing and supporting numeracy and statistical literacy in Geography. *Future Aims***:** (a) analyse the 2021 UK Census to determine social, cultural, educational, and economic shifts; (b) explore space time implications of exposures to multiple contextual environments and their influence on the life course; (c) pioneer new methods in statistics and data science, made publicly available in open access software.

Political Economy*: a*pplies spatially sensitive approaches to the study of economic, social, and political phenomena across local to global scales. *Highlights***:** (1) major monograph on *"More than rural: Textures of Thailand's agrarian transition*", (2) translational research from the global south that has shifted the paradigm of urban studies, (3) pioneering Ecuador experiment in living well. *Future Aims***:** (a) progress innovative mixed method approaches utilising insights from survey, visual, narrative, and participatory action research; (b) advance political ontology approaches to transform postcolonial ecology, socio-technical, social justice, biotechnology/bioethics debates; (c) enhance thinking in socio-economic justice, sustainability, equality, governance, and the politics of environmental change through detailed case study work.

Historical and Cultural Geography*:* focuses on the environmental histories of the early modern and modern periods. *Highlights***:** (1) major monograph on *"Malthus: The Life and Legacies of an Untimely Prophet",* (2) analysis of internal Migration in England and Wales, 1851-1911, (3) assessment of the Biogeographies of the Blue Bird of Paradise. *Future Aims***:** (a) novel reassessments of British migration history from quantitative and qualitative perspectives; (b) revisionist monographs in environmental history; (c) major theoretical monographs in postcolonial theory, Spinozist philosophy, and philosophical approaches to the environmental humanities.

Personal Finance Research Centre (PFRC)*:* studies personal finance from the consumer's perspective, providing technical and policy advice to a range of organisations. *Highlights***:** (1) understanding the poverty premium paid by lower income households, (2) producing practical resources to support customers in vulnerable situations, (3) examining the role of the financial services industry in reducing gambling-related harm. *Future Aims***:** (a) explore the potential of innovation and technology to support the financial wellbeing of lower-income consumers; (b) co-ideate new methodologies for citizen empowerment in the data economy; (c) examine the impact of problem gambling on families and their finances.

1.1.2 Current Research Strands and their Strategic Research Aims

Global Development & Environmental Change*:* integrates physical and human geography expertise to tackle global challenge research on urbanisation, food security, economic development, political conflict, environmental degradation, and disease outbreaks. The *strategic aims* are to investigate how violent conflict in drylands regions affect land degradation, how governance structures affect land use and carbon emissions, and how science influences the 2030 Global Development agenda.

Modelling & Geocomputation: This strand allows Human and Physical Geographers to exchange knowledge and skills through their shared focus on the latest data science, modelling, and computational methods. The *strategic aim* is to bring together advanced modelling approaches to explore alternative solutions to current problems; for instance, how social science modellers can shed light on climate problems thought machine learning or how physical science modellers can give insight into population flows.

Biogeochemistry*:* brings together School researchers and from across the University, to study pollution, global biogeochemical cycles, and the processes controlling interactions between people, ecosystems, and environment. The *strategic aims* are to determine the interlinkages between the ocean, ice, freshwater and terrestrial biogeochemical cycles, and how we can more effectively manage the carbon, nitrogen, and phosphorus cycles under environmental and social change.

Ethics and Subjectivity: draws together staff across the social and natural sciences to examine contemporary theoretical and political challenges to ideas of collective life posed by phenomena including racial injustice, environmental crisis, and the rise of populism. Its *strategic aim* is to put ethics at the centre of geographical and interdisciplinary debates, exploring the burgeoning field of bioethics, the ethical import of the UN's Sustainable Development Goals, and the field of non-western ethics.

Political Ecology*:* brings together researchers across the university to advance critical scholarship examining how non-human natures are conceptualised, mapped, governed, and reconstituted in emerging socio-environmental and resource hotspots. The *strategic aims* are to examine the multi-scalar knowledge dynamics and power structures that shape contemporary human-environment interactions, focusing on contested issues in both urban and rural contexts.

1.2 Research Strategy

Our REF2014 submission was built around the strong performance of our Research Groups and our strategy for the current assessment period was to retain this strength while developing

interdisciplinary and global challenge research. Understanding these challenges and developing solutions requires an interdisciplinary approach which Geography is ideally placed to lead.

We have achieved all the strategic research goals identified for REF2014 (quoted in italics below).

- *Recruit additional academic staff in key fields*[REF2014] and *Build and retain critical staff masses in Research Groups*[REF2014]. We appointed 22 new permanent faculty staff (growth of 7 FTE, ~16% increase) since REF2014, focusing on exceptional research talent, global challenges, and interdisciplinary research. This has refreshed our groups and brought new Human-Physical foci on development and climate change in Africa and Asia (**Parnell**, **James**, **Duminy**, **Rigg**, **Behzadi**); global warming, mitigation, and the Anthropocene (**Palmer**, **Ganesan**, **Mitchell**, **Ginn**, **Watson**); and flooding and water management (**Johnes**, **Atkins**, **Morgan**, **Coxon**).
- *Growth of Interdisciplinary research*[REF2014]*:* We created a structure to promote interdisciplinarity through our new Research Strands, increased our leadership of cross-disciplinary research in the University via the URIs (section 1.4) and externally through multiple strategic regional and international partnerships. We grew our intellectual strengths in sustainability research through our new Global Challenges Research Professor (**Parnell**).
- *Lead the intellectual challenges in the university and beyond*[REF2014]*:* We have strengthened the discipline through chairing and membership of a broad range of UKRI and learned society strategic development and funding panels; and advisory roles in Government, third sector and a wide range of businesses (see below and section 4).
- *Build our Postgraduate Community and Leadership*[REF2014]*:* PhD student awards increased to 97 (from 44.5) and we strengthened our training and pastoral provision. We lead three UKRI DTPs/CDTs, led two EU ITNs, and participated in 6 more (section 2.2), allowing our postgraduate community to flourish and greatly strengthening our intellectual environment (section 2.2).
- *Increase and Diversify Funding*[REF2014]*:* Research income grew by 17% pa with reduced reliance on UKRI (decreased from 61% to 54% of total funding). EU funding and UK Government funding each increased to £0.9m pa. Human Geography research income more than doubled to £0.7m pa. while the proportion of staff in receipt of significant research funding also increased (section 3).
- *Lead developments in HPC (High Performance Computing) and maintain cutting edge laboratories*[REF2014]: We are heavily engaged with management of the University's High-Performance Computing facilities, and Jean Golding Institute for data science, and lead its Biogeochemistry Research Platform. We have also invested >£1.9m in School HPC and laboratory facilities (sections 1.4, 3).

Our future research strategy builds on these successes, recognising the importance of growing diversity within our community and all the benefits this brings. It has five key elements:

1. Recruit and diversify staff to build synergies between research groups/strands, focussing on fundamental research of the highest intellectual and societal importance.
2. Enhance staff retention by continuing to strengthen the intellectual environment, investment in world-class facilities, and maintaining strong support frameworks to allow our staff to grow into global leaders.

3. Expand our research agenda geared toward promoting collaborative research with industry and government at city, national and international levels.
4. Further research impact and research-led entrepreneurship through broad and deep engagement with industry, government, regional partnerships, and NGOs.
5. Continue to increase and diversify our research income, grow our interdisciplinary research, and expand our postgraduate community.

We will use this research strategy to enhance our world-class research outputs and deliver far-reaching and demonstrable economic and social impact to all communities.

