International Benchmarking Review of UK Physical Geography

Royal Geographical Society with IBG

Advancing geography and geographical learning

Professor David Thomas,
Professor Phil Ashworth,
Dr Jo Nield and
Dr Catherine Souch

August 2017

International Benchmarking Review of UK Physical Geography

Professor David Thomas
University of Oxford
RGS-IBG Vice-President for Research and Higher Education (2013–2016)

Professor Phil Ashworth
University of Brighton
RGS-IBG Elected Council Member for Research and Higher Education (2014–2017)

Dr Jo Nield
University of Southampton

Dr Catherine Souch
Head of Research and Higher Education, RGS-IBG

Steering Group
Professor Joseph Holden, University of Leeds
Professor Susan Page, University of Leicester
Professor Danielle Schreve, Royal Holloway, University of London
Professor Mike Summerfield, University of Edinburgh
Professor Paul Valdes, University of Bristol

ISBN: 978-0-901989-44-4

August 2017

Contents

List of Figures

List of Tables

Foreword

It was with great pleasure that we accepted the invitation from the Royal Geographical Society (with IBG) to review this report on the health and global influence of UK physical geography. To our knowledge, such a comprehensive review has never been undertaken elsewhere, certainly not at the subfield level, and not in any of the five countries that we represent. We are unanimous in our endorsement of the documented achievements in this report.

This report on the state of UK physical geography is an excellent overview, and in-depth analysis, of its contribution both in the UK and internationally. It is beyond doubt that UK physical geography is a leading force worldwide as evidenced by all the metrics discussed in this report. The vibrancy of physical geography in the UK and its prominence at major international meetings, signals a bright future for the field if its core strengths can be maintained. Physical geography within the UK is a major international player in terms of any metric considered, whether numbers of undergraduate and graduate degrees awarded; research foci; intellectual contributions as judged by papers and journal editorial positions. The UK is performing better than most in terms of maintaining the visibility of physical geography as a distinct field. The strength of the field in the UK acts as an important role model for the future of physical geography globally.

Undoubtedly, the outstanding international visibility and attractiveness of physical geography in the UK results from a long and distinguished tradition that clearly benefits from the first language of its practitioners. We feel that the UK 'punching above its weight' is also a consequence of: (a) a higher educational system that has rigorous and transparent quality control measures at all levels. This also accounts for the richness of the data source of the current assessment; (b) the open and transparent employment culture.

It is certainly the case that identifying physical geography research involves consideration of academic departments beyond those named 'Geography' and the 'permeable subject boundaries' of the discipline are apparent. This we believe to be a strength, since research on the physical environment, particularly as it relates to society, is increasingly interdisciplinary and it is obvious from the report that this is an expanding field of endeavour. We agree with the report's thesis that this breadth of physical geography is a positive feature. Research projects on the 'big issues' (e.g. climate change) and harnessing 'big data' have emerged and would seem to have excellent potential in the future. There are clear indications of growing international collaboration and huge potential to drive capacity building and infrastructure development in low and middle-income countries (LMIC).

Achievements in UK physical geography teaching are doubtless outstanding in both volume and diversity. UK physical geography taught programmes are role models across the world. The availability of comprehensive and detailed information is laudable. Most impressive achievements include: a wide portfolio of topics covered and a great diversity of programmes available; great success in re-establishing physical geography at school level; high and increasing student numbers; trends especially encouraging for non-EU students; exciting module materials and course content. Obvious challenges include sustaining physical geography career trajectories, especially at postdoctoral and early career lecturing posts; and sustaining funding of blue skies research to secure UK physical geography's leadership in the longer term. Continuing effort will be needed to secure funding of hands-on practical education in field and laboratory. Essential also will be to address the staff diversity imbalance and ensure that more departments are recognized through the Athena SWAN Charter.

The report claims a number of research strengths identified in particular branches of British physical geography, most notably in Quaternary science, geomorphology (especially arid zone and fluvial geomorphology), biogeography and climate science. We accept this argument that is based on the identities of research groupings and type of research grants awarded, for example, by the Natural Environment Research Council (NERC). UK physical geography has certainly been able to attract substantial amounts of research funding from a range of sources.

The equipment base is impressive, especially in geochronology, and suited to the production of world-class research despite funding challenges. The emerging generation of physical geographers appears to be very well trained, largely content with their choice of topic/supervisor/institution and with strong international representation.

The mere existence of a systematic national assessment of academic research quality is impressive and a model that other countries could follow with benefit. This review takes advantage of the archived data to learn something about the changing patterns and content of physical geography research and its impact in the UK. The fact that Geography has advanced from 15% to 27% “world-leading” submitted outputs in RAE/REF between 2008 and 2014 is a noteworthy achievement. The volume of physical geography material submitted for assessment is high with a notable shift towards Big Science, Grand Challenges and science-society interface submissions. An increasing number of excellent physical geography outputs in the journals of other disciplines in addition to strong contributions to the traditional core journals represent notable achievements.

Impact is important because research excellence is now assessed additionally by the role research plays in wider society beyond academia. Geography’s impact was judged very highly with 34% of submissions ranked as “world-leading”. This is all forward-looking and bodes well for the future of Geography as a whole and physical geography in particular.

Robust intellectual exchange is evidenced by undergraduates going to other UK physical geography programmes for a PhD and by undergraduates from other countries attending UK institutions. The UK physical geography community demonstrates outstanding engagement with international professional society officer positions, occupies many editorial positions in international journals, is very active at convening conference sessions and collaborating on international grants, and engages in many honorary and visiting appointments overseas. We agree with the report summation that UK physical geography is international in outlook and highly influential in many subfields.

Overall, there is strong evidence that the quality of UK physical geography is outstanding. A summary of that evidence is that it makes major contributions to big, international science problems, collaborates and leads international agendas and punches hard in the delivery of research impacting on society and policy. We recommend this report to the community and confirm that UK physical geography is indeed in excellent health.

Professor Jacky Croke, University of Queensland, Australia
Professor Andreas Lang, University of Salzburg, Austria
Professor Mike Meadows, University of Cape Town, South Africa
Professor Olav Slaymaker, UBC, Canada (Coordinator)
Professor Ellen Wohl, Colorado State University, USA

Executive Summary

Physical geography in the UK is extraordinarily rich and diverse. It provides insights into processes and forms in the natural environment, including climate and atmosphere, geomorphology and landscape, biogeography and ecosystems, hydrology and water science, oceans and soils. The use, application and development of technologies, including Earth observation, GIS, and geochronological tools, are integral parts of contemporary physical geography.

This report is the first to compile evidence on the health and influence of UK physical geography. It uses documented evidence, most of which is in the public domain, to describe the nature and demand for physical geography in schools, the shape and size of physical geography in universities, the achievements and global influence of UK physical geography and its academic community, and the aspirations and skillsets offered by the next generation of physical geographers.

Physical geography brings a unique spatial perspective, and the capability to integrate across scales and subdisciplinary systems. It links to aspects of environmental science, mathematics, physics and life sciences. It sets intellectual agendas both within and beyond geography, and leads eminent international collaborative research programmes. The 'de-siloing' of science in the 21st century in response to big 'whole world' societal-environment challenges demonstrates the value of approaches which have always been integral to UK physical geography.

UK physical geography is international in outlook, is world-leading in many subareas, and influences the discipline worldwide. This is achieved through many routes including: international research partnerships; the training given to overseas students in UK geography departments, particularly at graduate level; and the roles played by UK-based academics in international professional bodies, international journal editorships and major conferences.

UK physical geography research is funded from diverse sources and punches well above its weight in terms of success rates at the UK Research Councils. In the last decade, European funding has also been vital in supporting UK physical geography research. New substantial funding opportunities are emerging including through the UK's Global Challenges Research Fund and Industrial Strategy, which physical geography is well placed to engage with. Additionally, the opportunities for postgraduate doctoral research in physical geography have been enhanced with the advent of the UK Research Council doctoral training programmes.

The future of physical geography is bright. It is witnessing a resurgence in popularity in schools in England. Curriculum changes, increasing physical geography's presence within A-Levels in England and Wales, are positive developments, as are a greater emphasis on fieldwork, individual project work and data skills. These provide opportunities for physical geography to bolster its position within the discipline in schools and beyond. The situation is not consistent across the UK; it is hoped that changes can be made in the content of Scottish Highers that leads to greater balance in the content of physical and human geography.

At university, physical geography is a popular and growing subject choice and attracts some of the highest-calibre students to its undergraduate degrees. As well as being taught in UK university geography undergraduate programmes, physical geography is widespread in other degree structures and departments. Successful course delivery is contingent upon institutions providing appropriate access to laboratory facilities, fieldwork opportunities and quantitative training. Physical geography undergraduates perform well in their degrees, express high level of courses satisfaction, and have excellent employment outcomes compared to many disciplines.

The independent review of this report by a panel of eminent overseas experts confirms that "it is beyond doubt that UK physical geography is a leading force worldwide as evidenced by all the metrics discussed in this report". Nonetheless, there are challenges, detailed within the report, that need to be addressed to enhance the scientific academic and public presence, inclusivity, resourcing, autonomy, and global reputation of UK physical geography. It is recommended that a working group representative of constituent bodies within UK physical geography, led by the Royal Geographical Society (with the Institute of British Geographers) (RGS-IBG), is set up to take forward the issues associated with these challenges.

1 Objectives and Scope of Analysis

1.1 Context and Overall Purpose

Physical geography is diverse and changing. This is evidenced by the waxing and waning of different sub-areas, the changing dynamics of specialist research groups and learned societies, and its representation as a discipline within higher education establishments, the UK's Natural Environment Research Council (NERC) and at international fora such as the meetings of the American Geophysical Union (AGU), The European Geosciences Union (EGU), the International Association of Geomorphology (IAG) and the International Union for Quaternary Science (INQUA), to name but a few.

Physical geography is not just carried out in traditional geography departments, but in a range of academic units (many with 'environment' in their title); nor is physical geography simply 'practiced' by academics with geography degrees. Physical geography has evolved rapidly as a discipline in the past decade and there is a need to assess the link between the new A-Level syllabus, introduced in 2016, what is taught in undergraduate and postgraduate taught (PGT) programmes, the connection between research and curriculum development in higher education institutions (HEIs), and how postgraduate research (PGR) training is changing in response to block grants and industry demands.

In the light of the RGS-IBG ESRC Human Geography Review published in 2013, *not* to review physical geography would be a disservice to a large, vibrant and important part of our community. Following discussion in the RGS-IBG's Research and Higher Education Committee and Council, it was agreed to carry out a systematic review of the health of physical geography in the UK[1]. In carrying out this review, the aim has been to:

- understand and establish the disciplinary, academic and institutional contexts within which physical geography operates today;
- identify the academic 'make up' of physical geography, including its constituent parts ('subdisciplines') and linkages to other disciplines, including the changes that may have occurred over the past two decades;
- quantify how physical geography fares in the research funding landscape (i.e., grants, consortia, doctoral programmes and capital investment);
- characterise the extent to which UK physical geographers engage with the broader international community;
- investigate the sustainability of physical geography, in terms both of identity and the pipeline of future physical geographers, both through degree pathways and research pathways;
- provide a resource for teachers, researchers and users of physical geography that provides a statement on the nature and health of the discipline and its future trajectory.

1.2 Terms of Reference

This review has aimed to first provide information to benchmark the current position of UK physical geography against the best of our global partners, highlighting recent changes, linkages to other disciplines, threats and opportunities. This part of the review was conducted by members of the UK academic community, all of whom are physical geographers. Secondly, the material generated was submitted to a small group of expert physical geographers from other global contexts, with the aim they assess the UK-based report and place it within their international experiences, commenting on the UK position within, and contribution to, physical geography worldwide. The focus is on the 21st century, primarily on the last decade, with an emphasis on research quality, capacity and impact, including recent changes and future prospects.

The review, initiated in spring 2015, was overseen by a small steering group from different subdisciplinary areas and a range of department types/institutional settings. The review embraced:

1. physical geography in traditional geography departments;
2. physical geography in departments called something else, some of which are geography departments in everything but name, while others are parts of larger schools;

[1] The RGS-IBG ESRC Human Geography Review received funding from the Economic and Social Research Council (ESRC). This physical geography review has not received external funding. Consequently, aspects of the report and its conduct differ with that for human geography, including that the external review panel met 'virtually' rather than having the opportunity to deliberate collectively face-to-face.

3. individuals who are physical geographers but are in other departments where the presence is small.

In January 2017, the report was submitted to five international physical geographers (Professors Jacky Croke, The University of Queensland, Australia; Andreas Lang, University of Salzburg, Austria; Mike Meadows, University of Cape Town, South Africa; Olav Slaymaker, The University of British Columbia, Canada; and Ellen Wohl, Colorado State University, USA) for their expert assessment.

1.3 Data and Approach

This review was not resourced in the same manner as the Benchmark Review of Human Geography, as there was no Research Councils UK (RCUK) sponsorship; therefore, an approach was adopted that made use of existing data and resources, as well as seeking modest amounts of new information. The four data components are:

1. **Metrics:** data available through existing sources, including research funding (from RCUK online databases); student and staff numbers and demographics (from the Higher Education Statistics Agency [HESA] and the Universities Central Admissions Agency [UCAS]); and careers, graduate employability and destinations (from the Unistats website). The exact source of each is introduced in the report text on the first occasion of use with qualifications on its use.
2. **Reports and published papers:** The review draws heavily on the publicly accessible reports of the UK national assessments of academic research quality (2014, 2008 and 2001) and the materials submitted by departments to these.
3. **Analysis of web pages:** Specifically, department pages for information concerning research groups and clusters, along with conference and journal websites for information on international engagement.
4. **Surveys:** Two surveys were undertaken for this study by the Research and Higher Education Division of the RGS-IBG.
   (a) A **departmental survey** circulated in autumn 2015, with open format questions on: undergraduate and postgraduate students, their preparedness, choices and challenges; programmes of study and courses offered; staff expertise and gaps; recent appointments; funding; and challenges the department/programme face. Twenty three responses (32%) were received from a range of institutions (Russell Group/post-1992 universities etc.); institutional settings (geography departments; larger units); large and small programmes; and from the four devolved countries of the UK. All responses were collected in confidence and specific institutions are not attributed in this report, with exceptions for illustrative purposes.
   (b) An **online survey distributed to PhD students** in the spring of 2016, to gather individual level data on undergraduate and masters training, PhD topics, funding sources and duration, research partners, longer term career aspirations, and particular challenges faced. A total of 88 responses from PhD students at 28 universities were received.

While some of the data provide information on longitudinal trends, others are snapshots that provide a benchmark for future comparisons.

The sections that follow represent a review of the state of physical geography in the first 15 years of the 21st century, with an emphasis on the most recent years. Material is organised into sections that progress from the undergraduate experience, to the research context, through to the nature of research and the contribution of the UK to physical geography internationally.

2 Undergraduate and Taught Graduate Demand and Curriculum Developments

The future health of the discipline, across physical and human geography, depends in part on the number of students studying the subject in schools and universities, the quality of their teaching and learning experiences, curricula/benchmark statements that guide what is taught, and students' awareness of physical geography and where it can shape their citizenship, interests, and career opportunities. In this section the 'pipeline' that school and undergraduate experiences represent for the subdiscipline is explored, with a particular focus on recent, current and future changes.

2.1 School Curriculum Changes and Preparation for Higher Education

School-level education policy in England, Scotland, Wales and Northern Ireland has diverged quite significantly since UK devolution and students can arrive at university with quite different educational experiences, knowledge, skills and understanding. Of the UK students studying in UK higher education, approximately 82% of the students are school-educated in England, 10% in Scotland, 6% in Wales, and 2% in Northern Ireland. EU students and other international students while common at postgraduate level (8% and 30%, respectively) are a much smaller proportion (4% and 9%, respectively) in undergraduate programmes.

What is taught as geography in England, Scotland, Wales and Northern Ireland, and increasingly within them (by examination board), differs. As context for this review, Appendix A provides a short overview of school-level geography education in the UK, the current policy landscape and recent and expected changes. Opportunities for engagement by those in higher education to address emerging knowledge and skills gaps of teachers are highlighted, particularly in physical geography, data skills and fieldwork.

2.2 Undergraduate Programmes in Physical Geography and Institutional Settings

Based on UCAS and Unistats data for 2015/16 for UK Higher Education Institutions (HEI), 83 UK providers offer a geography undergraduate programme of some kind. Of these, 76 deliver at least one BSc Geography and 61 deliver at least one BA Geography. As elaborated upon below, BA and BSc are not synonymous with human and physical geography, respectively. The exact nature of the degree(s) offered varies between departments; some offer only one degree programme option, others more than ten.

The units delivering these degrees and the degree names (e.g., single or joint honours) vary. While many are called 'Department/School/Division of Geography' (35/83), the majority and an ever-increasing fraction are combined departments or programmes within larger units commonly called Earth and Environmental Science, Social Science or other groupings.

The implications of geography, or clusters of geographers, in units not named geography are significant in terms of disciplinary identity (and accounting) and even more so because these units may be led by non-geographers. Furthermore, the effects of this extend far beyond undergraduate programmes to affect all aspects of physical geography activities in these institutions. This may raise issues in terms of appropriate allocation of resources for staffing, facilities and equipment and representation of disciplinary needs within institutions. These units also find themselves in a variety of schools, faculties and colleges (e.g., Natural Science, Social Science etc.). This inevitably means that geographers who identify themselves more with the natural sciences may not be in the schools/faculties/colleges where those disciplines are clustered, which may have implications particularly related to facilities. Equally, physical geographers may not be involved in campus-wide initiatives to promote science, particularly relevant in the context of doctoral training centres, implementation of Research Council demand management strategies, appropriate review of materials for appointments, promotion and the Research Excellence Framework (REF).

2.3 University Admissions

Meaningfully describing physical geography in standard UK Higher Education Statistics is beset with problems in terms of how geography is categorised. Courses are currently coded using the Joint Academic Coding System (JACS)[2].

[2] JACS is used by the Higher Education Statistical Agency (HESA) and by UCAS (University and Colleges Admissions Service) to classify academic subjects via a system of codes compromising one letter and up to three numerals. JACS is being replaced by a new subject coding system (HECoS) in academic year 2019/20. For more information see: https://www.hesa.ac.uk/blog/28-04-2017/farewell-jacs-and-hello-hecos

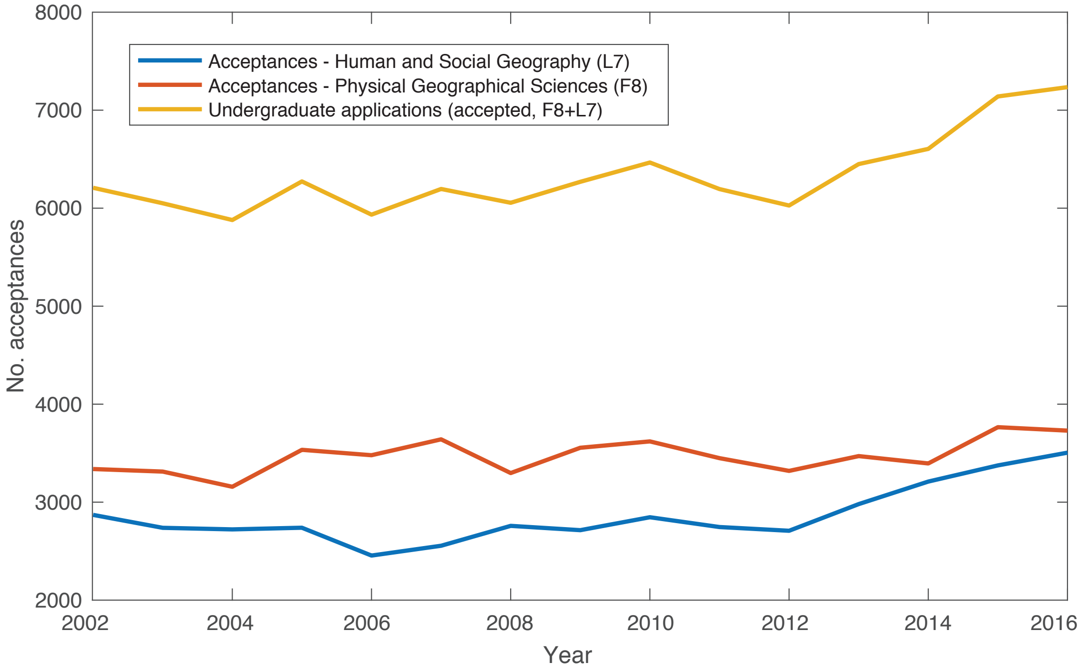

Figure 2.1: *Patterns of enrolments in UK geography degrees, 2002–2016 (see text for caveats when interpreting the L7 category). Source: UCAS.*

Broadly, the code F800 and derivatives refer to physical geography and environmental science and L700 to human geography. However, the way individual courses are coded means that it is not always possible, nor justifiable, to separate out physical (F800, which also includes environmental science) and human (L700) geography strands. This is a very important caveat in not over-interpreting differences evident in these data and their trends through time (relevant to Figure 2.1). There are a range of institution-specific reasons, historic and strategic, why departments admit selectively under either of these two codes. Some institutions admit all students under one code (e.g., Open University, Cambridge), some a mix of codes that relate to their A-Level subjects. There may be little relation between the code of admission (BA or BSc) and the types of options in courses the students select. Evidence of the full range of codes is provided in the preface to the Quality Assurance Agency (QAA) benchmark statement for geography. Virtually all programmes teach undergraduate students both human and physical geography in order to fulfil requirements of the benchmark statement for geography.

A better measure of trends in applications and admissions to geography is the sum of the two codes (F800+L700; Table 2.1 for the most recent data; Figure 2.1 for recent trends). Also reported in the table are the breakdown of full-time/part-time enrolments[3] and the gender profile of undergraduate students. At all levels, there are slightly more males studying physical geographical sciences (F8) than women; the reverse is true for human and social geography. However, it is important to note, as at school, geography is one of the most gender-balanced disciplines in terms of students.

For the period from 2002 (when categories significantly changed) to 2011, the numbers of students applying and being admitted to study geography were largely static. Since then numbers have risen slowly, both in terms of applicants and entrants, fluctuating year on year. Overall, geography enrolments have maintained market share (there have been changes in the total cohort of students applying to university over the last decade) and exceed the places available for study. After the first year (2012), increases in student fees (up to £9k) have had little impact on demand for places, and lifting of university caps on enrolments, started in 2013, has seen enrolments continue to rise (with rates of increase faster in human than physical geography). In a number of institutions, heads of geography programmes have noted pressures placed on their departments to take more students, given

[3] The greater apparent number of part-time students in physical (F8) compared to human (L7) geography is largely because the Open University admits students using the F8 code.

Table 2.1: *Students by subject, level of study, mode of study and gender, 2014/15*

Level of study	Mode of study	(F8) Physical geographical sciences			(L7) Human and social geography			Combined F8 and L7		
		Female	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
Doctorate	Full-time	300	350	650	310	270	580	610	615	1225
	Part-time	40	55	95	55	45	100	100	100	200
	Total	*345*	*405*	*745*	*365*	*315*	*680*	*710*	*715*	*1425*
Masters	Full-time	480	520	1000	510	325	835	995	840	1835
	Part-time	170	260	425	100	65	165	270	325	595
	Total	*650*	*780*	*1425*	*610*	*390*	*1000*	*1265*	*1165*	*2430*
Other postgraduate (research)	Full-time	10	15	25	10	10	20	20	25	45
	Part-time	5	5	10	0	0	0	5	5	10
	Total	*15*	*20*	*35*	*10*	*10*	*20*	*25*	*30*	*55*
Other postgraduate (taught)	Full-time	5	15	20	0	0	0	5	15	20
	Part-time	60	105	160	0	5	5	60	105	165
	Total	*65*	*120*	*180*	*0*	*5*	*5*	*65*	*120*	*185*
Undergraduate (first degree)	Full-time	5590	5750	11340	5590	4150	9740	11180	9905	21085
	Part-time	740	810	1545	40	55	95	780	860	1640
	Total	*6330*	*6560*	*12885*	*5630*	*4205*	*9835*	*11960*	*10765*	*22725*
Undergraduate (other)	Full-time	15	40	55	5	5	5	15	45	60
	Part-time	30	30	60	5	0	10	35	35	70
	Total	*45*	*70*	*115*	*10*	*5*	*15*	*55*	*75*	*130*
Grand total		**7440**	**7955**	**15390**	**6625**	**4925**	**11555**	**14075**	**12870**	**26945**

Note: the discussion in the text around categories and differences in how they are employed in departments.
Source: Higher Education Statistics Agency (HESA) Student Record 2014/15. Student data are weighted full time equivalents (FTE), following HESA rounding and suppression methodology. © HESA Ltd 2016.

the relative popularity of geography compared to other disciplines in their schools. In addition, there has been a recent trend for institutions with strong environmental science programmes to add geography to the name of the degree and in other cases to introduce new geography programmes (e.g., Bishops Grosseteste University, University of the Highlands and Islands, University of Lincoln, Oxford Brookes University, University of Surrey, University of East Anglia, University of York).

Virtually all the departments who responded to the request for information for this review (via the department survey referred to in Section 1.3) indicated that human geography degrees (if the option is given) and modules (once students elect options) enrol more strongly than physical geography degrees and modules, although there are exceptions. The differences in enrolments at entry, and which can widen as students move through the degree, can raise issues in departments in terms of teaching loads of staff and allocation of resources for some of the research-intensive needs of physical geography (e.g., laboratories, field equipment). The impact of the new curriculum being taught in schools in England from this autumn, with more physical geography (Appendix A), will be important to monitor to see if/how it encourages student interest and influences UCAS course choices.

2.4 Module Subject Material

The QAA geography benchmark statement[4], which was reviewed in 2013 with a new version published in 2014, specifies the knowledge and understanding expected of graduating students. It also stipulates expectations in terms of skills, abilities and attributes; modes of instruction; assessment, standards and levels of achievement. This statement provides the benchmark against which undergraduate programmes are accredited by the RGS-IBG. This is a new scheme introduced in 2016 and recognised by HESA in its key information for university programmes. To date, programmes in more than 30 universities have been accredited[5].

The statement is not intended to be prescriptive, rather it recognises that the teaching and learning

[4] http://www.qaa.ac.uk/en/Publications/Documents/SBS-geography-14.pdf
[5] Full details on the scheme, criteria and programmes accredited at http://www.rgs.org/accreditation

Table 2.2: *Undergraduate student qualifiers by subject, degree classification and gender, 2014/15*

Level of study	Degree class*	(F8) Physical geographical sciences			(L7) Human and social geography			Combined subjects		
		Female	Male	Total	Female	Male	Total	Female	Male	Total
First degree	1st	355	280	630	330	145	475	685	425	1105
	2:1	1035	1010	2050	1025	720	1745	2060	1735	3795
	2:2	220	445	665	155	230	385	375	680	1050
	3rd/Pass	35	85	120	15	20	30	50	100	150
	Unclass.	10	15	20	5	10	15	15	25	35
	Total	*1650*	*1835*	*3485*	*1530*	*1125*	*2655*	*3180*	*2960*	*6140*
Other undergraduate	N/A	60	105	165	30	40	70	90	145	235
Grand total		**1710**	**1935**	**3650**	**1560**	**1165**	**2725**	**3270**	**3105**	**6375**

** 1st = First class honours; 2:1 = Upper second class honours; 2:2 = Lower second class honours; 3rd = Third class honours; 'Unclass.' = Unclassified; N/A = not applicable*

Source: Higher Education Statistics Agency (HESA) Student Record 2014/15. Student data are weighted full *time equivalents (FTE), following HESA rounding and suppression methodology. © HESA Ltd 2016.*

of geography can occur through a number of routes. However, the statement does recognise progression by specialism through the course of a degree programme; the essential role of fieldwork and laboratory work; numeracy and numeric skills; research design and some form of independent research work as a required element; critical understanding of spatial variations, temporal dynamics and of scale; and understanding of how processes operate across local, regional and global scales to produce particular geographies. Specifically in terms of physical geography, there are expectations that:

(Section 3.7) *'..Geographers are able to use critically a systems framework to conceptualise patterns, processes, interactions and change in the physical world. They know how to incorporate into this framework: natural environmental impacts on human activity (for example natural hazards); human impacts on biophysical systems (for example air pollution, deforestation, desertification), and on components of the climate system; and on the management of environments and landscapes.'*

(Section 3.9) *'..Geographers have a clear understanding of the drivers of change in the natural world over space and time, demonstrating knowledge of the interactions between climate, ecosystems, and landscapes. They understand controls on fluxes of energy and matter within and between the earth's surface and the atmosphere. They are aware of typical rates of change, and of methods and approaches used to study change in the natural world. Concepts such as thresholds, intrinsic and extrinsic drivers, along with approaches such as biogeochemical cycles, sediment and water budgets and environmental reconstruction, underpin this knowledge of spatial and temporal change in biophysical environments'.*

Information about the modules and pathways through degrees taken by physical geography undergraduates, were derived from the survey sent to all heads of geography (see Section 1.3). Across the 23 departments that responded to the survey, there is considerable variation in the required and optional courses students take during their undergraduate programme. Across-the-board, students are required to study some elements of physical and human geography in their first year (a requirement for the RGS-IBG programme accreditation), with pathways through core and optional modules thereafter. The names of these courses, like the names of departments, are highly variable. Physical geography courses commonly cluster in terms of contemporary geomorphology/landscape systems, Quaternary studies, ecosystems and conservation, and climate science. Fieldwork, modelling, remote sensing and GIS feature prominently too. In some cases modules are numerous and very broadly based, while at other institutions they are more focused and specialised (e.g., coasts, environmental management). The range on offer is most often a reflection of the size of the department and the range of staff interests and expertise.

Some respondents to the department survey did highlight that there are sometimes disconnects between students' expectations and course

Table 2.3: *Staff by cost centre, academic employment function and gender, 2014/15*

Employment function	(111) Earth, Marine & Environmental Science					(124) Geography & Environmental Studies				
	Female		Male			Female		Male		
	No.	%	No.	%	Total	No.	%	No.	%	Total
Teaching only	295	47%	335	53%	630	160	43%	210	57%	370
Research only	590	40%	880	60%	1475	310	50%	310	50%	625
Teaching and research	405	25%	1230	75%	1635	460	34%	915	66%	1375
Not teaching and/or research	5		10		15	5		5		10
Total	*1295*	*34%*	*2460*	*66%*	*3750*	*940*	*40%*	*1435*	*60%*	*2375*
Non-academic contract	810	58%	575	42%	1385	470	64%	260	36%	735

Source: Higher Education Statistics Agency (HESA) Staff Record 2014/15. Staff data are weighted Full Person Equivalent (FPE), following HESA rounding and suppression methodology. © HESA Ltd 2016.

content and assessment. Students expect more content to be issues-based rather than focusing on concepts/theories, reflecting in part how they were taught at school (this applies to both human and physical geography). Respondents also noted that the perception of incoming students (not necessarily those that go on to specialise in physical geography) is that these modules are difficult, particularly in terms of the mathematical and statistical content. Moreover, students also often lack direct previous experience with GIS, remote sensing or spatial data handling. The impact of the effectiveness of the new schools-curriculum in this regard will be important to track (see further details in Appendix A).

Particular issues in the provision of undergraduate education relate to laboratory facilities and to fieldwork. Both are stipulated as requirements in the subject benchmark statement. Common challenges cited by academic staff are lab space and staffing for large compulsory practical classes; availability of PhD students to serve as demonstrators; and the need to keep pace with software developments in GIS and remote sensing, and their cost, although increasingly open-source solutions are being used.