1.3 Generating and sustaining research impact

We contribute to societal well-being, economic growth, and environmental sustainability by embedding research-user engagement and impact throughout our research (see section 4.2 and Impact Cases). Our Impact Director oversees our **School Impact Strategy**, ensuring that impact, knowledge exchange and outreach are embedded in our research wherever possible. We undertook an audit of impact activities in 2015, identifying and actioning:

- Strengthening human geographers' research practice to ensure they achieve their full impact opportunities, using workshops to illustrate the range of possible impact.
- Mentoring staff and providing training on how to access funding and address the impact agendas within their work.
- Collaborating with Policy Bristol to enhance the impact of our research on policy and practice at local to international level.
- Promoting and supporting internships for staff and students into policy roles and industry and encouraging new start-up enterprises.

This approach is part of our overall Research Strategy and supported by the University's **Impact and Engagement Strategy** (see REF5a). It enables our academic ambitions to be translated into impacts that are co-ordinated, often co-designed and/or co-produced with end-users, and carried through into multiple sectors, including industry, NGOs and charities, government departments and agencies, media, and with schools (section 3).

We continue to strengthen our impact activities and have set new goals for the next 5 years:

- Expand the reach and scope of our research, to ensure projects have the widest possible external engagement and impact.
- Increase our co-produced research as well as knowledge exchange engagement with policy makers, NGOs, and industry.
- Ensure impact goals and proposed stakeholder partners are routinely integrated into early-stage research planning for project proposals.
- Sustain the School's tradition of public engagement through the media and work with schools and learned societies.

1.4 Supporting interdisciplinary research

Geography at Bristol is highly interdisciplinary. Most of our grants involve co-investigators beyond Geography, and many staff have spent part of their careers outside Geography, bringing novel

ideas and approaches to the School. We strongly encourage this diversity which allows interdisciplinary working to be deeply embedded within our research portfolio, while our Research Strands promote effective sharing of new methods and skills between groups. These have also allowed us to build stronger research links between physical and human geography, supported by our strategic appointments. Evidence for success of this strategy is seen in our large range of national and international collaborations (section 3 and 4).

We are located within the Faculty of Science and collaborate and share facilities in all Faculties, particularly with the Faculty of Social Sciences and Law and the Faculty of Engineering, which co-hosts our cross-faculty Hydrology Group. We also have strong links with staff in the new Faculty of Life Sciences, cemented through multiple shared DTP/CDT studentships and large grant awards. These provide unparalleled opportunities to develop innovative interdisciplinary research on major global challenges.

Within the University we are strongly involved in interdisciplinary research via URIs and URCs:

Cabot Institute promotes cross-disciplinary research to develop practical solutions to improve how we live and interact with the environment. **Bates** was founding director, the current director is **Wadham**, while both Physical (**Andrews, Bates, Ganesan, House, Johnes, Mitchell, Monteiro, Richards, Sanchez-Baracaldo, Valdes**) and Human Geography (**Atkins, Fox, Jackson, Manley, Milner, Parnell**) staff have led themes, interdisciplinary research projects, and major public events.

Jean Golding Institute (JGI) provides a hub for data science and data-intensive research. Our Quantitative Spatial Science group is heavily involved with the JGI (**Wolf** is on Steering Group), as are Glaciology and BRIDGE groups. It is also linked to the Alan Turing Institute (national institute for data science) and **Wolf, Fox** and **Tranos** are Turing Fellows.

Brigstow Institute brings researchers together with partners across the city and beyond to experiment in new ways of living and being. Members of the School are extensively involved. **Fannin** is a member of the Steering Group and **Fannin, Ginn, Jackson, and Patchett** lead funded interdisciplinary projects.

Digital Futures Institute draws together experts in cybersecurity, digital health, and social sciences. **Fannin** is involved in the Responsible Research for Innovation theme, and **Atkins, Fannin, MacLeavy, Tranos and Collard** are all members of the Digital Futures Research Group.

Environmental Humanities Research Centre works on disentangling the beliefs, values, and meaning associated with environmental issues that face the global community. **Morgan** is on the Steering Group and **Millner**, **Patchett** and **Ginn** are members.

Perivoli Africa Research Centre is a cross-disciplinary community championing transformational research and partnership to advance Africa's achievement of its own aspirations. **Parnell** is on the Advisory Board and **Fox** and **Duminy** are participants.

1.5 Creating an open research environment

The School supports open access (OA) publication as part of our mission to be recognised globally for the quality of our research. Outputs are freely accessible via the University's repository, PURE

(see REF5a). The only exceptions are non-academic papers, particularly reports for industry or NGO groups, when copyright may be owned by the funder.

Our OA policy extends beyond publications, supporting openness with our research tools, model datasets, and genome sequences. For instance, BRIDGE make freely available >10000 paleoclimate model simulations totalling 250TB of data, used by >200 researchers across the world (www.paleo.bris.ac.uk). Other research data (totalling 71TB) are openly available on the University's Research Data Repository service.

Many of our models are freely available, including the *LISFLOOD-FP* flood inundation and *BISICLES* ice sheet models. Many staff maintain GitHub accounts to share research codes. For example, with other developers, **Wolf** maintains statistical and Python packages in the geographic sciences ecosystem, with 0.5 million monthly downloads.

1.6 Supporting a culture of research integrity

We embed research integrity training into our doctoral and ECR training programmes and provide ethics training for all new lecturing staff. All research involving human participants undergoes review by our School Ethics Committee, overseen by the Faculty of Social Science and Law Ethics Committee (at university level see REF5a). Research cannot start until ethical approval is granted.

All research undertaken in the School's laboratories uses documented Standard Operating Protocols, including those developed by our researchers. Compulsory training is delivered to new users in our rigorous H&S protocols and to ensure that data generated are robust and traceable through external audit. No field or laboratory research can start until a risk assessment and training have been completed and signed off by our Technical Manager and Laboratories Manager.

2. People

Overview

Staffing is the most important element of our research strategy. We recruit, support, and develop outstanding talent. We have grown our category A staff from 46.4 to 49.8, through high-level Chair (**Johnes, Parnell, Rigg**) and ECR recruitment (**Andrews, Atkins, Behzadi, Coxon, Day, Davis, Duminy, Ganesan, Gerlach, Ginn, House, James, Jellis, Landy, Mitchell, Morgan, Palmer, Sanchez-Baracaldo, Tranos, Watson, Williamson, Wolf**). Additionally, eleven existing staff were promoted to Senior Lecturer, six to Reader, and seven to Professor. We have improved our gender balance at senior level, with female professors rising from 2 to 7 through a combination of promotion and recruitment. Diversity has also increased but remains an area of concern (BAME staff increased from 2% to 8%). We also halved the number of fixed-term academic staff.

We have greatly increased, from 3 to 8, the number of prestigious ECR research fellowships, with five *NERC Independent Research Fellows* (**Arndt*, Ganesan*, Greene, Mitchell*, Watson***) and three *Royal Society University Research Fellows* (**Gasson, Ridgwell*, Sanchez-Baracaldo*)**. We also host two *Marie Curie* (**Jordan, Vishwakarma**) and one *European Space Agency* (**Landy***) fellows. Many have been offered permanent appointments at Bristol (marked *). We hosted three University Vice-Chancellor Fellows (**Hope, Palmer*, Seviour:** all have progressed to permanent

positions), while **Day*** is currently fully funded on an ESRC research project.

Our research is strongly influenced by the quality and vibrancy of our postdoctoral researcher (PDRA) community. We currently have 28 PDRAs (c.f. 22 in 2014) and have employed 71 PDRAs since REF2014. Senior staff provide mentoring (additional to their PI) and the School and University offer an extensive set of training opportunities to help develop their careers. Many have won fellowships and/or moved to permanent academic positions.