The size of undergraduate programmes, and institutional demands to increase these, has significant implications for fieldwork in particular. There are capacity issues in terms of residential field courses and also in terms of the number of staff needed to deliver these courses (given staff to student ratios). For all departments, the costs of fieldwork are particularly problematic given there is no government teaching grant support for geography to offset these in the current tuition fee mechanism, and universities, largely, do not levy additional fees for compulsory field modules. Optional, usually more advanced courses, generally do have additional fees. This raises issues of equity of access for optional international fieldtrips based on students' ability to pay.

In some departments there is also a sense that the interests of many students, and their level of knowledge and expertise, do not always map well onto the research expertise of staff. There is a perception that this divergence is increasing. Frequent concerns were expressed specifically about the mathematical background, confidence and expectations of students, and the particular implications of this for some elements of physical geography. What could be assumed as pre-existing knowledge (specific examples were cited about differential equations) is now not always the case.

An emerging trend is the development of integrated Masters programmes. These programmes enable students to undertake three years of undergraduate level study, followed by a fourth year of postgraduate level study, leading to a Masters qualification. Such programmes seem to be more common in physical geography than human geography. Survey respondents noted that while the uptake from direct admission is limited, reasonable numbers of students (often of the order of 10–15) are opting to transfer into them. These have been put in place in response to climbing fees, recognition of the challenges for students getting funding for Masters programmes, and to provide intensive research training to develop a pathway to PhD studentships.

2.5 Dissertations

Most programmes require students to undertake dissertations (or individual research projects); a small number provide options for literature reviews

Table 2.4: *Staff by cost centre, academic/non-academic employment function, mode of employment and gender, 2014/15*

Employment function	Mode of employment	(111) Earth, Marine & Environmental Sciences			(124) Geography & Environmental Studies		
		Female	Male	Total	Female	Male	Total
Academic contract*	Full-time	820	1970	2790	650	1165	1815
	Full-time, term-time only	0	0	0	0	0	0
	Part-time	325	350	675	245	220	465
	Part-time, term-time only	150	135	285	40	50	95
	Academic total	*1295*	*2460*	*3750*	*940*	*1435*	*2375*
Non-academic contract	Full-time	515	480	995	285	215	500
	Full-time, term-time only	0	0	5	5	0	5
	Part-time	285	90	375	180	50	225
	Part-time, term-time only	5	5	10	5	0	5
	Non-academic total	*810*	*575*	*1385*	*470*	*260*	*735*

**Academic contract includes: Teaching only, Research only, Teaching & research, Not teaching and/or research. Source: HESA Staff Record 2014/15. Staff data are weighted Full Person Equivalent (FPE), following HESA rounding and suppression methodology. © HESA Ltd 2016.*

or critical reflections on placements. The physical geography dissertations that students undertake are broadly based but tend to reflect modules on offer and staff expertise at the institutions they attend. Dissertations emphasise the research process and enable students to use techniques that are appropriate for addressing research questions. Each year the RGS-IBG awards the Alfred Steers prize for what is judged to be the best undergraduate dissertation in geography. The number of submissions varies from year to year, as do the topical and methodological foci. However, on average there have been approximately equal numbers of submissions from physical and human geography; in the last 10 years year half of the top dissertations and 49% of all submissions have been physical (see Appendix B). The British Society for Geomorphology (BSG) and Quaternary Research Association (QRA) also award undergraduate dissertation prizes. These are listed in Appendix B and show a range of topics and breadth of institutions recognised.

2.6 Students' Perceptions and Outcomes

According to the most recent Key Information Statistics (KIS) data[6] (2015), the award levels of first class degrees to students graduating from physical geography and human geography classified programmes (F8 and L7, respectively) are very similar (∼17.5%). However, the fraction of those getting an upper second class degree is slightly lower for those on F8 code courses (56% compared to 64%; Table 2.2).

In terms of 'student satisfaction', one of the metrics used in institutional and subject rankings, courses that specialise in physical geography or that allow a clear physical geography pathway through a geography degree tend to have higher levels of student satisfaction (92% in the 2014/15 National Student Satisfaction Survey [NSS] survey) than courses that specialise in human geography (89% in the same survey) and/or those that offer both human and physical geography (89%). Physical geography degrees also score higher than physical geography combined with something else (e.g., geology, other types of geography; for example, marine and coastal geography). Joint subject programmes ('geography and' / 'geography with', regardless of geographical specialism) have the lowest satisfaction in this comparison. However, all these values are high compared to other disciplines.

Across-the-board geography graduates go onto a broad range of jobs post-graduation (see Appendix C for examples from two institutions). Students and employers value the knowledge, skills and attributes they have developed (subject specific and generic). Across the discipline, rates of unemployment (from the HESA Destinations of Leavers from Higher Education [DLHE] survey) year-on-year are some of the lowest compared with other subjects taught at undergraduate level (see graph in Appendix C).

The survey of departments revealed a common

[6] KIS published by Unistats for students (https://unistats.direct.gov.uk/find-out-more/key-information-set). The data reported here were released in 2015

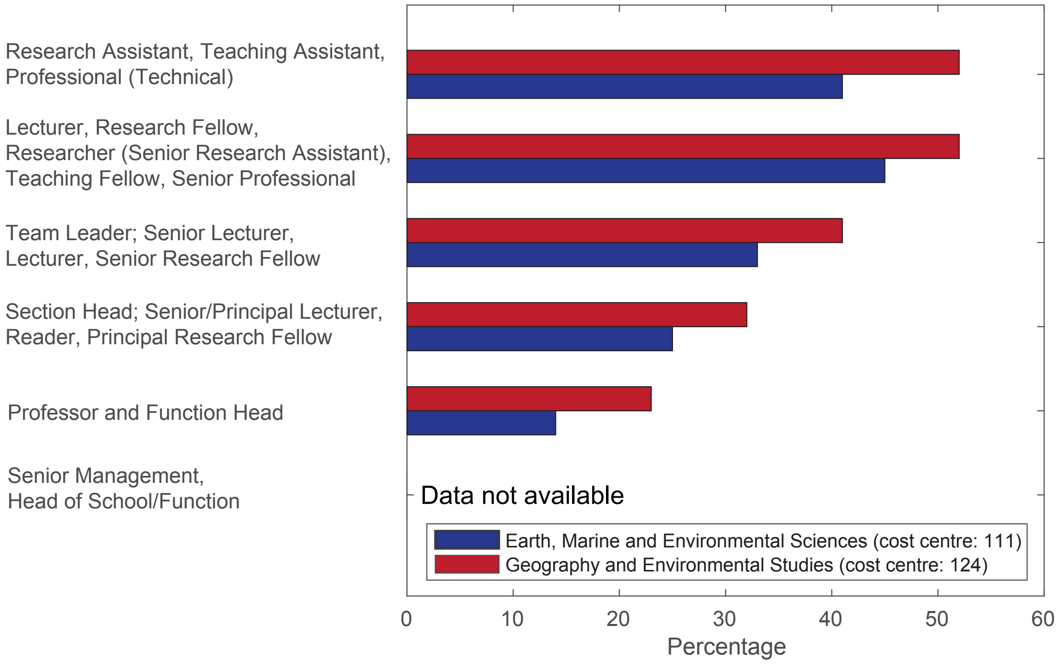

Figure 2.2: *Percentage of staff on academic contracts who are female, by academic grade, in cost centres 111 (Earth, Marine and Environmental Sciences) and 124 (Geography and Environmental Studies), 2014/15 (Source: HESA Staff Record 2014/15, via RGS-IBG.)*

perception that those graduating from physical geography pathways are more likely to directly use their degree in employment; for example, working for the Environment Agency, an environmental consulting company, conservation bodies and/or public utilities. These same respondents stated that this is often associated with some form of postgraduate degree.

2.7 Postgraduate Taught (PGT) Courses

A snapshot of numbers enrolled in physical and human geography Masters (taught and research) is also presented in Table 2.1. Discussion of trends in numbers and funding of those studying for PhDs is presented in Section 3. Although geography departments are developing more integrated Masters programmes (see Section 2.4), a small group of universities do offer formal MSc taught programmes, usually in both full and part-time modes. The number of PGT programmes in physical geography has probably decreased in the last decade, partly because of the withdrawal of NERC support for some programmes, but also with the trend towards MRes and the four-year integrated PGR degree (see Section 2.4). Existing physical geography PGT programmes tend to cluster around the themes of environmental management, river management and GIS. It is important to note that at some institutions enrolments are increasing, particularly for topically named programmes, and courses are over-subscribed. Increased demand at postgraduate level is largely from international students and, generally, GIS courses have the strongest recruitment. This has important implications for training and pathways to research careers.

2.8 Physical Geography Academic Staff

It is becoming increasingly difficult in multidisciplinary schools to specifically identify physical geographers, because of how both departments and individuals describe their research and teaching. Moreover, just as there are problems of coding students in terms of entry to ‘geography’ there are also challenges with tracking academic staff (through the system of JACS codes). Geographers are appointed into academic positions in departments that are not geography, and non-geographers are appointed into geography departments. In this context, physical geography is also both an importer and exporter subdiscipline in HEIs.

Tables 2.3 and 2.4 provide summary data on post-holders in the two most relevant cost centres

***Table 2.5:** Academic staff by cost centre, academic employment function (academic/non-academic), ethnicity and gender, 2014/15*

Employment function	Ethnicity	(111) Earth, Marine & Environmental Sciences			(124) Geography & Environmental Studies			Combined cost centres		
		Female	Male	Total	Female	Male	Total	Female	Male	Total
Academic contract*	White	1100	2070	3170	795	1230	2030	1895	3305	5200
	Black	5	35	40	10	20	30	15	50	70
	Asian	45	95	140	45	55	100	90	150	240
	Other**	35	40	75	30	35	65	65	75	135
	Unknown	110	220	330	60	95	155	170	315	485
	Total	*1295*	*2460*	*3750*	*940*	*1435*	*2375*	*2235*	*3895*	*6125*
Non-academic contract	White	695	485	1180	425	230	650	1120	710	1830
	Black	5	0	10	0	5	5	10	5	15
	Asian	25	15	40	15	5	20	40	20	60
	Other**	20	5	25	10	0	15	35	5	40
	Unknown	60	70	130	20	20	40	80	90	170
	Total	*810*	*575*	*1385*	*470*	*260*	*735*	*1280*	*835*	*2115*

**Academic contract includes: Teaching only, Research only, Teaching & research, Not teaching and/or research.*
** Including 'Mixed'.
Source: HESA Staff Record 2014/15 via RGS-IBG. Staff data are weighted Full Person Equivalent (FPE), following HESA rounding and suppression methodology. © HESA Ltd 2016.

for physical geography, as context and as a benchmark for future studies. These data include information on academic employment function and mode of employment by gender. For 2009/10, the ESRC Human Geography Review reported 1935 full time equivalents (FTE) geographers (drawing across these two costs centres) measured by the subject discipline in which their highest qualification was awarded. Of these, 1165 FTE staff were classified as human geographers (∼60%). While not completely reliable, this suggests the remainder, ∼800 (∼40%) are best described as 'physical geographers'. This mix is not inconsistent with data from the two most recent research excellence assessments in terms of the proportions of human and physical geography staff submitted in institutional returns (see Section 4).

As with human geography, physical geography has an under-representation of minority ethnic groups among university students and staff, and of women especially in the more senior ranks of academic staff. The gender issue is well illustrated in figures 2.2 and 2.3. First, Figure 2.2 shows an interesting difference between the two cost centres in the proportion of females undertaking senior roles: in Geography and Environmental Studies (GES) the 2014/15 data show equal numbers of males and females in these positions of responsibility; in Earth and Environmental Sciences this rises to almost 70% of senior roles being undertaken by women. Yet in both cost centres, the numbers of females in other senior posts (i.e. professorships) is less than 25% in GES and as low as 14% in ESS. Only in less senior appointments is a near gender balance achieved (Figure 2.2).

Figure 2.3 Illustrates the gender split by employment function and contract type. This shows that a significantly higher proportion of GES staff are on permanent contracts compared to EES. In the main category of contract type (permanent/open contracts), where both research and teaching is undertaken, gender imbalance occurs, especially in EES departments. Fixed term contracts represent a significant number of early career staff, often in postdoctoral work. There is close to gender balance within fixed term contracts, regardless of category, in GES; in EES there are greater numbers of males than females on fixed term contracts, although the imbalance is much less marked than amongst those on permanent contracts. As many university departments, including those that contain physical geography, seek Athena SWAN awards, an opportunity exists to create workplace inclusivity that can foster greater employment equality. However, by December 2016 only 13 UK geography departments (and departments with 'environment' in their title and that include physical geography teaching and research) and 12 earth science departments had attained Athena SWAN awards.

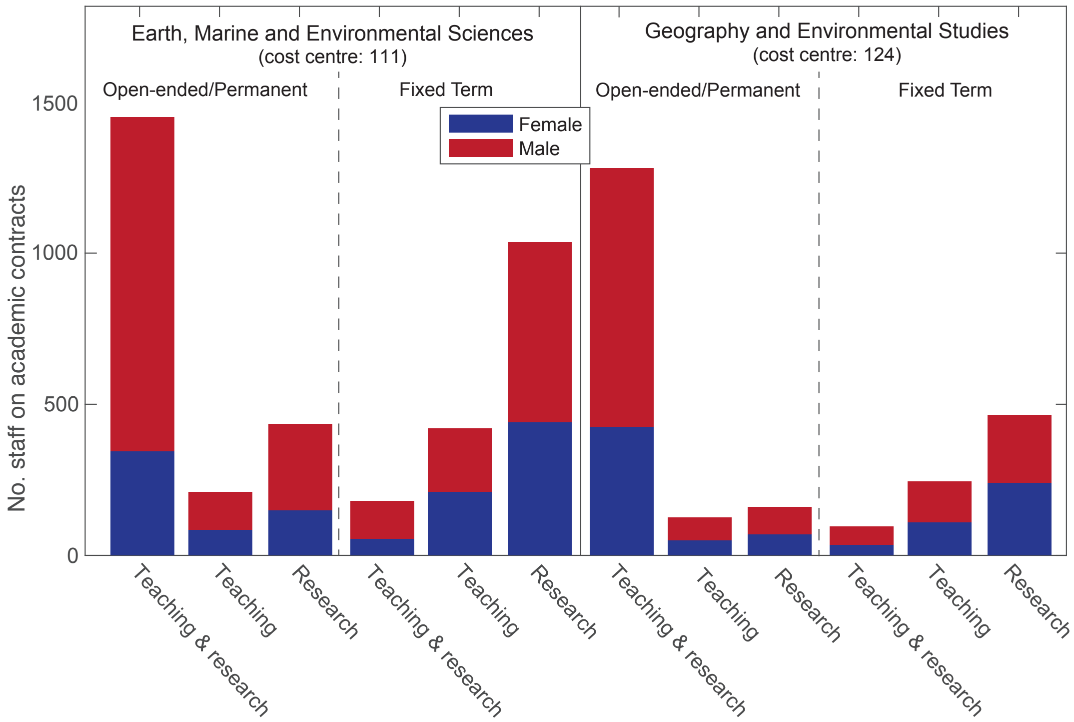

Figure 2.3: *Number of male and female staff on academic contracts, split by employment function (teaching, research or teaching & research), terms of employment and cost centre (111 = Earth, Marine and Environmental Sciences; 124 = Geography and Environmental Studies). Source: HESA Staff Record 2014/15, via RGS-IBG. © HESA Ltd 2016.*

The ESRC Human Geography International Benchmarking Review reported that most staff in geography are UK nationals (75%), the UK proportion increasing among older staff. Among younger staff, EU nationals represent a significant and apparently growing minority (17% under 35). The EU referendum result will have implications for this cohort in terms of its future contribution and sustainability.

HESA data show that in 2014/15 staff in both GES and EES had near-identical ethnicity profiles: 85% white, 4% Asian and 1% black (with 10% unknown; Table 2.5).

2.9 Summary

Virtually all universities in the UK offer an undergraduate degree in geography, with strong elements of physical geography. Physical geographers may not be in the schools/faculties/colleges where science disciplines are clustered, with implications for access to facilities and inclusion in campus-wide initiatives. Physical geography is an importer and exporter discipline in HEIs; geographers are appointed into academic positions in departments that are not geography and non-geographers are appointed into geography departments.

Undergraduate numbers are robust and growing, with further increases expected given recent increases in geography uptake in schools in England. The health of PGT courses is more mixed and increasingly departments are developing integrated Masters programmes to address more specialised research and professional training. Physical geography undergraduates perform well in their degrees, express high levels of satisfaction, and have good employment outcomes.

While the modules and pathways taken by undergraduate students vary across institutions, physical geography courses commonly cluster in terms of: contemporary geomorphology and landscape systems; Quaternary studies; ecosystems and conservation; and climate science. Fieldwork, lab work, modelling, remote sensing and GIS feature prominently too. Teaching staff note disconnects between entering students' expectations and course content, particularly in terms of the conceptual/theoretical base and mathematical/statistical skills. Particular challenges in the provision of undergraduate education relate to laboratory facilities and to fieldwork, given costs and class sizes.

3 Physical Geography: The Context of Research

3.1 Breadth of Physical Geography

Physical geography is no longer carried out just in traditional geography departments (as noted in Section 2). It spans a wide range of subject disciplines and can be found in environmental science, geology, computing, engineering, biomolecular and even medical sciences. Even a single branch of physical geography, such as geomorphology, can find a myriad of 'homes' such as in departments of geography, earth sciences, environmental sciences, geosciences or earth system sciences (Parsons, 2006[7]; Richards and Clifford, 2008[8]; Clarke et al., 2017[9]). Furthermore, a growing number of physical geographers are now based within faculties or colleges that have their intellectual core in the social sciences or humanities (see Section 2.2). Although probably not specific to physical geography, the interdisciplinarity of the subject means geographers stretch well beyond their own departmental base and often lead, or have co-membership of, cross-college institutes, research centres or 'Grand Challenges'. Arguably, physical geographers may now have more collaborations outside geography departments than within. This diffusivity of physical geography is not a weakness, nor a dilution of expertise, but it does mean that physical geography has permeable subject boundaries. A recent survey of members' primary research interests for the BSG[10] showed over 20 subject areas are investigated by its members ranging from areas that might be regarded as traditional and longstanding components of the field (e.g., fluvial, 28% of members; glacial, 17% of members) to the less prolific and newer fields of research (e.g., carbon cycle, 3% of members; deltaic, 2% of members; BSG member survey, 2014, 292 respondents). It is therefore challenging to produce metrics on research output and performance for what may be deemed physical geography. This needs to be borne in mind when absorbing the material discussed below.

[7] Parsons, A.J. 2006. Whither geomorphology (re-)revisited. Earth Surface Processes and Landforms, 31(12): 1595–1596, doi:10.1002/esp.1444

[8] Richards, K., Clifford, N. 2008. Science, systems and geomorphologies: Why LESS may be more. Earth Surface Processes and Landforms, 33(9): 132–1340, doi:10.1002/esp.1718

[9] Clarke, L.E., Schillereff, D.N., Shuttleworth, E. 2017. Communicating geomorphology: an empirical evaluation of the discipline's impact and visibility. Earth Surface Processes and Landforms, 42(7): 1148–1152, doi:10.1002/esp.4129

[10] http://www.geomorphology.org.uk

3.2 Structures and Sub-groupings in Physical Geography

Most (but not all) UK geography, environmental studies, environmental science and earth science departments are structured into autonomous groups of scientific enquiry with critical mass (cf. Thrift, 2002)[11]. Some physical geography groupings are reported as involving 4 or 5 academic staff, others are 20+. Some groups function as externally facing intellectual hubs of expertise, others are more of a collection of staff that work both together and independently in a similar field. The research groupings reported in the REF2014 are reported in Section 4 and commonly have an environmental or Quaternary theme, sometimes set in the global context. A review of the research groupings displayed on the web (January 2016; Table 3.1, see also Section 4.3.1) reveals a near-identical match to those reported at the REF census date (November 2013). This suggests either convergence into themes with short-term stability and longevity, or a temporary hiatus until internal structures are reshaped for an optimal performance in REF2021. It is striking that even in the largest geography departments, not one physical geography group name is repeated in another university, though of course this may a deliberate effort to differentiate in the competitive market place. There is no standard nomenclature for groups of physical geographers working on common themes; however, it is notable that the large geography departments label their expertise using 'traditional' or 'core' physical geography themes rather than obvious multi-disciplinary or all-embracing headings. This may be a function of scale, with smaller departments grouping around broader themes.

3.3 Hiring Trends

The department survey[12] (autumn 2015) returned responses of hiring trends of physical geographers in UK HEIs from nine pre-92 Universities (including three Russell Group) and three post-1992 universities. Although the response rate was not high, the responding units do embrace some of the diversity of institutional contexts. The overall message was of an expansion of staff numbers in geography to match the recent growth in student numbers, and that the demography of UK physical geographers was shifting, fuelled by acceleration in the retirement of a number of senior professors in physical

[11] Thrift, N. 2002. The future of Geography. Geoforum 33(3): 291–298.

[12] Details in Section 1.3

Table 3.1: *Research groupings of physical geography as displayed on the websites of the eight largest geography departments (> 40 FTE) as defined by the volume of all geography staff submitted to C17 in REF2014. Website search undertaken in January 2016*

University	Total FTE Staff submitted to REF2014 C17	Physical geography web groupings
Bristol	46.45	Bristol Glaciology Centre Hydrology Group Bristol Research Initiative for Dynamic Global Environments
Cambridge	45.7	Environmental Systems and Processes Glacial and Quaternary Science
Durham	62.9	Catchments and Rivers Hazards and Surface Change Ice Sheets and Sea Level
Exeter	51.8	Environmental Change Landscape and Ecosystem Dynamics
Leeds	48.9	Ecology and Global Change River Basin Processes and Management
Nottingham	40.9	Geosciences Environment and Society
Oxford	53.85	Climate Systems and Policy Landscape Dynamics Biodiversity, Ecosystems and Conservation
University College London	40.4	Past Climates Recent Environmental Change and Biodiversity Environmental Modelling and Observation

geography. New staff hires, when permitted, were not usually one-to-one replacements of expertise, but rather were in new emerging, interdisciplinary fields (e.g., natural hazards, resilience, geocomputing, Earth Observation, geospatial analysis, sustainability, climate science), or were identified as 'rising stars' as part of university-wide schemes to attract the brightest minds regardless of research specialism.

3.4 Research Funding

Physical geographers obtain research funding from a variety of sources (e.g. RCUK, government, industry, charities), in the UK, EU and beyond, and from responsive and directed programmes, as well as commissioned projects and consultancy. The REF2014 summary research metrics for C17 (geography, environmental studies and combined submissions) showed 44% of research expenditure was from RCUK funds, 15% from EU sources, 9% from industry (excluding pure consultancy) and 6% from charities[13]. These data on grant income do not capture the full record of activity because REF only reports on 'research' income (where research is defined by the Higher Education Funding Council for England (HEFCE) as a process of investigation leading to new insights); therefore, it omits the applied consultancy work that engages some physical geographers.

It is challenging to provide a single measure of grant volume and success when the sources of income are so diverse and the boundaries of physical geography are so diffuse (sections 3.1 and 3.2); however, of the RCUK funding bodies, probably one of the most common sources of competitive income for physical geographers is via NERC, who fund research that seeks to understand and predict how our planet works, and how it can be managed responsibly[14]. NERC maintains a database, GoTW[15], which records all grants awarded since 2000. The GoTW database has limitations (e.g. only the Principal Investigator, PI, is recorded unless a Split Award) but it is a database that allows all grants awarded to be searched by region, institution, person, science keyword or programme. The database is only part-year in 2000, but is complete for every year thereafter up to present day.

[13] Research Excellence Framework 2014: Overview report by Main Panel C and subpanels 16 to 26, Table 8, p. 46, dated January 2015.

[14] http://www.nerc.ac.uk/about/whatwedo/strategy/

[15] Grants on the Web: gotw.nerc.ac.uk

The GoTW database was interrogated and sifted so that only grants associated within the broad remit of 'physical geography' were left for analysis. This gave a total of 1583 grants in 26 different responsive mode and directed programme schemes. Since 2000 there have been over 100 Directed (also called Strategic) Programmes at NERC that involve an element of physical geography, although some, such as the International Ocean Drilling Programme (IODP) are probably more marginal to geographers. The NERC physical geography income database used here includes PGR block grants (Doctoral Training Grant, DTG; Centre for Doctoral Training, CDT; Doctoral Training Programme, DTP) but does not adjust the grant volumes to take into account inflation, changes in science budget at NERC or the introduction of Full Economic Costing (FEC) in 2005.

Table 3.2 shows the summary data for NERC grants in physical geography awarded to UK HEIs. Over £280M has been awarded since 2000 to 684 different PIs. Surprisingly, the number of institutions holding at least one grant is small (50), but three institutions have received over 100 NERC grants as lead investigators (Universities of Edinburgh, East Anglia and Birmingham). Only eight post-1992 universities have held a NERC grant as PI since 2000. The number of individuals with more than one grant as PI (330) is fairly high given that they may also be CI on other successful awards, and 11 individuals have been awarded more than 10 NERC grants as PI since 2000. Anecdotal evidence suggests there is a core of physical geographers that is successful at NERC and that physical geographers do contribute to the vast majority of the 15 research areas that are used to map research activity at NERC[16]. With low success rates at NERC in recent years (10% in July 2014, but which has since risen to 20% in July 2016 in responsive mode), and a gradual shift to multi-disciplinary science, physical geographers have looked increasingly to programme grants from the EU, although the success rates in recent Horizon 2020 (H2020) applications are now approaching the low RCUK levels.

Despite the caveats outlined above about the changing financial drivers since 2000, Table 3.3 shows the annual grant value and number of awards in physical geography from NERC. After a rapid rise in income (partly caused by the introduction of full economic costing, FEC) the volume has stabilised to an annual award of about

Table 3.2: *Summary data for all NERC grants awarded in the broad remit of physical geography between 2000 and 2015*

Metric	Value
No. of grants	1583
Total grant value	£281,887,649
Mean grant value	£178,072
No. individuals as PI	684
Mean No. grants per individual (PI)	2.31
No. individuals (PI) with >5 grants	54
No. individuals with >1 grant	330
No. institutions with at least 1 grant	50
Mean No. grants per institution	32

100 grants worth near £30M. Given the pressures on NERC science budget, success rates in standard grants of between 10 and 14% between 2013 and 2015, and renewed focus on environmental science in its broadest sense, this represents a strong performance by physical geographers.

Table 3.3: *Annual awards of grants in physical geography by NERC*

Start year	No. of grants	Total grant value (£)
2001	47	4,067,871
2002	72	8,259,353
2003	69	7,387,337
2004	71	8,226,645
2005	72	9,023,071
2006	84	14,389,814
2007	79	12,249,378
2008	116	24,305,486
2009	156	21,821,603
2010	189	29,108,266
2011	113	20,514,534
2012	146	29,883,846
2013	137	31,518,029
2014	113	33,728,088
2015	115	27,277,624

The nature of physical geography science that is being funded through NERC is broad in total remit, but is narrowly focussed within individual departments that have specialist centres of excellence. The new Demand Management measures that were introduced by NERC in 2015[17] may concentrate funds further into existing science areas with a sustained history of successful applications.

Given NERC's strategic mission, it is not surprising that many NERC funded research

[16] http://www.nerc.ac.uk/funding/application/howtoapply/topics/

[17] http://www.nerc.ac.uk/funding/available/researchgrants/demand/dm-review2015-17/

Table 3.4: *Sample of NERC grants that involve physical geography as held at Durham University between 2000 and 2015. Note that only one grant for each researcher in receipt of a NERC award is listed. Full details are on the NERC GoTW site*

Start	Grant title	Grant value (£)	Programme
2005	Assessment of spatial controls on shallow landslide activity and hazard in upland environments	24,189	Urgency
2008	Analogue modelling of pre-failure strain accumulation for landslide failure prediction	87,981	New Investigator
2015	Assessing the role of oceanic forcing in West Antarctic Ice Sheet retreat since the Last Glacial Maximum	205,872	Standard
2012	BRITICE-CHRONO: Constraining rates and style of marine influenced ice sheet decay	369,925	Consortium
2010	Building rural resilience in seismically active regions	23,693	Directed Programme
2014	Communicating And Visualizing Erosion-associated Risks To Infrastructure (CAVERTI)	37,191	KE Innovation (Risk)
2013	Constraining Antarctica's contribution to sea-level change: development of a new glacial isostatic adjustment model for Antarctica	406,340	Independent Research Fellowship
2013	Dating and modelling fast ice-sheet grounding-line retreat over the last 4000 years in the SW Weddell Sea, Antarctica	104,316	Standard
2004	Development of a sediment transport model with a CFD framework	107,268	Postdoctoral Fellowship
2005	Flow structures and flow partitioning at river channel bifurcations	177,261	Standard
2004	Gravel-bar dynamics: testing a 2-D modelling approach	2,933	Small grant
2014	How does the development of particle scale structure control river scale morphology?	205,286	Standard
2012	How important are ice streams in accelerating ice sheet deglaciation?	197,631	Standard
2010	Investigating the potential contribution of the East Antarctic Ice Sheet to future sea level change	204,272	Postdoctoral Fellowship
2005	Landslide assessment and flood erosion risk from the North Yorkshire Floods (19 June 2005)	25,096	Urgency
2011	Late Glacial Sea Level Minima in the Western British Isles	213,103	Standard
2006	Numerical testing of hypotheses for the recent thinning and acceleration of Greenland outlet glaciers	95,799	New Investigator
2003	Peat mass movements and geomorphological impacts of an extreme rainfall event - 19 September 2003, County Mayo, Ireland	13,854	Standard
2010	Sediment signatures of the 2010 Chile Mw 8.8 earthquake	51,729	Urgency
2004	The development of progressive failure in cohesive landslides	12,259	Standard
2012	The influence of evolving bed topography on marine ice stream stability	236,113	Postdoctoral Fellowship
2011	The role of physical erosion in the weathering of fossil organic carbon: An investigation using the trace element rhenium	76,935	New Investigator
2010	Understanding transient response to climate change in coupled hydro-eco-geomorphic landscapes	246,126	Postdoctoral Fellowship

Table 3.5: *Ten largest ESPRC grants awarded to topics within the broad theme of physical geography between 2000 and 2015*

Start year	Grant title	Grant value (£)	Institution
2008	Carbon capture from power plant and atmosphere	3,452,949	University of Edinburgh, School of Geosciences
2012	Rural hybrid energy enterprise systems	2,690,768	University of Nottingham, School of Geography
2007	Air quality in airport approaches: impact of emissions from aircraft in ground run and flight	2,039,914	University of Cambridge, Geography
2003	Towards the next generation of computer models for the prediction of flood level and inundation extent	1,956,546	University of Bristol, Geographical Sciences
2004	Hydraulic modelling of remote river basins	1,873,176	University of Bristol, Geographical Sciences
2006	Automated biogeochemical sensing of icy ecosystems	1,789,810	University of Bristol, Geographical Sciences
2013	Delivering and evaluating multiple flood risk benefits	1,434,824	University of Nottingham, School of Geography
2011	Adaptation and resilience of coastal energy supply	1,415,336	University of Liverpool, Dept. Geography and Planning
2009	Water availability and quality: natural environments, domestic use and food production	1,302,692	Lancaster University, Lancaster Environment Centre
2008	CO2 Aquifer Storage Site Evaluation and Monitoring (CASSEM)	719,423	University of Edinburgh, School of Geosciences

projects in physical geography have a focus on environmental change. Table 3.4 shows a sample of NERC grants awarded to Durham University, the largest geography department in the UK (in terms of staff FTE submitted to REF2014). A range of science programmes provide funding and these awards map neatly onto the three Research Groups presented in REF2014 and on the web (see Table 3.1). However, there is little room in the NERC system for the lone scholar, and researchers in departments with small pockets of excellence often have to work in teams involving several HEIs.