Our research students bring raw talent and vitality to our research environment. We have increased the number of PhD studentships (100% increase in doctoral awards), created a new MScR scheme attracting 7-8 students per year and lead three UKRI DTPs/CDTs. We have led two and participated in six further EU ITNs.

Thirteen staff have moved to new posts. Three took positions at UK HEIs, while ten moved to overseas universities, two left due to retirement and, sadly, one died in post.

2.1 Staffing strategy and staff development

Our staff development strategy is designed to ensure strong, sustained, and responsive support for scholars at all stages of their careers. All have annual meetings with the Head of School or senior academic to discuss workload, ambitions, and career progression. New lecturers choose a senior colleague as mentor, and research staff receive mentoring. University training courses develop research, leadership, and teaching skills. Mentors also receive training.

Our School Promotions Committee (new since REF2014) gives constructive feedback before submission of promotion applications. Collegiality, advancement of equality and diversity, interdisciplinarity, and all forms of impact are promotion criteria, alongside excellence in research, teaching and administration. As evidence for the effectiveness of our processes, 24 of our staff (>70% of staff in post >2 years) have been awarded promotion. Our gender and BAME statistics are discussed in section 2.3.

2.1.1 Staffing and recruitment policy

Our strategy is to attract, develop and retain the best scholars. Our Research Committee collects ideas from Groups and Strands, identifying strategic opportunities to deepen and widen our research portfolio. These are then discussed by all staff. EDI issues are addressed throughout the process, from phrasing of job advertisements to shortlisting and interviews (see section 2.3).

Evidence for success is the high quality of applications (typically >80 applicants from >10 countries per post) to the resulting world-class appointments and improvements of our gender balance. We also recruit via the 'Exceptional Talent' route, head-hunting staff for their strategic value (e.g. **Johnes**) and appointed one of three University Global Challenge Research Chairs, **Parnell,** to advance our research on global sustainability and development. We commonly make proleptic appointments to outstanding research fellows (9 during REF period).

We also offer *Visiting Associate* and *Senior Research Fellowships* as dynamic 2-year appointments which help strengthen the research environment (section 4.1).

2.1.2 Support for ECRs

All ECRs are offered mentors, for PDRAs these are in addition to their PI. We provide targeted training programmes for ECRs, where senior staff and others offer workshops e.g. *How to Write 4* papers, Winning Fellowships and Funding, and Developing Impact*. The University also runs >100 training courses for ECRs. New lecturers are protected from large administrative roles and given a light teaching load.

We work closely with fellowship applicants, alongside the RED team, to support applicants for the process. Mock panels help all candidates prepare for interviews and, once in post, our Staff Review and Development programme provides support for ECRs to implement their long-term research plans.

2.1.3 Study Leave

All academic staff qualify for a half-year, teaching-free period of study leave every four years, allowing extended periods of research and/or impact activity. Staff can apply for a University Research Fellowship, which provides £10k funding to support their leave (awarded to 10 of our staff during this REF period). Staff are also encouraged to apply for external support for study leave (e.g. **Bamber, Bates** and **Valdes** received Leverhulme senior fellowships). There is a research stipend of £1000 pa to all staff who are not in receipt of external funding and new starters receive funds of £5k pa for two years. Results of study leave are monitored and many of our research outputs, grants, and impact successes have arisen from this leave.

2.1.4 Researcher-Business-Policy Exchanges

Staff are encouraged to undertake business or policy exchanges e.g. **House** spent 1 year as *Head of Climate Advice* at the Government Office for Science, while PDRAs and PhD students have been seconded to a range of organisations (section 2.2.3). In addition, **MacLeavy** is a steering group member for the *City Listening Project*, **Fox, Duminy** and **Parnell** support multi-stakeholder efforts to advance the *UN Sustainable Development Goals*, and **House** co-chairs the *Bristol Advisory Committee on Climate Change*, all in partnership with *Bristol City Council*. **Rigg** advises the *FAO* in Laos. **Parnell, Rigg, Fox, Duminy** work with multi-lateral and national bodies on a range of development issues. Several staff are advisors and directors of companies (section 4.3).

2.1.5 Recognition and Rewards for Success.

The most direct expression of success is through the promotion structure. In addition, our research successes, fellowships, vivas and awards of honours are also announced on our webpage, social media and notified to the Deans and Vice-Chancellor leading to broader recognition and celebration across the institution. Major successes are celebrated with a drink's reception open to all staff and students.

2.2. Research Students

We provide a vibrant centre for postgraduate research (PGR), with PhD student numbers[1] increasing by 100% (from 44.5 to 97), and MScRs rising to 7-8 per year (from 1-2 in REF2014). Additionally, we are co-supervising with many other UoAs to support our interdisciplinary research. PGRs have written 129 papers as first author, and 87 papers as co-authors.

PGR students are central to the life of the School, and are fully integrated into research groups, participating in presentations and seminars, and providing peer mentoring. They work closely with PDRAs and fellows and benefit from support from researchers across the School. They also contribute impact through our many CASE studentships (~20% of physical geography studentships).

Staff play leading roles in postgraduate research training: NERC GW4+ DTP (Director: **Valdes**), ESRC SW DTP (Director: **Harris**), and the NERC Freshwater Biosciences and Sustainability CDT (co-Director: **Johnes**), as well as leading two EU ITNs (**Flecker**, **Anesio**).

2.2.1 Recruitment

PGRs are recruited via a competitive process, with strategic steers when funded via DTPs/CDTs. PGRs are also recruited to individual opportunities (e.g. tied to research grants), scholarships (e.g. overseas governments) and self-funded positions. The PGR Director has oversight of all applications, to ensure standards are consistent. We have dedicated School PGR administrative support and all applications are centrally administered. We are heavily oversubscribed, typically with >4x more applications than funded studentships.

The University annually funds a Postgraduate Teaching Assistant for the School. This provides up to 4.5 years funding, to include one year of teaching spread over the first three years.

Our recruitment adheres to the University's EDI Policy. Our ambition is to create a student body that is balanced and diverse. During REF2021 period, 46%/54% of our doctoral students identified as female/male, and 20%/77% were BAME/white. Approximately 70% were from the UK, 10% from EU and 20% other overseas.

In total, 46% of our current students are supported by UKRI bursaries, 6% from the EU, 6% from overseas government (e.g. China, Mexico), 13% self-funding, and the remainder from a variety of university, industry, and charitable sources (e.g. Met Office, Wessex Water, CGG-Robertsons, and UCAS).

2.2.2 Monitoring and Support Mechanisms

The PGR School is led by the Director and Deputy Director of Postgraduate Research comprising Physical and Human Geography staff, supported by an Administrator and Director of MScR. Four PGR students represent their community on School and staff-student committees.

[1] Where the primary supervisor is one of the staff in the UoA.

Each PGR student has a minimum of two internal supervisors. Many also have external co-supervisor(s) from another university or research-user organisation. Supervisors meet with their students at least bi-weekly. Annual Progress Monitoring (APM) is reviewed by the PGR Directors and follows the requirements of the Faculty in which the student is registered:

- HG progress: 12-18 months after registration PGR students give a presentation and submit a report. This is examined orally by two assessors who recommend either progression, revisions and/or further examination before progressing.
- PG progress: annual meetings examine a formal report, skills audit, and conducts an interview with two assessors.
- All students give an oral presentation to which the whole School is invited.
- Where concerns about progression are flagged, we operate an enhanced academic support process.

2.2.3 PGR support and Integration

Our PGR community is housed in a dedicated space, with each allocated their own desk space and computer. Support and integration of our PGR community is provided by:

Wellbeing: We have in-house *Wellbeing Advisors* and University wellbeing schemes (section 2.3.2). All new students are paired with a "buddy" from the existing PGR community, and one supervisor takes the role of "pastoral tutor". When wellbeing issues are raised, PGR directors advise and monitor until the problem is resolved.