Whilst NERC is probably the most obvious source of UK funding for physical geographers who are addressing environmental challenges, some researchers are also successful at the Engineering and Physical Sciences Research Council (EPSRC), the remit of which is to engage in research and innovation in the engineering and physical sciences and currently supports four inter-linked domains of productivity, connectivity, resilience and health[18]. The EPSRC Grants on the Web (GoW) database stores data for all grant awards to a PI since 2000. The summary data show that 70 grants have been awarded to 55 individuals (as PIs), in 25 different institutions, worth a total of £27M. Notably, the mean level of award at EPSRC is more than double that at NERC at £384K. Table 3.5 shows the ten largest EPSRC grants awarded since 2000 in topics that are within the broad remit of physical geography. Particularly successful physical geography science areas supported by EPSRC are within the energy, water and resilience themes. Some individuals and institutions are particularly successful at targeting the EPSRC, as also witnessed with NERC.

Table 3.6: *Grant awards for physical geography projects funded by the Leverhulme Trust*

Award year	No. of grants	Total grant value (£)
2011	3	292,750
2012	2	296,716
2013	1	224,415
2014	5	1,234,279
2015	5	1,087,098
2016 (data to June)	3	569,964

Charities are also a growing source of funding for areas of physical geography, especially in the face of declining open-call opportunities from RCUK. The Leverhulme Trust is an increasingly important source, particularly in Quaternary science, which

[18] http://www.rcuk.ac.uk/documents/documents/strategicprioritiesandspendingplan2016/

Table 3.7: *Five largest Leverhulme Trust grants awarded to topics within the broad theme of physical geography between 2011 and 2016*

Start year	Grant title	Grant value (£)	Institution
2015	Changing the face of the Mediterranean: land cover and population since the advent of farming	298,065	Plymouth University, School of Geography, Earth and Environmental Sciences
2014	Carbon sequestration from wildfires? Quantifying the role of pyrogenic carbon	289,875	Swansea University, Department of Geography
2016	The Breckland Palaeolithic project: culture, technology and evolving humans	255,147	Queen Mary, University of London, School of Geography
2014	Calving glaciers: long-term validation and evidence	238,775	University of Aberdeen, School of Geosciences
2015	Landscape archaeology of the Kalahari: how did major hydrological shifts affect Stone Age mobility and landscape use in the late Quaternary?	234,895	University of Oxford, School of Geography and the Environment

has never been strongly funded by NERC. Table 3.6 gives data for Leverhulme research grants since 2011 that can be considered to be physical geography or to have strong physical geography dimensions[19], totalling over £3.7M.

From 2012 to 2015, grants ranged in size from £144,570 to £289,875 (see Table 3.7 for examples). The scale of funding available for individual awards is less than from RCUK, in part because FEC is not supported, while at least 75% of any grant has to be spent on staffing costs; major equipment purchases are precluded. In addition to these awards, Leverhulme Early Career Fellowships and standard Fellowship awards have gone to investigators working on the environment and based in geography departments.

Small research grants and awards are also made by learned societies that physical geographers are associated with. The importance of these awards should not be underestimated, and their value is more than their fiscal size; they can pump prime new research ideas, fund early career researchers, and support modes of enquiry that are less favoured by RCUK. The RGS-IBG has a highly competitive grants programme from which physical geographers are very successful in securing awards. In the period 2011–2016, physical geography secured 165 awards totalling £439,878 in value, compared to 125 awards for human geography valued at £251,137. Importantly, many of these awards go to early career researchers and postgraduates, though more established academics also source funds for projects that may act as a 'test bed' for research that then grows into bigger projects funded by charities or RCUK (Table 3.8). The BSG, the QRA and the British Ecological Society (BES) also provide small grants for individual projects, early career researchers, and research networks.

The EU has also been a vital source of physical geography research funding. Whilst approximately 15% (equivalent to £42M) of geography and environmental studies income has been earned from the EU (REF2014 Main Panel C Report) since 2008 it is not possible to undertake a more subtle analysis of the contribution of physical geography to that success. There are certainly some major FP7, EU2020, Interreg and other network grants that include significant physical geography components. Some of these funding streams have a long history of evolution (e.g., from one framework programme to the next) and of providing sustained funding for infrastructural investment and sharing (e.g. HYDRALAB+[20]). Others are directed 3- or 5-year programmes (e.g., DESURVEY and DESIRE focussing on desertification modelling and mitigation[21]). The REF2014 Impact Case Studies in the Geography sub-panel C17 certainly showed evidence of a wealth of co-produced research with non-governmental organisations and government agencies (e.g., Environment Agency; Department for Environment, Food & Rural Affairs) that is funded through commissioned research or open tender consultancy.

[19] Indicated by the awardee, their departmental affiliation or the subject area of the project, as reported in Leverhulme Trust documentation.

[20] http://hydralab.eu/about-hydralab/history/

[21] http://www.geog.leeds.ac.uk/people/person/work-in-progress/?shortname=m.kirkby

The UK Government recently announced £4.7Bn of Research & Development funding by 2020–2021 to invest in science and innovation to deliver the UK Industrial Strategy[22]. The underpinning principle behind the Industrial Strategy is to stimulate stronger productivity and more balanced economic growth. Physical geography has a role to play here and can contribute to the delivery of some of the '10 pillars' of activity including the targeted investments in science, research and innovation skills; upgrading infrastructure (e.g. flood defences) and delivering affordable energy.

The funding environment that lies behind physical geography research in the UK is clearly not static. With the UK's departure from the EU confirmed, European funding will inevitably become even more challenging to obtain. More positively, investment in new schematic partnership programmes such as Newton Funds (from 2014) and the Global Challenges Research Fund (GCRF)[23] (from 2016) will offer new opportunities for interdisciplinary research that physical geographers can positively engage in (Lane, 2016[24]). In this rapidly changing funding environment it will be important to assess the effects of these on the capacity for physical geography to carry out interest-led discovery science, which ultimately fuels the development of new ideas and the evolution of the subdiscipline. This potential reshaping of physical geography is not 'destructive' (Clifford, 2002[25]; Richards and Clifford, 2008[26]) but rather is creative in the way it may bring physical geography into partnership with different research domains and communities.

3.5 Capital Investment

The survey[27] of geography departments in autumn 2015 highlighted that the physical geography equipment base in universities is advanced and largely suitable for undertaking world-class research. New equipment is predominantly funded through internal investment via the HEI Resource Model, or allocation of Science Infrastructure Investment Fund (SRIF) and HEFCE Research Capital Investment Fund (RCIF) monies; for example, in recent years many geography departments have invested in Differential Global Positioning Systems (dGPS), Terrestrial Laser Scanning (TLS), Unmanned Aerial Vehicle (UAV), and other landscape monitoring equipment, while geochronology laboratory techniques (e.g., luminescence, thermoluminescence [TL], Optically Stimulated Luminescence [OSL], U-series dating, Sr-isotope dating, cosmogenic nuclide analysis) are also well represented. Since 2013, NERC have provided over £15M funds to support long-term capital priorities within the UK environmental sciences in both programme-specific and open bidding competitions. Geography has done well in the former, with at least four departments securing major investments, but less well in the latter where the majority of 59 successful bids have been in the fields of earth science, chemistry and genomics[28].

3.6 Postgraduate Research Students (PGR) in Physical Geography

Postgraduate research creates the next generation of university academics and researchers as well as feeding highly trained individuals into non-academic activities in the private and government sectors.

RCUK external funding for postgraduate studentships in physical geography is predominantly provided by NERC, although EPSRC also fund PGR in certain thematic areas that reach out into the physical and environmental sciences. Because competition for RCUK funds is intense, increasingly institutions seek a mixed funding model; for example, university studentship schemes, graduate assistantships, match-funding or top-ups to international fees.

Over the past decade at NERC there has been an evolution of the funding policy for PGR studentships with a variety of different funding streams on offer ranging from supervisor applications for specific projects to algorithm-derived studentship allocations. In 2014 a new funding system was put in place by NERC with two parallel programmes: (i) Responsive PhD training through Doctoral Training Partnerships

[22] https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf

[23] GCRF comprises funds (£1.5Bn distributed over 5 years) from RCUK and UK government Official Development Assistance (ODA) in a series of research programmes addressing global problems ('priority challenges'), a number of which have environmental components.

[24] Lane S.N. 2016. Slow science, the geographical expedition, and Critical Physical Geography. The Canadian Geographer. doi: 10.1111/cag.12329

[25] Clifford, N. J. 2002. The future of Geography: When the whole is less than the sum of its parts. Geoforum 33(4): 431–436.

[26] Richards, K. and Clifford, N. 2008., Science, systems and geomorphologies: why LESS may be more. Earth Surface Processes and Landforms, 33: 1323–1340. doi:10.1002/esp.1718

[27] Details in Section 1.3

[28] http://www.nerc.ac.uk/funding/available/capital/strategic

***Table 3.8:** Examples of awards for physical geography research from the RGS-IBG, 2016*

Award type	Project title	Institution
Geographical Fieldwork Grant	Evaluating the effects of climate change on Svalbard glaciers	Newcastle University
Geographical Fieldwork Grant	Incognita Patagonia: Exploring the Last Patagonian Icefield	University of Cambridge
Monica Cole Research Grant	Quantifying biomass burning emissions factors within the Berbak landscape, Indonesia	King's College London
Geographical Club Award	Testing the terrestrial response to thermohaline circulation (THC)-driven Holocene climate events around Atlantic Canada	Southampton University
RGS-IBG Postgraduate Award	Protecting aquatic diversity in rapidly changing tropical landscape	Imperial College, London
Dudley Stamp Memorial Award	Expanding the record of Indo-Pacific Warm Pool rainfall changes through new karst field site development	University of Oxford
Gilchrist Fieldwork Award	How does converting tropical forest to oil palm affect ecosystem function?	University of the West of England
Small Research Grant	The influence of glacier structure, reflectivity and surface temperature on turbulent energy fluxes	Aberystwyth University
Thesiger-Oman Fellowship	Initial Motion of Boulders in Arid Zone Bedrock Channels: Implications for Hydrology and Geomorphic Evolution of Desert Wadis	Southampton University

(DTPs) and Large Grant associated studentships; and (ii) Focused PhD training through Centres for Doctoral Training (CDTs, Collaborative Awards in Science and Engineering (CASE) studentships and other sources. The bulk of NERC studentships are distributed through DTPs and CDTs. The DTPs fund 240 studentships (costing £25M) per year for five intakes starting October 2014. A total of 15 DTPs are supported within the UK with a studentship quota of between 12 and 28 per year[29]. Most DTPs are consortia but five universities hold their own DTP for distribution amongst departments with an environmental focus. Geography departments play a large part in many NERC DTPs. No post-1992 universities either lead or are partners in a NERC DTP. Each NERC DTP has a strong focus on providing multi-disciplinary training to the new generation of environmental scientists, with some DTPs offering different streams of expertise (e.g. Oxford: biodiversity, ecology and evolutionary processes; the dynamic earth, surface processes and natural hazards; the physical climate system). The last intake from the current DTP round is October 2018 and a mid-term review[30] of the DTP programme is being used to inform decisions about the commissioning process of new DTPs from Spring 2018.

Also in 2014 NERC created Focused Studentships that provide individuals with specialist professional, technical and academic skills as identified by the scientific community. NERC-supported CDTs are in 'Oil and Gas' (10 studentships per year), Soil Science (8 per year) Risk and Mitigation (10 per year), Use of Smart and Autonomous Observation for the Environmental Sciences (10 per year.), and Modelling and Quantitative Skills in Ecology and Evolution (24 per year). The duration of the allocated CDT funding varies between three and five years. A new call for CDTs in either 'Freshwater bioscience and sustainability' or 'Environmental science underpinning the sustainable future of the energy sector' with 8 studentships per year over three years will start in 2018–2019.

In the period 2001—2008, 1648 doctoral degrees were awarded from UK geography and environmental studies departments (Research Assessment Exercise [RAE] 2008 data); in 2008–2013, 1850 were awarded (REF2014 data). These data do not allow physical and human geography awards to be differentiated.

[29] http://www.nerc.ac.uk/funding/available/postgrad/responsive/dtp/

[30] http://www.nerc.ac.uk/about/whatwedo/engage/engagement/dtpevaluation/

Differences in the numbers of units submitted in the two assessments make detailed comparison difficult; nonetheless, the mean number of awards per department per year rose from 5.6 in 2001–2007 to 6.4 in the period 2008–2013. However, the distribution of PGR students is highly uneven across geography departments in the UK for example, from individual REF2014 submissions it can be seen that in the period 2008–2013 the largest geography PGR community in the UK, at the University of Oxford, awarded 122 doctoral degrees, Durham University awarded 87, King's College London awarded 86, and the University of Leeds awarded 65. Fourteen units awarded less than ten doctorates in the same five-year period (Figure 3.1).

There is a considerable diversity and range amongst the topics that physical geography research students investigate, and at individual institutions these largely map onto the research specialisms of academic staff and fall within the remit of the research groupings that exist. Appendix D provides an illustration of the diversity of doctoral topics in physical geography at one institution.

3.6.1 Experiences of PGR students in physical geography

A survey of UK-based physical geography PhD students was circulated through departments and research groups. In total, 88 responses were received from 28 institutions; over half (56%) of the responses came from the departments at the universities of Bristol, Durham, Oxford, Leeds, Southampton, Manchester and Liverpool. Of the respondents, 33% were in the first year of their PhD, 23 (26%) in the second year, 22 (23%) in the third year, and 17 (19%) in the fourth year. Students were largely from the UK but international students were also represented. Of the respondents, 22% had first degrees from Australia, Brazil, Belgium, Benin, Canada, China, Germany, Italy, Kenya, Malaysia, Netherlands, Portugal, USA, or Zimbabwe. While 30 (34%) had undergraduate degrees from the same institution as their PhD enrolment (most common in the responses from universities of Bristol, Durham and Manchester), there is a strong flow of students between institutions across all types (older and newer). A small number of post-1992 universities (post-1992) had respondents only with undergraduates from the same institution. The disciplinary backgrounds of the students are varied. More than half (48) have a degree in geography, 15 in environmental science, 10 in geology or earth science, 8 in environmental management, 7 in biology, 3 in mathematics, 3 in archaeology, 2 in engineering, and 2 in forestry; a broad range of subjects account for the remaining students.

In terms of the focus of study, the largest group (32) were working on water related topics (fluvial processes, marine/freshwater ecology, hydrological response to climate change), followed by climate and atmospheric change (11), glaciology (10), ecosystems (4), natural hazards (4), conservation (2), forestry (2), and dryland dynamics (2).

A third (29) are supported by NERC, a further 28 by scholarships or other awards from the host university or academic department, 8 by government agencies, 7 by trusts and foundations, and 2 by industry. In total, 14 reported they were unfunded, and were therefore supporting themselves. Perhaps unsurprisingly, the most common challenge reported to affect an individual's research related to funding. A third (28) stated that they had, or envisaged they would, run out of funding and that this would impact upon completion and thesis submission. A number highlighted specifically the challenges of funding for international fieldwork. Others (13) stated they were not getting enough support from supervisors (due to sickness, leave or lack of interest), 10 stated they could not balance work and life effectively and 3 noted mental health issues.

Others noted the challenges presented by moving in to physical geography from a different disciplinary background and of sourcing specialist training, particularly in specialist computational skills and in coding. Some students reported difficulties in the training provided by their departments where it did not distinguish between the often markedly different needs of human and physical geographers. Having adequate funds for specific aspects of a research project was also reported as either problematic or generating unfairness of opportunity. This was highlighted as a distinct perceived disadvantage for field scientists compared to computer modellers, with funds for overseas fieldwork and specific laboratory experiments lacking for some students. Others challenges cited by students were more generic (e.g. of part time study; culture shock, language and distance from families; challenges of being a single parent; lack of peer support).