Research Culture: Students join a Research Group, playing an important role in the vitality of these groups, for example organising/chairing seminars/discussions. They work closely with their supervisor and other members of the group, benefitting from and offering a wide range of peer-to-peer support.

Supervision: Most of our students form hugely rewarding relationships with their supervisors. However, occasionally this does not work. Students can raise supervision issues directly with PGR Directors who will implement improvement strategies. If mediation fails, an alternative supervisor is provided (<2% of studentships).

Wider Research Environment: PGR students are part of our community through research group and School-wide activities, attendance at seminars, representation on our committees, and inclusion in all School social activities. We also fund PGR social events.

Skills development: Bristol Doctoral College provides >200 courses/activities annually covering research skills, professional development, employability, entrepreneurship, responsible research, and teaching. Our students on average attend ~8 courses/activities per year. Skills training is monitored at the APM.

Bespoke training: Our DTP/CDT students have further opportunities for specialist training. Where possible, this training is open to non-UKRI students, with School financial support for self-funded students for their academic development.

In-house training: The School provides tailored training in disciplinary-specific topics such as *Research Design for Human Geographers, Engaging in Outreach,* and *Training for Vivas*. PGRs who contribute to teaching take the University's CREATE PGR teaching programme.

Placements/internships: Students have opportunities to widen their experiences through placements with our many partners. Numerous examples include internships at the Welsh Assembly Government, Wessex Water, Parliamentary Office of Science and Technology, and Schumacher Institute in the past year alone.

2.3 Equality and Diversity

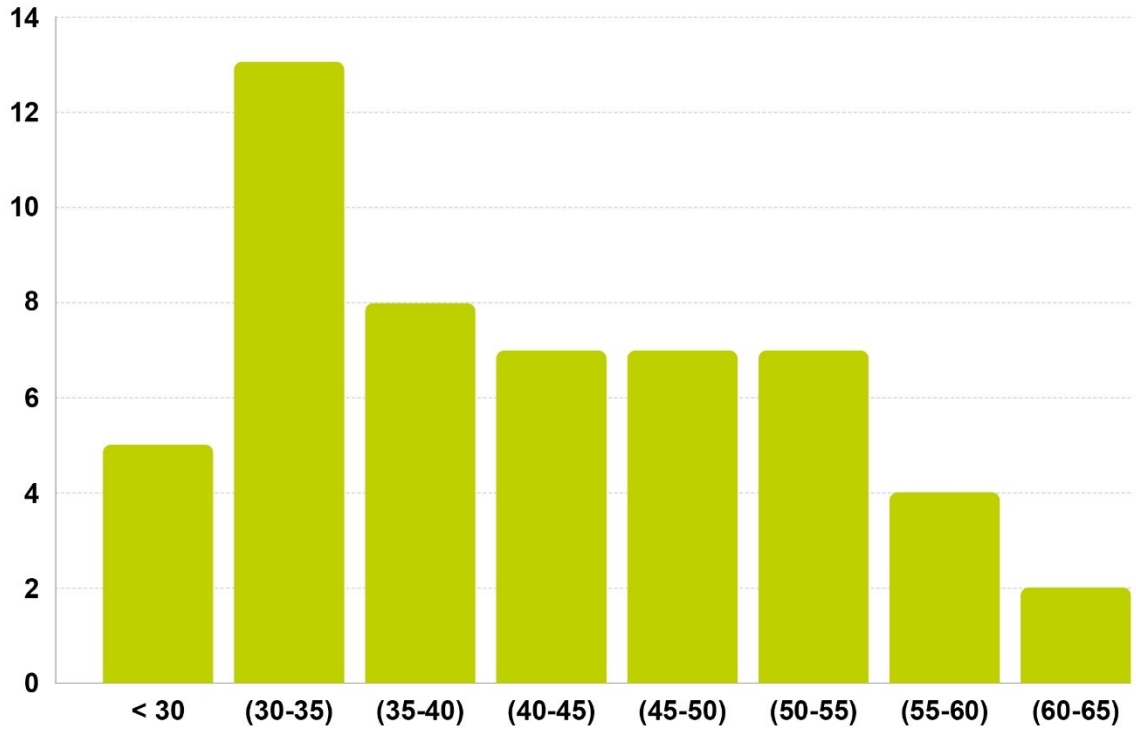
We are strongly committed to supporting EDI in our community. We renewed our Athena Swan bronze award and monitor all aspects of School activities for EDI issues via our **EDI Committee** which meets termly and reports to School Board.

Recent examples of EDI activities:

- Our short-listing procedures consider male and female candidates separately, helping combat unconscious bias.
- We ensure that maternity leave is correctly reflected in our study leave system.
- We raised the profile of women in the School by naming our new study centre after our first female graduate: *Grace Reeves Study Centre*.
- We run a specific mentoring scheme for female ECRs supported by senior staff (total of ~25, 75% of whom have subsequently won permanent posts or fellowships)
- We advertised a PhD position in Human Geography solely for BAME Applicants.

We have actively encouraged female staff to seek promotion and established a School Promotions Committee to support such staff. This has increased the number of female staff applying and gaining promotion. During the REF period, 50% of promotions to readerships and 60% to professor were female. Currently 60% of readers and 40% of professors are female, and female staff are in many senior leadership positions (Directors of Education, Research, Impact, and REF Lead) providing strong positive role models.

Our ethnic diversity has also improved (from 2% to 8% BAME) but unfortunately remains low (c.f. 14% of UK population). Our age structure is relatively young (Figure 3).



(**Figure 3:** Number of category A staff by age.)

2.3.1 Our EDI policies

Study leave arrangements. Study leave is open to all academic staff and is monitored for EDI issues, with periods of parental leave and part-time working accounted for when determining staff eligibility.

Supporting flexible/remote working. Staff are encouraged to make Flexible Working Requests as required, with seven members of staff currently working flexibly. We also provide for part-time working with three staff currently on part-time contracts.

Career pathways for part-time and fixed-term staff. Fixed-term staff on research-only pathways can be promoted up to full Professorship (e.g. **Collard**), with tailored promotion criteria. Our few fixed-term lecturers have equal opportunities for study leave and promotion/progression. Part-time staff have criteria adjusted appropriately.

Conference/travel support for those with EDI needs. Staff are allocated £1000 pa to support travel and/or caring support. Where additional funds are needed, staff are supported to apply to Faculty and/or University schemes.

Support for applying for funding, promotion, and leadership roles. We provide support for all staff with EDI issues. Senior staff act as mentors for several years providing continuity in support for career development, funding, and leadership opportunities. Mentors receive training and the system is monitored through annual EDI review.

Support for staff returning from leave. Staff can request different schedules for returning to work, and the University's *Returning Carer's Scheme* offers up to £10,000 to help restart research

activities, with five staff benefitting from this scheme. Staff returning from longer-term breaks are also supported: e.g. **Sanchez-Baracaldo** returned to science after a 5-year career break, won 3 prestigious fellowships, and is now Reader.

Support for staff with protected characteristics. We support several disabled staff and students. Adjustments are made in discussion with the individual, as they are the experts in managing their condition. Staff are also helped to use the *Access to Work* scheme which provides the necessary practical and financial support.

Supporting the wellbeing of staff and research students. We run School yoga and wellbeing sessions focused on tackling stress and mental health. The University's *Mental Health and Wellbeing Strategy* also provides a diverse range of activities. An annual staff survey allows staff to raise issues, and we then develop an action plan and monitor its effectiveness through our EDI review.

3. Income, infrastructure and facilities

Overview

We have substantially diversified and increased our research funding portfolio, benefitting from significant investment in infrastructure and facilities, direct and in-kind funding from external partners, and access to national and international facilities, and networks. We achieved all our REF2014 funding ambitions, including:

- Research income increased to **>£25m** (65% increase) and per annum income to **£3.6m** (from **£3.1m**) from diverse funding sources including government, industry, and charities.
- Secured major research grants including (as lead PIs) 3 UKRI Large Grants each >£2.3m, 2 further grants >£1m and 4 ERC grants totalling £7.8m.
- Greatly diversified the number of staff with research awards with 90% of staff in post >12 months receiving significant research funding (>£15k per person). c.f. 63% in REF2014.
- More than doubled human geography research income to £0.7m pa.
- Expanded the number of ECR research fellows with 5 NERC IRFs, 3 Royal Society University Research Fellows, and 3 Vice Chancellor Fellows
- Strengthened strategic partnerships with: e.g. Met Office Academic Partnership, focussed on extreme weather and societal implications and solutions; African Centre for Cities, the premier urban research centre on the continent; Asia Research Institute in Singapore, Asia's leading centre for interdisciplinary research.

3.1 Research funding and strategies for generating income.

Our success in winning research funding reflects the quality and ambition of our staff, and our strategy of encouraging and supporting construction of high-quality proposals. We ensure that all staff have the time and support to develop, receive feedback, and refine high quality proposals (**49% overall success rate of submitted research proposals** during REF period). Staff with EDI circumstances are supported through mentoring and funding support appropriate for their needs (section 2.3).

We have targeted large grants as these allow us to undertake large-scale, strategic,

interdisciplinary research. Their development requires additional support, and we have five delivery pathways ranging from school level to URI and GW4 networks, supported by the University's RED staff. Our success in securing this funding is evidenced **by 21 staff with grants >£500k**, with **14 holding grants >£1million**. Additionally, our Global Challenges chair (**Parnell**) has helped develop new GCRF income routes, including supporting successful bids from 11 staff who are PI/CoI on GCRF grants.

Our School Research Committee organises peer-review of proposals. RED provides training in developing and embedding impact, including how to find partnerships and contribute to the economy and society. They also provide finance, personnel, and policy support, and run mock interview panels using experienced senior academic staff. Our proposals also benefit from a cadre of high-level postdoctoral researchers who help co-produce research bids.

Additionally, we support engagement in cross-disciplinary research through our leadership and collaborations with other researchers via the *URIs*, and our *GW4 Partnership* with the universities of Exeter, Bath, and Cardiff. This stimulates highly impactful cross-HEI research clusters (e.g. GW4 Water Security Alliance, **Johnes** is co-director) and access to cutting-edge shared facilities (>1700 items) across the GW4 partnership. Further strategic research partnerships are described in section 4.

Research Funding Portfolio

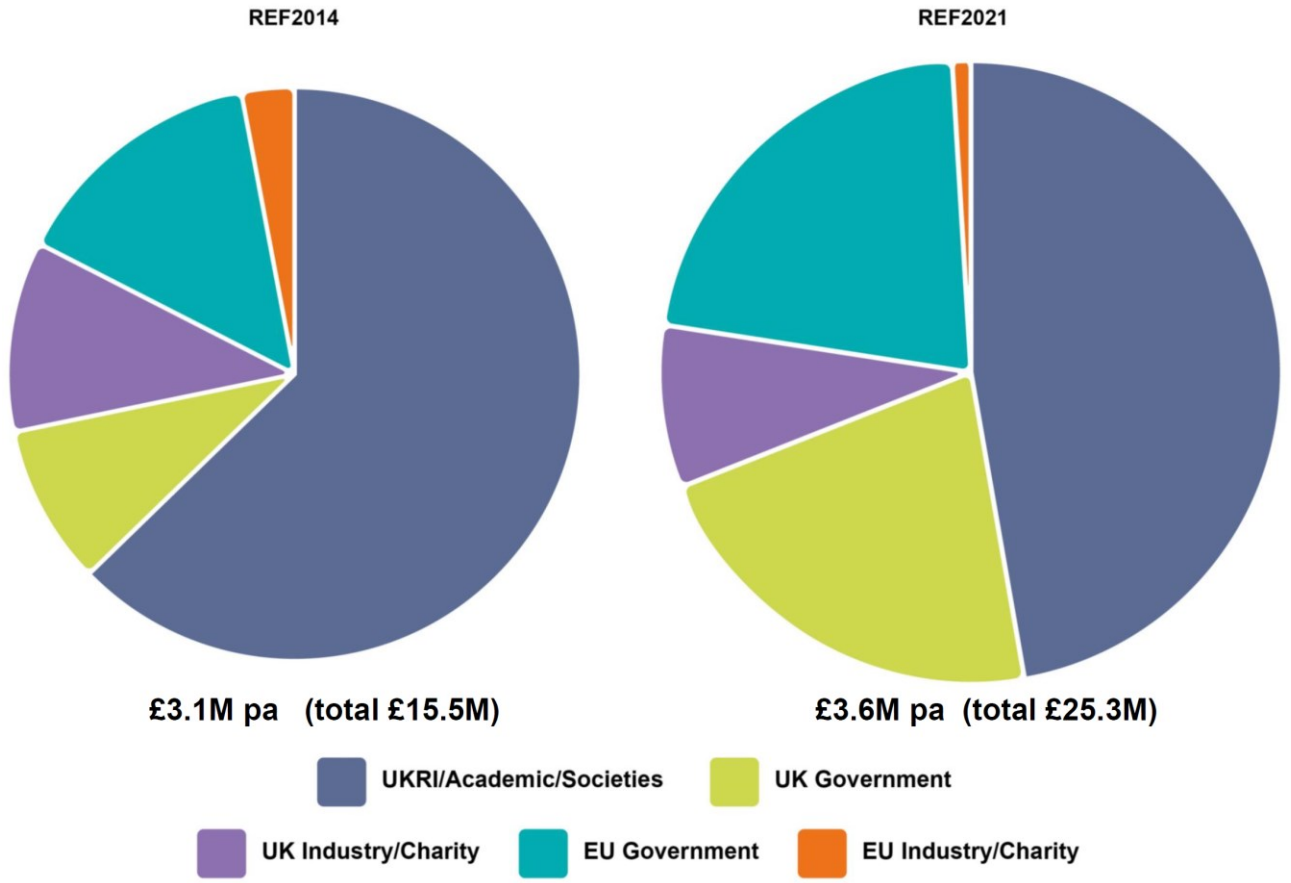
Our strategy has led to substantial success in winning major awards. These include leadership of 3 *NERC Large Grants*: *DOMAINE* (PI **Johnes**, £2.65m) investigating dissolved organic matter in freshwater ecosystems; *Black and Bloom* (PI **Tranter**, £2.45m) how microbial processes accelerate melting of Greenland; and *SWEET* (PI **Lunt**, £2.32m) investigating the Earth's response to past high CO_2 levels. We also lead a NERC-China collaboration on *biodiversity change during the Paleogene/Neogene* (PI **Valdes**, £1.1m), collaborate on an ESRC Large Grant on *Understanding Inequalities* (Co-I **Manley**, £2.08m, Edinburgh PI), and a cross-disciplinary NERC-AHRC programme on *BioResilience in Colombia* (Co-I and Social Science Lead **Millner**, £1.13m, Exeter PI). We have won *4 ERC grants*: Advanced (**Bamber**), Synergy (**Tranter**), Consolidator (**Ridgwell**) and Starting (**Dixon**). We have had considerable success with prestigious research fellowships (section 2).