Despite the issues raised above, over half of those surveyed intended to pursue further research

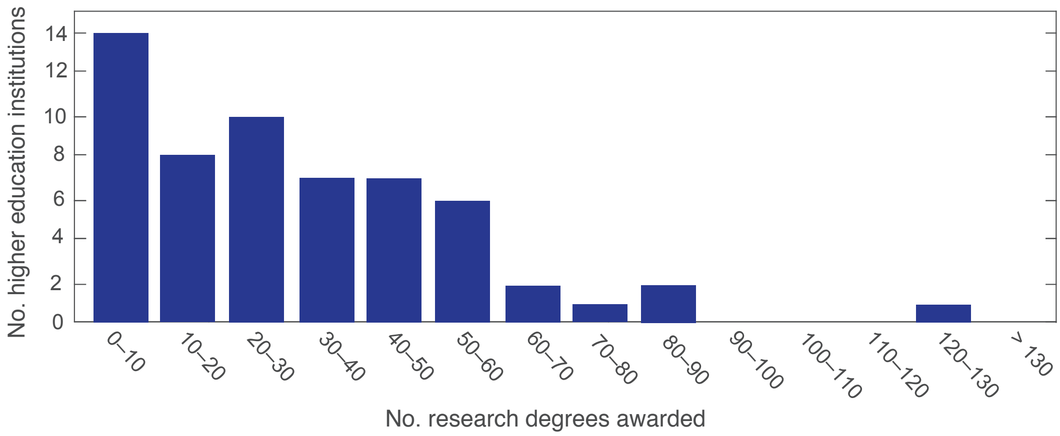

Figure 3.1: *Distribution of geography doctorate research degrees awarded by institutions between 2008 and 2013 (Source: REF submissions).*

following completion of their doctorates, and over a third wished to pursue a long term career in academia. However, a recurrent comment in responses was the perceived lack of viable career options in academia and a lack of post-doctoral opportunities to allow these aspirations to be met.

3.7 Physical Geographer Community

The RGS-IBG research groups and the RGS-IBG annual conference give a sense of identity, at various levels and to varying degrees, to human geography in the UK. The annual conference and the opportunity to establish research groups are open to physical geographers but their engagement is much less than that of their social science colleagues. In fact, of 31 research groups listed on the RGS-IBG website[31], three embrace aspects of physical geography (the Biogeography Research Group, with 220 members; the Climate Change Research Group, 208 members; and the Coastal and Marine Research Group, 87 members), but compared to their human geography counterparts, these are, variously, smaller in representation, less active, or currently inactive. Others, such as the GIS and Quantitative Methods research groups, cut across human and physical geography for their membership.

Does this matter for the state of physical geography in the UK? The answer is probably not, because physical geographers interact through different arenas and fora. Much evidence suggests a thriving, albeit distributed, subdiscipline, with interactions between some component areas and substantial interactions with other sciences. UK physical geography engagement with the RGS-IBG annual conference may be limited, but engagement at and within the very large international meetings of EGU and AGU is well evidenced (see Section 5). Further, within the UK key component parts of the community are represented by the BSG (473 members in August 2016, just over half of whom are students, the vast majority doctoral) and the QRA (over 1200 members, around a third of whom are postgraduates), both of which have major annual conferences in the UK. Moreover, both groups have memoranda of understanding and clear programmes of collaboration with the RGS-IBG, which involve prizes, conferences, advocacy work particularly around schools etc. Other subareas of UK physical geography interact through bodies such as the International Society for Aeolian Research (ISAR), BES, and the Geological Society of London. Thus, while there is not a centralised community of physical geographers in the UK *per se*, the health of the subdiscipline is not impaired because of active engagement in other parallel international and national scientific communities. There is though perhaps a lesser sense of overall community compared to human geography as the various groups do not come together regularly, which would allow both formal and informal interactions to occur.

Beyond the academy, physical geographers are well connected to those in government (local, national and international), business (environmental consultancies, insurance industry as specific examples) and not-for-profit organisations (e.g., conservation). Evidence of

[31] In fact 30 are listed. The RGS-IBG has MOUs in place with both the BSG and QRA. Historically the BSG (then the BGRG) was a research group of the RGS-IBG.

this is provided by impact case studies submitted to REF2014 (Section 4.5), funding for studentships (Section 3.6.1), and consultancies and research funding directed through departments (Section 3.4). With the recent announcement of a Head of Geography in Government[32], operating within the Government Science and Engineering (GSE) profession umbrella, opportunities for the voice of the discipline to be heard in UK government will be enhanced.

3.8 Summary

Physical geography performs well against most independent measures of research activity and intensity. It punches well above its weight in success at the RCUK (NERC and EPSRC) and the award of RCUK studentships through block grants such as the DTPs. Important areas and aspects of research are funded from other sources too, notably charities and professional societies, the latter often playing a vital role in supporting pump-priming research. Whilst there are challenges for physical geography to secure sufficient internal and external resources to fund a full science base, there are also exciting opportunities to welcome a more diverse and multi-disciplinary physical geography and celebrate the benefits of its research to the global community. Doctoral students are a key part of the renewal and sustainability of the subdiscipline, with UK universities hosting geography PGR communities of widely differing sizes, as evidenced by the numbers of degree awards that have been made. Despite a wide range of challenges that impact on the ability of PGRs to conduct their research, a sizable proportion wish to pursue related research in academic careers on completion.

[32]https://governmentscienceandengineering.blog.gov.uk/2017/07/25/gse-to-recruit-new-head-of-geography/

4 Physical Geography: Research Assessment and Excellence

4.1 Research Assessment in the UK

The UK's systematic national assessments of academic research quality[33] have, since their inception, provided data and textual material that allows both snapshots of the activities of universities and peer-review assessment of the quality of this research. As geography is one of the constant units of assessment within RAE and REF (though with evolving structures, see below) these assessments provide a means to look, nationwide, at changing research activities and the quality thereof, and to extend analysis of some of the points and issues introduced in the previous section. The nature of the commentary that follows is not to interrogate the purpose and structure of RAE/REF, rather it is to use the publicly accessible materials these reviews generate[34] to learn something about the changing patterns and content of physical geography research and its impact (in the widest sense). This is attempted here for the last three national assessments: RAE2001, where geography was Unit of Assessment (UoA)35; RAE2008 (UoA 32), and REF2014 (subpanel 17). The purpose is to look at *overall* trends in quality and activity (and in 2014, at the impact of research outside academia). It is *not* to comment on the quality of research at individual institutions (though information on what research is done at an institution can be extracted from the publicly available submission materials).

Table 4.1: *Content of assessment units including geography*

Year	UoA/Subpanel	Official title
1996	UoA35	Geography
2001	UoA36	Geography (with hosted Development Studies subpanel)
2008	UoA32	Geography and Environmental Studies
2014	Subpanel 17	Geography, Environmental Studies and Archaeology

There are several caveats to the use of such material. First, the 'results' of the assessments do not formally disaggregate physical geography from other parts of the discipline. However, at the

[33]Until 2008, Research Assessment Exercises [RAE] and in 2014, Research Excellence Framework [REF]
[34]Available at http://www.rae.ac.uk and http://www.ref.ac.uk

end of each assessment process the relevant panels submit written reports that do examine trends within their disciplines and in the case of geography these very clearly pull out the physical and human components. Second, while geography has been a constant UoA, in 2008 this was grouped with environmental studies and in 2014 with archaeology as well (see Table 4.1). Fortunately (from the perspective of this review), most (but not all) universities submitted separate returns for their geography and archaeology departments, so that the subpanel commentaries on final outcomes and trends distinguish the two disciplines. Third, a small number of universities did not submit to the geography panel in every assessment exercise. In some cases this reflects the waxing, waning, regrouping and renaming of research activities at some universities, for assumed strategic reasons. This does not mean physical geography research was not being undertaken, simply that it was submitted to be assessed under the auspices of a different assessment panel. Fourth, a small number of departments have chosen to submit their human geography research to the Geography panel and their physical geography research to another subpanel, particularly Earth and Environmental Science (subpanel 7 in REF2014), usually in association with the research of another department at the institution concerned.

Table 4.2: *Number of submissions to 'Geography' including by other disciplines aggregated within the RAE/REF unit*

Assessment	RAE 1996	RAE 2001	RAE 2008	REF 2014
GES*	59	55	49	42
Development		7	OP	OP
Archaeology	OP**	OP	OP	22
Combined				7
Total	*59*	*62*	*49*	*74*

*Geography and Environmental Studies
**Own panel

Thus, for RAE2008, the universities of Birkbeck, Brighton, Coventry, Huddersfield and Lancaster were amongst those that did not submit to the Geography UoA whereas they had in the 2001 assessment, while the University of Glasgow submitted only human geography to the Geography UoA in 2008 and again in 2014. The University of Reading followed this practice in REF2014, dispersing physical geography activities to various other units of assessment and submitting only human geography to Subpanel 17. For REF2014, the University of Edinburgh was amongst institutions that did not submit any of its geography to Subpanel 17, despite being the home of significant geographical (both human and physical) research. Some institutions, for example Kingston University, moved in the opposite direction, submitting to UoA 32 in 2008 when Environmental Studies was added to the assessment group's title, and to Subpanel 17 in 2014.

Taking this background information into consideration, Table 4.2 shows the number of institutions submitting to the RAE/REF group with geography in the title, which provides the basis of the material upon which the rest of this section is based.

4.2 Excellence and Quality Profiles

The outcomes of the RAE/REF activities have been assessments of the individual submitted units, subsequently used by central government to influence the core research funding delivered to universities. The grading systems used in the exercises have changed, becoming more refined over time, so that in 2008 a single grading number (on a scale of 0–5, with 5 the best) was replaced by a profile showing the percentages of overall unit research activity judged to meet the standard for each of 5 classes from 4* (world leading) to 1*(national quality), plus unclassified. The 5% granularity of outcomes in 2008 was refined to 1% in 2014.

Table 4.3: *Overall geography quality profile data, RAE/REF 2008 and 2014 assessments*

	4*	3*	2*	1*	U
RAE2008 raw	13.16	34.39	37.25	13.57	1.6
RAE2008 5%	15	35	35	15	0
REF2014	27	42	26	5	0

The overall research quality profile for individual assessment areas was not published for RAE2008, but can readily be calculated from publicly available data; for REF2014 the data were produced formally (and for Subpanel 17 that for Geography & Environmental Studies was differentiated from that for Archaeology). Table 4.3 shows the percentage distributions across the grades (for 2008 this is shown both as raw mean data and in the 5% granularity used in official outcomes): these are overall outcomes, aggregating the assessments for research outputs, research environment and research impact.

These data show a significant increase in the percentage of research in geography judged to be world-leading (4*) and internationally excellent (3*) compared to recognised internationally (2*) and nationally (1*) [see RAE and REF documentation online if further explanations of terminology are required]. This marked increase in judged research quality does not, however, allow the respective contributions of the physical and human components to be disaggregated, and this is not possible to achieve from the available data, since the grading given to individual pieces of submitted research are totally confidential. We can only assume that the relative contributions to the high quality were equal, but we can explore the data in other ways to consider both the relative volume of physical geography and the areas of physical geography that contributed to this.

4.3 Changes in Subject Material Submitted to Research Reviews

The areas of physical geography research present in assessment materials can be examined both by looking at the research themes or groupings in individual submitted departments and, perhaps more systematically in terms of perceived excellence, through the subject matter of outputs returned for assessment. Since over 80% of all material submitted (with an even higher percentage for physical geography) to the last review was in the form of journal articles, then the journals themselves also give an indication of the fields of activity.

4.3.1 Groupings

One way of assessing the significance of physical geography is to look at how submitting institutions viewed their own research in terms of the themes/groups/clusters referred to in submissions, and to look at the proportions of physical and human geography within. The 2008 exercise contained a section where research groups were named. In 2014 this was optional and many institutions chose not to do so; nonetheless, groupings are readily identifiable within the research environment text that had to be provided (see also Section 3.2). Although many submissions identify the academic staff members associated with groupings, the size of groups cannot be readily assessed, as in many instances some staff are attached to more than one group. Likewise, research income, postgraduate numbers, etc., are also not attached to group information, and in 2014 submitted outputs did not have to be associated with the named groups.

Table 4.4 summarises the data on research groupings for the 2008 and 2014 assessments. Interestingly, while the total number of human geography groups exceeds that of physical groups (with the gap narrowing in 2014), the number of institutions with only physical groups marginally exceeds those with only human groups. This is likely a function of environmental studies departments being returned within the Geography UoA/subpanel. Nonetheless, it does suggest that physical geography remains very evenly matched in terms of its occurrence within UK geography departments between assessments.

Table 4.4: *Number of Research Groups in UK geography submissions to RAE/REF assessment exercises*

	2008	2014
No. units of assessment *	49	49
No. physical geog. groups	76	88
No. human geog. groups	94	97
No. units with no physical groups	4	3
No. units with no human groups	5	7

*Includes, Geography & Environmental Studies and relevant parts of 'combined', submissions in 2014

What are the physical geography research groupings? While groups have titles, this is more difficult to assess than it might first appear. Take for example, Quaternary, a term that appears in many group titles around the UK. In some cases in 2014, Quaternary (or palaeo) research stands alone as a title, but often it is linked with climate change, or surface processes, or recent environmental change, and so on; all of which are themes that are also used as 'stand-alone' titles in some departments. Geomorphology is used relatively little as a stand-alone title, though subfields including fluvial, glacial and coastal exist. 'Processes' is widely used, but also in various combinations that relate to atmosphere, catchment, landscape, hydrological, etc. Biogeographical/ecological themes are equally difficult to disentangle. It may be suggested that themes are 'cut' into groups according to expertise, personnel, institutional priorities and so on, and while interesting, the names alone do not give a clear indication of the research that is actually carried out. For many institutions the titles of physical geography sub groups differ to varying degrees from 2008 to 2014. Reading the submitted Research Environment statements from REF2014 in detail shows that various reasons underpin changes and these are no different to the points raised above: personnel changes, institutional priorities, developments in science needs and international and national agendas, etc. The changing face of physical geography is therefore more than an issue related to the superficiality of research group titles, as it also relates to content, which is more clearly viewed though the types of outputs that were submitted for assessment and their intellectual content.

4.3.2 Volume of submitted material

Despite the reduction over time in the number of institutions submitting to the geography components of the research assessment processes and the withdrawal of the physical component by other institutions in favour of submitting to Earth and Environmental Science, the volume of physical geography material submitted for assessment is high. The report of the 2008 RAE review for example noted that the number of outputs submitted as physical and as human geography were almost equal (2240 compared to 2380). It was argued then that institutions had seen a preferential growth in physical geography, which is in contrast to the information/perception generated from other sources, such as the RGS-IBG's own study groups and conferences. Certainly the data in Table 4.2 does not suggest a diminishment in the presence of physical geography in recent years.

A high volume of material submitted in 2014 was also physical, but it was noted that as well as excellent research within the subfields of activity (discussed below), there was a notable move towards physical geographers 'doing' and contributing to 'Big Science', transcending disciplinary boundaries and addressing themes not only relevant to wider science, but also very much at the science-society interface. This may serve the discipline well into the future with the changes emerging in RCUK funding and the development, for example, of cross-council funded 'Grand Challenges' research.

4.3.3 Output sources

The RAE2001 report noted the increasing number of excellent geography outputs published in the journals of other disciplines; in 2014 this 'outside influence' of physical geography was noted, for example, by the *Nature* journals being the fourth most commonly used journal for submitted outputs (with *Proceedings of the National Academy of Sciences* [PNAS], *Geology*, *Science* and *Geophysical Research Letters* all in the top 20 most used, out of a total of 1095 different journals used for submitted outputs). Only two of these (*Geology* and *Geophysical Research Letters*) were in the 2008 'top 20'. If the 'amount' of physical geography seems to be declining on the basis of other indicators, in the sphere where excellence is assessed it appears on the basis of outputs to not only be holding its own, but also to be engaging, contributing and leading in multidisciplinary science arenas.