Much of our work involves collaboration and leadership of international consortia, tackling problems of global significance, with awards from NERC directed and highlight topics: Antarctic, Arctic, Peru Glaciers, Ice Sheet Stability, SE Asia Hazards, SHEAR, Greenhouse Gas Removal, UK Droughts, Life and Planet, Global Methane Budget, and Changing Arctic programmes (**Wadham, Tranter, Anesio, Payne, Arndt, Landy, Sanchez-Baracaldo, Fox, Bates, House, Freer, Coxon, Ganesan, Lunt**).

We have been funded via Newton Fund programmes on *UK-China Critical Zone Science* (**Johnes**), *UK-Vietnam hydro-meteorological hazard* (**Fox**), *Climate Science for Service Partnership* research in Brazil (**Mitchell**) and *Impacts of glacier retreat on river water quality* (**Wadham**). We have several cross-disciplinary UKRI GCRF programmes e.g. *South Asia Nitrogen Hub (***Ganesan***)*, *Glacial Flour-Power* exploring the socio-economic benefits of glacial flour in the Himalaya (**Wadham PI, Ginn, Millner**), and *WIDER-SOMA* on war impact on drylands and social-ecological resilience in Somalia (**Michaelides PI, Sanchez-Baracaldo, Fox**). Further GCRF funds

were awarded for Education for Sustainable Futures (**Parnell**), Urban Responses to COVID (**Parnell**) and multi-hazards (**Rigg**).

Large research grants have been secured under the *AHRC-REACT* scheme on new museum experiences (**Patchett**), EPSRC *UK-Japan Civil Nuclear Research Programme* (**Richards**), and *Bristol Urban Area Diagnostics Pilot Programme* (**Manley**), and from *ESRC* via the *Quantifying Cities for Sustainable Development* (**Fox**), and Turing Institute via the *Identifying Urban Areas* (**Wolf**) programmes. We were also awarded a Singapore Research Council grant on *Transboundary Environmental Commons in Southeast Asia* (**Rigg**), while The Gates Foundation support *Family Planning and Reproductive Health and Cities* (**Parnell, Duminy**).



(**Figure 4:** Comparison of awards by funding sources for REF2014 and REF2021. The larger circle represents the 17% pa increase.)

Our increased training and mentoring have resulted in diversification of our grant portfolio, with UKRI/academy funding contributing only 47% of total income (down from 63% in REF2014, see figure 4). We have been awarded substantial funding from business (water, oil, gas, nuclear, re-insurance – £1.7m) and government and policy sectors (e.g. Defra, DfiD, Environment Agency, Natural England, BEIS – £1.1m). Enhanced training has also increased our research impact across our portfolio of activities. Examples are described in our impact case submissions and section 4.2.

3.2 Organisational infrastructure supporting research and impact.

We generally do not make a distinction between supporting research and supporting impact. Impact is embedded within research and is co-ordinated via our research groups and strands and overseen by our Impact director. At University level, RED and the URIs provide seed corn funding and support to cultivate cross-disciplinary research.

RED also coordinate impact acceleration awards to strengthen user engagement, exchange of knowledge, and commercialisation. We have received 25 such awards totalling £558k to >50% of our staff, to deliver impact and establish/sustain/develop partnerships with stakeholder organisations, under the UKRI Impact Accelerator Accounts and Knowledge Exchange programmes and HEFCE QR Strategic Priority Fund.

Policy Bristol works with our staff to optimise the influence and impact of research on policy and practice. Recent examples include a policy briefing papers: "*Bursaries are an important component of widening participation in Higher Education"*, and "*Household finances: income, saving and debt",* submitted to a Parliamentary Select Committee inquiry.

3.3 Operational and scholarly infrastructure supporting research and impact.

Our cutting-edge infrastructure comprises HPC, research laboratories, field hydrochemistry facilities and platforms, extensive library, special collection and archival facilities, and flexible spaces for creative co-working. These are supported by School, Faculty, and University research investment, plus substantial income from our portfolio of UKRI, EU and Industry funded research.

3.3.1 Research Laboratories

Our research laboratories comprise *AQUALAB* (aquatic biogeochemistry), *LOWTEX* (low temperature research), *BIOGAS* (gaseous phase analysis of environmental materials), and *MICROLAB* (microbiological and molecular) (http://www.bristol.ac.uk/geography/laboratory-facilities/. These provide high-throughput multi-element analysis at ultra-low concentration and form a key node of the cross-Faculty Biogeochemistry Research Platform (led by **Johnes**). Through this we have access to the Organic Geochemistry laboratories and UKRI-NERC National Environmental Isotope Facilities in Chemistry, Bristol Isotope Geochemistry Laboratories in Earth Sciences, the Bristol Radiocarbon Accelerator Mass Spectrometer, and the Bristol Genomics and Proteomics facilities in Life Sciences.

New equipment is resourced through research grant applications, and through the annual Faculty of Science major equipment call, providing ~£1.5m during this REF period. This has enabled research grant awards for laboratory-based projects, totalling £9.2m.

All labs are 100% Laboratory Efficiency Assessment Framework (LEAF) accredited.

3.3.2 Experimental platforms and field infrastructure

We run the Test Rig for Advancing Connectivity Experiments, a hillslope hydrology facility with state-of-the-art, large-scale artificial hillslope and accompanying rainfall simulator. We also

manage a high-resolution observation platform in the Hampshire Avon catchment (Defra Demonstration Test Catchments programme), and the NERC DOMAINE platform in the Conwy catchment, providing access to these platforms and open-access data archives to internal and external researchers.

3.3.3 High Performance Computing

Much of our research, in both physical and human geography, focusses on modelling and geocomputation. To facilitate this research, the School supports two small clusters totalling 900 cores for dedicated modelling work, and 8 general purpose servers (totalling 256 cores and 500TB of storage), funded by industrial and UKRI research income. Research groups have also purchased 512 cores and 320TB of storage in the University's high throughput system.

The University has also invested heavily in HPC systems (£9.9m during REF period). The latest HPC machine, when installed, was the most powerful UK University HPC. We make extensive use of this, using 27% of the facility (>30m CPU hours per year).

We also use national HPC facilities such as *ARCHER* and the NERC JASMIN facility (data intensive supercomputer) allowing us to perform e.g. the first ever simulations of distant past climates using the latest generation Hadley Centre model (HadGEM3).

3.3.4 Space/facilities for research groups

Academic staff have individual offices clustered by research group to facilitate collaboration. Research fellows and PDRAs have shared office space, while PGRs have open-plan office space to enable cross-pollination of ideas. Staff meet through groups, strands, lectures, and social events. All staff and students are provided with desk, computers, library, and e-resources, and access to high-performance computing and laboratory facilities as required.

3.3.5 Library, special collection, and archival facilities

All staff and students have access to Bristol Library services, offering access to >10,000 e-journals. The University has Special and Archival Collections supporting a diverse range of our research, particularly in our Historical and Cultural research group. For example, **Patchett** used the *Special Collections* to develop a series of research-led workshops; **Mayhew** used the *Penguin Collection* for a research publication; and **Fannin** used the *Feminist Archive South* of which she is now a Trustee. **Mayhew** was a member of the University's review of its Library Services Division, and its Special and Archival Collections, and currently sits on the University's Special Collections Steering Group.

3.4 Relevant equality and diversity issues

EDI issues and support are described in section 2.3. They ensure that all staff have sufficient time and resources to develop research bids and access the research infrastructure. Evidence for the success of this support is provided in the major leadership roles that female staff hold and awards and recognition of their standing (section 4.6). For example:

- **Johnes** leads a £2.65m NERC Large Grant and chairs multiple grant awarding panels in the UK and internationally.
- **Michaelides** is Bristol PI on a H2020 grant and PI on a GCRF award (total £1.5m).
- **Millner** is social science lead on a large NERC-AHRC grant (total £1.1million).
- **Wadham** holds a Royal Society Wolfson Research Merit Award, directs the Cabot Institute, and leads >£1.6m grant funding.
- ECR **Ganesan** holds >£1.2m from GCRF and NERC Highlight programmes.
- **Flecker** led an EU ITN on Mediterranean-Atlantic exchanges totalling €2.6million
- **Parnell** is Deputy PI on a GCRF Global Challenges grant (£8m) and chairs many international grant awarding panels.