One further broad observation can be made from the output sources. In 2008, the list of the top 20 most submitted journals included seven other titles that are outlets of physical geography research: *Quaternary Science Reviews*, *Earth Surface Processes and Landforms*, *Geomorphology*, *The Holocene*, *Journal of Quaternary Science*, *Hydrological Processes*, and *Remote Sensing of Environment* (see Table 4.5, also Richards et al. 2009[35]). Many of these remained in the top 20 in 2014, but the remote sensing and hydrology journals, as well as two Quaternary journals and interdisciplinary *Journal of Geophysical Research*, were displaced by other titles. Notable is that the two geomorphology specialist journals remained popular, despite some concern about the demise of this subfield.

4.4 Research Areas, Themes and Subthemes: An Overview from Groupings and Outputs

Post-review reports can be used to identify changes within specific subfields, and developmental trends in others. It is clear that Quaternary science has been a hallmark element of high quality research in UK physical geography through all three reviews, but the nature of the best research has evolved in a manner that reflects, or even leads, international trends.

Site/region/location specific research, while retaining a significant and sometimes essential role in activities, has been surpassed in importance by developments both in methodologies and techniques (including UK departments being vitally important in chronometric developments), and by the integration of Quaternary research within wider debates regarding global climate and environmental change. This research has often been truly international (in locations, research teams, and assessed quality) as well as both empirical and modelled. Such research figures

[35] Richards, K., Batty, M., Edwards, K., Findlay, A., Foody, G., Frostick, L., Jones, K., Lee, R., Livingstone, D., Marsden, T., Petts, J., Philo, C., Simon, S., Smith, S., Thomas, D. 2009. The nature of publishing and assessment in Geography and Environmental Studies: evidence from the Research Assessment Exercise 2008. Area, 41.3: 231–243, doi:10.1111/j.1475-4762.2009.00908.x

***Table 4.5:** Most common journals in RAE2014 and REF2014 'Geography' panels*

Rank	RAE2008		REF2014	
	Journal	**No. subs.***	**Journal**	**No. subs.**
1	*Environment & Planning A*	154	*Quaternary Science Reviews*	157
2	*Quaternary Science Reviews*	125	*Environment & Planning A*	128
3	*Transactions Institute of British Geographers*	105	*Transactions Institute of British Geographers*	121
4	*Environment & Planning D*	94	*Nature 'family'*	94
5	*Geoforum*	83	*Journal Archaeological Science*	87
6	*Journal Geophysical Research*	81	*Geoforum*	83
7	*Earth Surface Processes & Landforms*	73	*PNAS***	78
8	*Geomorphology*	70	*Environment & Planning D*	67
9	*The Holocene*	63	*Earth Surface Processes & Landforms*	63
10	*Journal Quaternary Science*	60	*Geomorphology*	56
11	*Urban Studies*	60	*Antiquity*	55
12	*Progress in Human Geography*	56	*Geology*	52
13	*Antipode*	48	*PLoS ONE*	50
14	*Geophysical Research Letters*	46	*Progress in Human Geography*	46
15	*Journal of Historical Geography*	46	*Antipode*	45
16	*Political Geography*	42	*Science*	45
17	*Hydrological Processes*	41	*Urban Studies*	45
18	*Geology*	40	*Geophysical Research Letters*	44
19	*Remote sensing of Environment*	40	*Annals Association American Geographers*	41
20	*Annals Association American Geographers*	38	*Journal Quaternary Science*	40

*No. of submissions **Proceedings of the National Academy of Sciences

prominently in many institutions that achieved high standing in 2001, 2008 and/or 2014.

Geomorphology, for so long a mainstay of UK physical geography, has also evolved, likely in the face of the demand for research that addresses 'Big Science' questions of global importance, and where 'Big Data' are needed, often to test models relating to the dynamics of integrated systems. This evolution has possibly led to a change in the identity of geomorphology, as well as in the direct use of the term as a subdiscipline of physical geography[36]. In the 2008 RAE summary it was described as being 'reinvigorated by tensions created by Earth system science'. Aeolian, glacial and fluvial investigations are highlighted in the 2014 overview, all experiencing significant evolution of research and its impacts. For example, fluvial geomorphology, so often reductionist in approach, has now become a 'subdiscipline' that might be called water science and which often operates in a manner integrating hydrology, geomorphology, ecology and water chemistry, often at catchment scales. Aeolian geomorphology has moved away from a reductionist focus to contribute, for example, to research that addresses major issues in atmospheric science influenced by particulate transport. UK glacial geomorphology was also seen to have evolved by 2014 into a subdiscipline that contributes to key global scientific debates associated with global warming and past and future Earth dynamics. In a globally competitive research environment, all these fields show great UK strengths and excellence.

Biogeography has also developed through the last three review periods, though this was observed to possibly be partially consequential on changes within the Biological Science subpanel, leading to more whole-ecosystem research being returned to the Geography subpanel, including in tropical environments, but also recognising world-leading strengths in this area at some institutions (e.g., Universities of Oxford and Leeds on tropical ecology/biogeography). Smaller-scale research, in phylogenetics and phylogeography, is also a growing area of strength in some geography departments. Earth observation, GIS and geospatial analysis, are well embedded in the discipline, to the point that they are not 'separate' entities but are widely mainstreamed. For example, there is increasing evidence of this through the application of remote sensing and GIS technologies to observe and quantify

[36] Woodward, J. 2015. Is geomorphology sleepwalking into oblivion?. Earth Surface Processes and Landforms, 40(5): 706–709, doi:10.1002/esp.3692

temporal and spatial changes (e.g. in vegetation cover, ecosystem condition and anthropogenic impacts). These technologies, additionally through the use of modelling, are providing insightful and novel linkages between, for example, studies of future climate change and those of the Quaternary Period. Some traditional areas of physical geographical research, regarded as in decline (both in quantity submitted and level of excellence) in the first decade of the 21st century, were considered to be rejuvenated by 2014. These included soil studies and coastal/marine processes (including the relevant parts of geomorphology). Traditional descriptive climatology, also a significant past element of physical geography, was reported to be evolving in the 2008 RAE. By 2014 the excellence of climate science in UK geography departments was identified as contributing to many major global debates, and within the context of integrative research that cuts into the other fields and subfields described above. In many cases, applied areas of research have developed that include a strong numerical and/or modelling contribution from physical geography. These include many of the above subfields, as well as in ecosystem services.

It is undoubtedly the case that the research excellence reviews have seen marked changes in the nature of the work submitted by institutions as 'the best'. The evidence is that while traditional areas or representations of enquiry may sometimes be regarded as having declined, closer examination suggests that the major trends have in fact been evolutionary and integrative, with greater contributions to major science themes that require specialisms to be used and developed in robust transdisciplinary structures that are often part of international programmes or concerns that cut across traditional disciplinary silos.

4.5 Impact of Physical Geography

With research excellence now assessed additionally by the role research plays in wider-society beyond academia, it is useful to examine some aspects of the impact submissions that were required in REF2014. Most helpful perhaps is to consider the quality and content of the impact case studies that submitting institutions provided to subpanel 17, rather than the underlying philosophy of the wider 'impact agenda' or the ways in which departments are addressing impact within their institutional frameworks.

The overall impact component of geography in REF2014 was judged very highly, with 34% graded at 4* and 41% at 3*. Less than 5% was judged to be lower than 2*. The 49 geography, environmental studies and combined submissions included 170 impact case studies. The subject area report also notes that overall geography case studies were fairly evenly split between socio-economic and environmental themes, with those with an environmental component often focusing on hazards (including climate) or components of environmental management, where an underpinning of physical geography research was often a contributory factor. Again, the quality of individual elements cannot be commented upon because such material is confidential, but the subject matter and types of impact of the individual case studies can be gleaned from publicly available material.

The research underpinning the impact case studies can be extracted and classified from the submitted material. Of the 170 case studies, 90 are predominantly underpinned by human geography research and 80 by physical geography. There are inevitably some where both contribute to the underpinning research. If this is broken down further, then 35 of the physical case studies are associated with research in biogeography/ecosystems (including marine) or components thereof; 31 by research that concerns the physical landscape including geomorphology (including glacial) and Quaternary research (including studies on aggregate extraction); and only 14 by research that is climate science (though there are some of the ecosystem-based case studies that this also contributes to).

Case study classification is complex and by their very nature individual studies rarely have a unique thematic or methodological identifier. A number of academic studies of impact are underway, though little is widely available yet. Table 4.6 shows common impact types, from a study of all impact case studies (i.e. including Archaeology) submitted to all subpanels in REF2014. It can be seen that physical themes are very highly represented (highlighted in bold, with those where physical geography contributes to some studies in italics), not least in areas where environment and society interact (which is just the sort of nexus where impact can be achieved).

Impact of physical geography on societal challenges has been facilitated by the RGS-IBG Chartered Geographer (CGeog) scheme, introduced in 2002. Since inception, close to 700 individuals have been enrolled as CGeog, with many of the individuals engaged in consultancy or central government, where professional accreditation is of value to those using the discipline in non-academic contexts. Within academia, the greatest uptake has been amongst physical geographers, who are often engaged in consultancy work.

Table 4.6: *Common impact types in REF2014 Subpanel 17*

Area/impact type/impacting upon*	Approx. % case studies
Informing government policy	60
Cultural and heritage preservation (mainly archaeology)	40
Community and local government	30
Nature and conservation	20
Parliamentary scrutiny	20
Water and flood management	15
Climate change	15
International development	10
Media	10
Museums/exhibitions	10
Public engagement	10
Modelling and forecasting	<10
Marine & ocean science	<10
Oil and gas	<10
Transport	<10
Software development	<10
Business and industry	<10
Archives	<10
Schools/education	<10

Note: data based on a study at King's College London. See the full report at: http://www.hefce.ac..uk/pubs/rereports/Year/2015/analysisREFimpact/
*Bold text denotes physical themes. Italics denote themes where physical geography contributes to some studies.

4.6 Summary

It can be difficult to interrogate data and information from the UK national research assessments in a manner that draws out physical geography in a clear way, because of the nature of the assessments and the confidentiality of some of the material within. Some elements, particularly funding, have not been considered here, because it is simply not possible to disaggregate the physical geography component within the data available from RAE and REF materials; funding is assessed separately in Section 3 and international components in Section 5. It should also be recognised that the nature of the assessments has always focussed on the strongest research (i.e. through requiring submitting institutions to select the 'best' research of their academics).

Nonetheless, the sections above attempt to use the data that are available or to mine the textural information to generate some quantitative information about physical geography, its research themes, strengths, and contributions to wider science and society. Overall, there is good evidence that the quality of UK physical geography is high, and has improved over time, especially between the 2008 and 2014 assessments. A summary of that evidence is that it makes major contributions to big, international science problems, collaborates and leads international agendas, and punches hard in the delivery of research impacting on society and policy.

5 Internationalising Physical Geography

The analysis so far has focussed on sustainability, institutional context and research in physical geography, and how these may have evolved over the last 10–15 years. However, it is vital that this review also considers how UK-based physical geography interacts with and influences the discipline beyond the UK. Physical geography in the UK engages broadly with the international community, through hosting international visitors and students, by individuals holding visiting professorships in overseas universities, and through research collaborations with and within international teams. UK physical geographers also contribute to the health of the discipline globally, through leadership on international learned society committees, convening sessions at international conferences, editing international peer reviewed journals and being recognised for their research through medals and awards from overseas organisations.

5.1 International Learned Societies and International Esteem

UK physical geographers are active leaders in international learned societies. Over the last 15 years they have taken on senior roles within the EGU by chairing the Natural Hazard, Geomorphology, Sedimentology, Stratigraphy and Palaeo, Cryospheric Sciences and Soil, and Environment and Ecosystem Interactions divisions, as well as overall Programme Chair in 2010–2011. A physical geographer will be president of the EGU in 2017–2018. Eleven geography-related international societies are currently, or have been, chaired (within the last 15 years; Table 5.1) by UK academics, with further activity on Executive Committees and more than 44 general committee memberships. The UK is particularly strong in leadership of geomorphology and Quaternary science, with notable engagement in the biogeography community. This follows similar trends in research quality noted in Section 4. For example, the inaugural meeting of the IAG was hosted in Manchester in 1985, and UK physical geographers continue to have a strong presence on the Executive Committee of IAG, including Vice-President and President positions from 2001–2009.

UK physical geographers also take a leading role in international journal editorship (Table 5.2; Appendix E). The top three physical geography journals (*Global Ecology and Biogeography*, *Cryosphere* and *Journal of Biogeography*, according to the 2015 ISI ranking) all currently have a UK-based academic within their Editorial Group (20% of each group are UK physical geographers). Quaternary Science Reviews, the fourth ranked physical geography journal (and that from which the most REF2014 submitted outputs came from, Section 4.3.2) has three UK Associate Editors (43% of Associate Editorial team). Other strong representation within the lead-editorial group or associate editor team includes *Journal of Quaternary Science* (ranked 5th, 40%), *Journal of Glaciology* (ranked 8th, 28%), *Earth Surface Processes and Landforms* (ranked 12th, 38%), *Geomorphology* (ranked 13th, 33%), *Progress in Physical Geography* (ranked 17th, 57%), *The Holocene* (ranked 22nd, 64%) and *Permafrost and Periglacial Processes* (ranked 23rd, 33%).

Five of the seven EGU flagship journals (*Earth Surface Dynamics* [E-SURF], *Cryosphere*, *Hydrology and Earth System Science*, *Natural Hazards and Earth System Sciences*, *Soils*) currently have UK-based geographers within the Chief Editorial Team; all seven have UK representation within the full editorial team (including Associate Editors). Representation is particularly strong within *E-SURF* (18%). Further afield, UK geographers contribute to flagship AGU journals including a strong presence on the *Journal of Geophysical Research-Earth Surface* board (an Editor-in-Chief and four associate editors, 19%) and three Associate Editors of *Water Resources Research* (3%). During the REF2014 and RAE2008 cycles, there were 31 Chief Editors, 102 Editors, 58 Associate Editors and 210 Editorial Board mentions within named physical geography related journals. Historically, there has been a particularly strong presence on Geomorphic and Quaternary journals (Appendix E, Table E.1). Again, this follows identified strengths in research quality (Section 4). Historically, UK geographers have also had a strong role in shaping the flagship journal of the International Association of Sedimentologists (*Sedimentology*), with the last two Editor-in-Chiefs based in UK geography departments.

UK physical geographers are recognised for their contributions to science through international medals and awards, including 13 EGU and 9 AGU medals since 2004. Additional international distinguished medals awarded over the REF2014/RAE2008 periods to UK physical geographers include the UNESCO/WMO/IAHS[37]

[37] United Nations Educational, Scientific and Cultural Organization/ World Meteorological Organization/ International Association of Hydrological Sciences

Table 5.1: *UK leadership on international society committees (based on current online information and REF2014 and RAE2008 data)*

Position	Organisation
President/Chair/Vice Chair	Coastal Education and Research Foundation (regional) International Society for Aeolian Research International Biogeography Society Estuarine and Coastal Science Association International Association for Mathematical Geosciences International Union of Quaternary Research (INQUA), Commission on Stratigraphy and Geochronology (SACCOM) International Association of Hydrological Sciences International Mycological Association International Association for Urban Climate INQUA Palaeoclimate Commission International Association of Geomorphology
Treasurer	International Society for Diatom Research International Society for Photogrammetry and Remote Sensing International Glaciological Society International Palaeolimnology Association
Secretary	International Biogeography Society INQUA-PAHE Working Group
General Committee Membership (additional examples)	International Association of Geomorphologists International Association of Sedimentologists International Union for Quaternary Research International Association for Vegetation Science European Association of Remote Sensing Laboratories The Ecosystem Service Partnership International Association of Cryosphere Science

International Hydrology Prize, the Martha T Muse Prize, the Zeldovich Medal of the committee on Space Research and the Russian Academy of Science, Chien Ning Prize from the World Association for Sedimentation and Erosion Research, Acharius Medal from the International Association for Lichenology and the Geological Society of America Farouk El Baz Award for Desert Research.