3.5 How infrastructure, facilities and expertise are utilised for impact

Facilities are available free of charge (or at-cost) for our impact and outreach activities, ensuring that all staff can engage in impact. Once established, further costs are recovered from the stakeholder or through our UKRI impact plans enabling easy initial engagement with stakeholders in anticipation of future benefits. We find this “loss-leader” approach is highly successful, stimulating a range of future engagement and collaborative funded research, while also further embedding impact activities within our research culture.

We also contribute our expertise to a wide range of public and third sector organisations through participation in policy placements within the business, NGO, and government sectors, and by accepting invitations to join advisory panels for external organisations. Recent examples include PhD student placements with a range of government and business organisations (section 2.2), while staff have offered evidence and advice to Parliamentary Select Committees, Government departments and agencies, and the Bank of England (section 4.2/4.3).

3.6 Quality/operation of specialist research infrastructure and facilities

Our world-class specialist facilities and infrastructure are maintained and developed to ensure that they remain at the leading-edge, as are our shared facilities. Local facilities are funded through research grants and faculty infrastructure funding. Shared facilities are funded via University strategic funding and external funding initiatives.

School laboratories are supported by 6.5 FTE core-funded technical staff, overseen by a technical manager, in liaison with the Director of Laboratories. We also have specialist support for HPC research, while costs for specialist IT and laboratory technical support are routinely included in research grant applications ensuring highly skilled staff are available to support research delivery.

3.7 Cross-HEI shared or collaborative use of research infrastructure

As well as ARCHER and JASMIN, additional collaborative HPC facilities include a distributed computing framework via Oxford’s climateprediction.net system (**Mitchell, Watson**) and HPC facilities at ECMWF (**Watson**) and UK Met Office (**Lunt, Valdes**). Dutch Super Computing has also been used with large-scale social science data (**Manley**), leading to the Dutch national funding agency initiating a programme for social scientists to use these facilities.

Other NERC and UKRI facilities have been extensively used by a range of our staff, including the National Environmental Isotope Facility nodes (**>15 staff**), the Sequencing Facility (**Williamson, Sanchez-Baracaldo**) and Diamond Light Source facility (**Tranter, Richards**), while our field work in the UK uses the Defra DTC platform (**Johnes, Freer**) and in Svalbard, Greenland and Antarctica makes use of national infrastructure managed by British Antarctic Survey (**Anesio, Tranter, Wadham, Williamson**).

3.8 Significance of major benefits-in-kind

Many research projects secure substantial benefits in-kind from stakeholders, comprising access to equipment/facilities, data, staff time, and placements/internships. These benefits provide significant support for the delivery of our research and impact, and total >£2m of direct contributions.
Examples include:

- Unison, Single Parents Action Network, and Bristol Women's Voice each contributed 2 days staff time for an austerity symposium organised by **MacLeavy.**
- EU Commission supported priority early access to EU population grid data to explore segregation across the EU (**Manley**)
- Wessex, Welsh and Scottish Water, Environment Agency and the Rivers Trust gave free access to data, infrastructure, and staff time totalling >£1.5m (**Johnes**)
- GETECH plc gave us free access to paleogeographic reconstructions equivalent to >£2m normal commercial access (**Lunt**)
- Walz GmBH provided a prototype fluorometer and Photon Systems Instruments gave access to their PlantScreen technology for use in Greenland (**Williamson**).

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

4.1 Research collaborations, networks, and partnerships

We have an outward-looking ethos as evidenced by the many staff who collaborate across academic disciplines (section 1.4) and with stakeholders. These range from within the University and City, to national and international networks and are shown below.

(**Figure 5**. External collaborations: each point represents one or more collaborators. We have a total of 8200 external co-authors/collaborators from >4800 different organisations.)

We host many external collaborators, providing free visitor space, access to laboratory facilities, and HPC, helping us develop new funded collaborations. *Visiting Associate* and *Senior Research Fellowships* further strengthen these partnerships. These include 5 *Benjamin Meaker Visiting Professorships* (fully funded, 3-6 months), >20 other visiting professorships, and >100 visiting ECRs collaborating for periods of 1-24 months.

Recent examples of large collaborative activities include:

- *University-Met Office Academic Partnership* brings together Met Office weather and climate scientists and Bristol's researchers. **Mitchell** is chair, **Valdes** and **Bates** sit on the advisory panel, **James**, **Andrews**, **Coxon** are on its leadership team, and many staff are in its 'knowledge pool'.
- The *GW4 Water Security Alliance* (co-director **Johnes**), a network of >200 academic staff and research user organisations including Government departments/agencies, water industry, conservation charities and consultancies.

4.2 Action to develop impact and enrich the research environment

Staff are actively encouraged and offered support to develop their research impact (sections 1.3, 3.2). Examples are included in our Impact Case Studies but we have many more examples of substantial success in delivering impact, enriching the research environment for our staff, students, and collaborator networks.

- **Valdes** and **Lunt** received >£1M funding from STATOIL and two geoscience consultancies to develop Earth system models for past time periods. This helps to infer location of

preferential source rock regions without drilling, potentially saving companies £100's millions in exploration costs.

- PFRC (**Davies**) wrote an ESRC-funded practical guide to demonstrate to businesses and policymakers how they could improve products and services to eliminate the poverty premium. They then worked with the *Joseph Rowntree Foundation* and *Big Society Capital* to launch the *Fair by Design Fund* (FbD) to address these issues.
- PFRC (**Collard**, **Davies**) also offered advice on personal finance issues to *UK Government* (policy on financial inclusion and financial capability), *Santander* (improving financial confidence among lower income households) and *Macmillan* (the financial costs of cancer).
- Our research has also impacted on the development of school geography curricula for Singapore (**Rigg**) and the UK (**Harris**, **Mayhew**), and on undergraduate quantitative and statistical literacy (**Harris**) via the *Nuffield Q Step* programme. **Harris** also contributed to the *A-Level Content Advisory Board*, the *QAA Benchmark Statements for Geography Panel* and the *RGS-IBG Data Skills in Geography* project.

This coincidental development of research and impact is part of our research strategy, often generating further funding, whilst our nascent work is developing future impact, and all are central to our research and impact culture, enriching our research environment.

4.3 Wider contributions to the economy and society

Our research has made major contributions to the economy and wider society. At **governmental level**, staff have contributed to a large variety of activities (e.g. UK Climate Change Research Assessments, House of Lords Select Committee on The Arctic, Parliamentary all-party group on new definitions of constituencies, and Bank of England Climate Change Stress Test). Staff are also members of the Financial Services Consumer Panel, Natural England Science Advisory Committee, and several DEFRA advisory groups.

Third sector contributions include extensive work with Bristol City Council (e.g. One City Plan, Climate Emergency Declaration, Committee on Climate Change, Carbon Neutral City Strategy, Local Review of Progress Towards the UN Sustainable Development Goals, and The City Listening Project) and other councils (e.g. advice to the Good Work Nottingham council project, tackling economic insecurity).

Multilateral contributions include advice to: OECD on natural resource funds and on nitrogen; Asian Development Bank assessment of climate risk management; UN FAO review of Laos; World Meteorological Organisation Integrated Global Greenhouse Gas System; and the G20 Urban Technical Task Team. Five of our staff have been IPCC Lead Authors/Editors, contributing to all three working group reports and four special reports.

We also undertake **leadership roles with commercial and charity organisations** including invited membership of Wessex Water's Catchment Panel (www.wessexwater.co.uk), non-executive directorship of Greenstone+ (www.greenstone.plus), directorship of Fathom (www.fathom.global), trustee of two charities for asylum seekers (www.bhn.org.uk) and (https://hillhouseretreats.com), and technical advisor for Earth System Data (www.earthsystemdata.com).

4.4 Engaging with diverse communities

Schools outreach

- We provide professional development for teachers via the *Geographical Association.*
- We deliver *Widening Participation* lectures involving ~20 staff each year.
- We visit schools in China, Hong Kong, and beyond to develop the profile of Geography overseas.
- We present our research to support geography teachers' development via the *Princes Teaching Institute* (www.princes-ti.org.uk) and *Inspiring the Future* (www.inspiringthefuture.org) platforms.
- We contribute to popular school's outreach platforms including the Natural History Museum's *Science Uncovered* series and its *Nature Live Talks*.

Public outreach and engagement

We regularly contribute to local and national outreach events. We have also explored novel ways of engaging the public in our research, including:

- An experimental intervention in 'philosophical outreach' at *Nottingham Contemporary,* introducing audiences to the work of Felix Guattari as a way of apprehending contemporary crises (**Gerlach**, **Jellis**)
- A new exhibit for the *Smithsonian Museum of Natural History* (4 million visitors per year), showing global mean temperatures throughout the Phanerozoic **(Valdes**, **Lunt**)
- Climate modelling of *Game of Thrones* and *Middle Earth,* to engage the public in understanding how climate models work, with >100,000 tweets/retweets during the first 8 hours and covered in many media outlets (e.g. Guardian, Telegraph, PBS) (**Lunt**).
- Co-production of two films based on our work. "*Plight of flying insects in the Anthropocene"* premiered at the *Edinburgh International Film Festival* (**Patchett**)
- Co-production of the play "*A Sad Tale of a Dying Glacier*" via NERC-funded *Trans.MISSION* project run by the *Hay Festival 2020 and shortlisted for the AHRC Research in Film award 2020*, to communicate glacier science to new audiences (**Wadham)**.
- Our work commemorating the *Centenary of Women's Suffrage* led by **Fannin** used digital engagement, educational workshops, and exhibitions to engage nearly 3,000 people across the Southwest.
- High-profile public engagement events including multiple staff participating in Café Scientifique and Pint of Science and exhibits at The Royal Society Summer Exhibitions (**Sanchez-Baracaldo**).

We are active in raising knowledge of environmental change including through schools' *Climate Question Time*, public events by the *Royal Institute, Royal Meteorological Society, Extinction Rebellion, Bristol Youth Strike for Climate Change, Bristol Refugee Network*, webinars by the *International Emissions Trading Association*, and numerous talks and panels at all recent COP, OECD, UNECE, UN FAO, and European Commission meetings.

Many staff undertake outreach through social and mainstream media including on the Discovery Channel programme *What on Earth?* podcasts on *Arctic Sea Ice Extent* for the Guardian, and

interviews for many broadcast media including: BBC Radio 4 (*Today, Farming Today, From Our Own Correspondent, Counting Carbon, Costing the Earth, Inside Science* and *Thinking Aloud*), BBC 5 Live, BBC, ITV and Al Jazeera TV news, and China Global Television Network. We were scientific advisors for a BBC documentary on *Icebergs*, and consultants for a new *BBC series on Past Environments*, airing in 2022.

We also routinely work with local organisations through our student outreach and training programme, including *Bristol City Council, Bristol Zoo*, and numerous small charitable trusts with minimal financial resources who benefit from access to our research facilities and staff.

4.5 Contributions to sustaining the discipline and to interdisciplinary research

We play significant roles in learned societies both within geography and the wider research communities. **Fannin, Gerlach, Ginn, Jellis, MacLeavy, Manley, Rigg** and **Wolf** have contributed to RGS meeting organisation/sessions/chairing/groups. **Bamber** was *President of the EGU*, 2017-2019 (>20,000 members). **Johnes, Lunt, Sanchez-Baracaldo** organised Royal Society Meetings and an International Scientific Seminar series. Multiple staff have acted as authors/editors on influential interdisciplinary reports from eminent societies including the *Geological Society of London*, *Royal Society, Royal Academy, Royal Academy of Engineering* and *Royal Meteorological Society.*

4.6 Our wider influence on the research base

Our wider influence has been recognised in a range of prestigious awards and honours including, most recently, two Antarctic glaciers named for **Bamber** and **Tranter**.

Editorships and Refereeing

Staff are editors, guest editors and on the editorial boards of >40 journals including *Progress in Human Geography* (**Manley, Parnell**) and *Transactions of the Institute of British Geographers* (**Harris**); specialist journals from *Environment and Planning B* (**Wolf**) to *Journal of Glaciology* (**Tranter**); and major interdisciplinary journals such as *Philosophical Transactions of the Royal Society* (**Lunt**), *Environmental Humanities* **(Ginn),** Manchester University Press (**Parnell**), and *Agricultural History Review* (**Morgan**). We also edit book series with *Routledge* (**Jackson**) and *IB Tauris* and *Ashgate* (**Mayhew**). In total we peer review publications for >250 journals and book presses.

Funding Councils

We undertake research grant assessment for major funding bodies including the Royal Society, UKRI, EU, ERC, NASA, NSF, French National Research Agency, Leverhulme, the British Academy and many other funders.
Staff have been UKRI chairs (**Bamber, Johnes, Valdes, Parnell**), panel members (**Bates, Lunt, Mitchell, Tranter**) for NERC, chaired cross disciplinary UKRI panels (**Johnes**), and been panel members for ESRC (**Fannin, Fox, Jackson, MacLeavy, Manley, Parnell**), ERC (**Fox, Manley**), GCRF (**Parnell**), Royal Society (**Bates, Johnes**) and British Academy (**Fox, Gerlach, Jackson, Jellis**), while **Bates** was a member of NERC Science Board 2013-17.

Internationally we have assessed grants for >20 national funding councils, chaired a range of international research panels including for the Academy of Finland, Swiss and Dutch Funding Councils, Belmont Forum, and International Science Council, while **Johnes** represented UKRI at the UK-France-USA-Canada Tetrapartite Meeting on Living Landscapes.

Fellowships, prizes, invited plenaries and keynotes

Our staff routinely attend a broad spectrum of disciplinary and cross-disciplinary conferences/workshops and have been invited to present >240 plenary, keynote and invited lectures at international conferences.
As well as our ECR Fellowships (section 2), we have won 3 Royal Society Wolfson Merit Awards (**Bamber, Bates, Wadham**), 3 Leverhulme Senior Research Fellowships (**Bamber, Bates, Valdes**), a Leverhulme Major Research Fellowship **(Mayhew)**, 2 AGU Fellowships (**Bamber, Bates**), 2 British Academy Fellowships (**Johnston, Jones**), 5 Academy of Social Sciences Fellowships (**Harris, Johnston, Jones, Parnell, Rigg**), Fellowship of the Royal Society of Biology (**Johnes**), a Rachel Carson Fellowship **(Ginn**), and 3 EGU medals (**Valdes, Tranter, Ganesan**) We take particular pride in securing a *British Academy Rising Star Award* (**MacLeavy**) and *Alan Turing Fellowships* (**Fox, Wolf, Tranos**), while the quality of our research has been recognised in the UK honours system with a *CBE* (**Bates**), and awards of the *Murchison Award* (**Jones**) and *Victoria Medal* (**Rigg**) by the Royal Geographical Society.