5.2 Physical Geography in International Conferences

UK physical geographers are heavily involved with convening annual sessions at international conferences including the EGU and the AGU. They are particularly involved with geomorphology, cryospheric and hydrological sessions; at EGU 2016 there was at least one UK geography convenor in 33, 31 and 29% of these sessions, respectively (Table 5.4). This agrees with the quality make-up of UK physical geography research (Section 4). Temporal trends (Table 5.4) have remained consistent over the last 8 years (the limit of available data), with the standard deviation of percentage sessions with one UK (geography or non-geography) convenor in the geomorphology division less than 5%. Convenor engagement at the AGU is also strong, with comparable session convenorship by geography session contributions (27% within the Earth and Planetary Surface Processes Division).

Table 5.2: *Current UK geography-based editors (based on January 2016 data)*

Journal Type	Editor-in-Chief or Editorial Team			Associate Editors			Editorial Advisory Board Membership		
	UK total	UK %	US %	UK total	UK %	US %	UK total	UK %	US %
Top 30 journals*	11	14	30	34	11	28	91	14	31
EGU family**	5	15	6	18	6	15	-	-	-
AGU family**	1	2	71	7	3	55	-	-	-

*Top 30 ISI ranked physical geography journals **7 journals

Table 5.3: *Trends in UK convenorship of EGU and AGU sessions*

Division	% Total UK convenorship		% Session with at least one UK convenor		% Total geog. convenorship within sessions that include one UK geographer		% Total geog. convenorship	% Session with at least one geog. convenor
	UK	US	UK	US	UK	US	UK	UK
EGU 2016								
Cryospheric Sciences	17	6	54	28	32	4	11	31
Climate: Past, Present, Future	10	6	37	23	29	3	5	16
Atmospheric Sciences	12	12	41	39	23	2	3	10
Hydrological Sciences	12	7	44	35	26	5	9	29
Natural Hazards	12	5	39	20	32	4	6	16
Soil System Sciences	12	6	36	26	31	4	8	22
Geomorphology	15	2	38	9	37	1	13	33
AGU 2015								
Earth and Planetary Surface Processes	10	80	27	100	38	52	10	27

This is despite the AGU conference attracting a larger number of scientists (recently 24K vs. 13K) and restricting the number of convenors per session to 4 (some EGU sessions have 12+ convenors). Moreover, UK geographers are more active than their US counterparts at convening overseas conferences. The percentage of US scientists convening EGU sessions with at least one geographer is at most 5%, or 12% when considering US participation from all disciplines. This is much lower than the UK equivalent of AGU convenorship (38% and 10%, respectively) in the Earth and Planetary Surface Processes Division. An example of UK engagement on a more discipline-specific platform can be seen in convenorship of the International Conference on Geomorphology (ICG). For example, in Melbourne, Australia (2009) 19% of sessions were convened by UK physical geographers, and in Delhi, India (2017), 23%.

Table 5.4: *Temporal trends in UK convenorship of Geomorphology Division EGU sessions*

Year	% Total convenorship		% Session with at least one convenor	
	UK	US	UK	US
2016	15	2	38	9
2015	18	2	45	10
2014	17	2	51	7
2013	13	4	43	16
2012	16	3	45	11
2011	13	2	40	8
2010	20	0	51	0
2009	18	3	43	8

5.3 Global Partnerships and Science

UK physical geographers typically collaborate with overseas colleagues through joint grant proposals and project partner inclusions. Since 2000, NERC have also funded over £4.5M in geography related projects to PIs in overseas countries, including Bolivia, China, India, South Africa, Australia, Peru, Italy and the US. Further evidence of the international reach of UK physical geography is that over the REF2014 cycle, over 99 grants were funded by international award bodies (Table 5.5).

Table 5.5: *Grants awarded to UK geographers from international funders*

Funding body	No. grants reported during REF2014 cycle
European Research Council	57
National Science Foundation	11
International charities	10
European Space Agency	4
German Research Council	4
Australian Research Council	3
Scandinavian funding bodies	3
Other (Canadian, Nigerian, Belgium)	3
NASA	2
Japanese Funding Bodies	2

The new GCRF (see Section 3) strives to stimulate co-production of research between UK scientists and those in low–middle income countries (LMICs). As well as hosting international visitors, UK physical geographers are recognised for their international leading research through visiting professorships and research fellowships at overseas universities. Within the RAE2008, there were 93 of these mentioned spanning 24 countries (Table 5.6), with positions in USA, China and Australia being the most common. The REF2014 statements were reported differently, with non-specific holders and locations making it hard to separate human and physical geography visiting research positions, but within geography in general, 105 were specified.

Table 5.6: *Honorary and Visiting appointments of UK physical geographers at overseas institutions, 2001–2008 (data from RAE2008)*

Country	Total	Professorships	Research Fellowships
USA	24	6	18
China	13	8	5
Australia	10	2	8
France	6	4	2
Canada	5	5	0
New Zealand	5	1	4
Norway	4	3	1
South Africa	4	2	2
Austria	3	2	1
Sweden	2	2	0
Chile	2	1	1
Italy	2	1	1
Spain	2	1	1
Bulgaria	1	1	0
Israel	1	1	0
Kazakhstan	1	1	0
Malaysia	1	1	0
Thailand	1	1	0
Czech Rep.	1	0	1
Denmark	1	0	1
Finland	1	0	1
Germany	1	0	1
Peru	1	0	1
Taiwan	1	0	1

Source: data from RAE2008 statements

5.4 Summary

UK physical geographers interact and promote the discipline on a global level. Within learned societies and journal custodianship, physical geographers are particularly active in the fields of geomorphology, biogeography and Quaternary science. Strengths within international annual conference convening broadly follow the societal leadership trends. UK geographers are convenors in all disciplines, but particularly geomorphology, cryospheric and hydrological sciences. Finally, UK physical geographers are actively engaged with international collaborative projects and fund these projects through international sources, particularly within the EU and US.

6 Summary of Key Findings and Future Challenges Facing UK Physical Geography

This report compiles evidence on the health and reach of UK physical geography. It describes the nature and demand for physical geography in schools, the shape and size of physical geography in universities, the achievements and global influence of UK physical geography and its academic community, and the aspirations and skillsets offered by the next generation of leaders in physical geography. A number of key findings are given below, divided into thematic sections. Ten challenges are then presented that may be used to frame future discussions on maintaining the prominence of UK physical geography in the global research community.

6.1 Context

UK physical geography is international in outlook, is world-leading in many subareas, and influences the discipline worldwide. It makes major contributions to 'Big Science' problems of global importance, sets intellectual agendas both within and beyond geography, and leads eminent international collaborative research programmes. UK physical geography increasingly delivers research that impacts on society and policy, and changes lives for the better in fragile and vulnerable environments and communities. It is a popular and growing subject choice in schools and attracts some of the highest-calibre students to its undergraduate degrees. The future is bright for UK physical geography as it works to support resilience in a changing world and promote responsible management of the environment.

6.2 Universities, Departments and Staff

UK physical geographers interact and promote the discipline on the global stage through engagement with the international scientific community, hosting international visitors and PhD students, holding visiting professorships in overseas universities, and collaborating within international teams on grants and publications, particularly within the EU and US. UK physical geographers also promote and serve the discipline globally, through leadership of international learned society committees, convening sessions at international conferences and editing international peer reviewed journals. UK physical geographers are recognised for their world-renowned research through medals and awards from distinguished overseas organisations.

UK physical geography is diverse, and changing, as evidenced by the waxing and waning of different sub-areas, the changing dynamics of specialist research groups and learned societies, and its representation as a discipline at NERC and international fora (e.g. AGU, EGU). The interdisciplinarity of the subject means physical geographers stretch well beyond their own departmental base and often lead, or have co-membership of, cross-institution institutes, research centres or 'Grand Challenges' initiatives. The subject is dynamic, and frequently new staff hires are not one-to-one replacements of expertise, but occur in new emerging, interdisciplinary fields (e.g. natural hazards, resilience, data analytics, sustainability, climate science), or through the appointment of 'rising stars' as part of university-wide schemes to attract the brightest minds regardless of academic discipline.

Virtually all universities in the UK offer an undergraduate degree in geography, with strong elements of physical geography. Current estimates are that approximately 800 of ~2000 FTE academic staff in geography departments are physical geographers. However, increasingly physical geography is not just carried out in traditional geography departments, but in a more diverse range of academic units (many with 'Environment' in their title). This can sometimes mean that physical geography and physical geographers are not clearly identifiable, which has implications for disciplinary visibility (and accounting).

Physical geographers may not be in the schools/faculties/colleges where science disciplines are clustered, with implications for access to essential facilities for research and teaching and for inclusion in institution-wide initiatives relevant to physical geography. For example, these may include: activities and decisions pertinent to doctoral training centres; implementation of research council demand management strategies; appropriate review of materials for appointments; promotion; and the REF.

Ethnic diversity amongst university geography staff and students is unacceptably narrow, with clear underrepresentation of many groups. Gender imbalance occurs at many career stages, with balance between males and females only apparent in fixed term appointments (i.e. in employment categories that are least secure).

The equipment base in many geography departments is advanced and largely suitable for world-class physical geography research. Renewal is largely funded from internal institutional sources rather than from external capital funding budgets and this fragile dependence on HEI finances may have implications for basic equipment renewal and the agility to invest in cutting-edge technologies as they come to market.

6.3 Research Groupings and Disciplinary Strengths

Most (but not all) UK geography, environmental science and earth science departments are structured into autonomous groups of scientific enquiry with critical mass, varying in size from 4 or 5 academic staff, to 20+. There is no standard nomenclature for groups of physical geographers working on common themes. Large geography departments tend to label their expertise using 'traditional' or 'core' physical geography themes rather than obvious multi-disciplinary or all-embracing headings. There have been constant changes within departments and to physical geography research group clusters in the last decade as a result of personnel changes, institutional priorities, developments in science needs, and international and national agendas. These changes reflect the capacity of physical geography to adapt to evolving research environments.

In 2008 it was argued that institutions had seen a preferential growth in physical geography since the preceding RAE (2001). A high volume of material submitted to REF2014 was also physical geography, not only in submissions to the Geography, Archaeology and Environmental Studies subpanel, but also to the Earth and Environmental Science subpanel. There has been a notable move towards physical geographers 'doing' and contributing to 'Big Science' agendas, transcending disciplinary boundaries. Research is seen to address themes not only relevant to wider science, but also very much at the science-society interface. This may serve the discipline well into the future with the changes emerging in RCUK funding and the development, for example, of cross-council funded 'Grand Challenges' research.

Quaternary science, a hallmark element of high-quality research in UK physical geography, has evolved in a manner that reflects, or even leads, international trends. Site/region/location specific research, while retaining a significant and sometimes essential role in activities, has been transcended in importance by developments both in methodologies and techniques, including UK departments being vitally important in chronometric developments. This Quaternary research is increasingly integrated within wider science and society debates regarding global climate and environmental change. This research has often been truly international, in terms of research locations, research and teams as embeds both empirical and modelled approaches.

Geomorphology, for so long a mainstay of UK physical geography, has also evolved, likely in the face of the demand for research that addresses globally important ‘Big Science’ questions. This includes research where ‘Big Data’ are needed, often to test models relating to the dynamics of integrated systems. The practicing of fluvial geomorphology, which two decades ago was dominated by reductionist approaches, has widely developed towards a ‘subdiscipline’ of water science. This commonly integrates hydrology, geomorphology, ecology and water chemistry, often at catchment scales, as exemplified by recent NERC impact programme awards. Despite the limited environments in the UK where processes can be observed to be operating, UK aeolian geomorphology has moved in a similar direction, contributing for example to research that addresses key issues in atmospheric science influenced by particulate transport. UK glacial geomorphology also contributes to major international scientific debates associated with global warming and past and future Earth dynamics.

Biogeography has developed through the last two decades, with more whole-ecosystem research being returned to the REF2014 geography subpanel. Again, research is global in outlook and practice, including research in cold, temperate and tropical environments that may integrate with other sub-areas, such as climate science and elements of human geography.

Climate science in UK geography departments has strengthened in the last decade and is contributing to many major global debates. This includes independent climate research but also, significantly, research that integrates with other sub-areas of physical geography, with other science disciplines, and with the social sciences including components of human geography.

Some areas of physical geographical research that were mainstays of the subdiscipline and which appeared in decline showed evidence of rejuvenation in submissions to REF2014. Soil studies and research in coastal and marine processes, including contributions from within geomorphology, are examples of areas of growth, which are also contributing to science enquiry beyond the discipline. The use, application and development of technologies (including Earth observation, GIS, and geochronological tools) is an integral part of contemporary physical geography. In many cases, applied areas of research have developed that include strong numerical and / or modelling contributions from physical geography. These developments include many of the above subfields, as well as in ecosystem services, which is also a good example of the interplay of the natural and social science dimensions within geography.

Overall, there is significant evidence that the quality of UK physical geography research is high, and has improved over time, especially between the peer-review RAE2008 and REF2014 assessments. A summary of that evidence is that UK physical geography makes major contributions to big, international science problems, collaborates internationally and leads international research agendas, and punches hard in the delivery of research impacting on society and policy.

6.4 Research Funding

Physical geographers obtain research funding from a variety of sources (e.g., RCUK, government, industry, charities), in the UK, EU and beyond, and from responsive and directed programmes, as well as commissioned projects and consultancy. Physical geography performs well against most independent measures of research activity and intensity. It punches well above its weight in success at the RCUK (NERC and EPSRC) and the award of RCUK studentships through Block Grants such as the DTPs, including CASE studentships. Whilst there are challenges for physical geography to secure sufficient internal and external resources to fund a full science base, there are also exciting opportunities to welcome a more diverse and multi-disciplinary physical geography and celebrate the benefits of its research to the global community.

As with other disciplines and subdisciplines, the decision of the UK government to pursue leaving the EU ('Brexit') following the June 2016 referendum is likely to reduce significantly the access UK physical geographers have to European research funding sources. In 2014 these represented 15% of UK geography department research income. This is likely to increase further the pressure on UK funding sources, including from Research Councils and new initiatives such as the GCRF. With NERC already using demand management mechanisms to control submission levels to its responsive mode funding calls, the landscape of demand and supply for research funding is likely vulnerable to further pressures and challenges.

The investment of significant new funding in schematic partnership programmes such as Newton, GCRF and the Industrial Strategy creates new opportunities that include environmental elements that physical geography can both lead and contribute. Such a dramatic shift in the funding landscape may drive physical geographers to be consortium members of truly multi-disciplinary groups that span all of the Research Councils. Geographers may be particularly well placed to engage in these multidisciplinary activities given the intrinsic diversity of their own discipline.

6.5 Schools, Undergraduates and Taught Postgraduates

Undergraduate numbers are robust and growing, with further increases expected given the recent increases in geography enrolments in schools in England. Curricular changes at A-Level will enhance the amount of physical geography taught; however, the outlook is not as positive in Scotland with concerns widely expressed about the content of the Scottish Highers.

Physical geography is taught at undergraduate level through a diversity of degree structures and pathways, with significant variability in content and student opportunities between institutions. Despite this, physical geography courses commonly cluster in terms of: contemporary geomorphology/landscape systems; Quaternary studies; ecosystems and conservation; and climate science. Fieldwork, lab work, modelling, remote sensing and GIS feature prominently too.

Physical geography undergraduates perform well in their degrees, express high levels of satisfaction, and have good employment outcomes compared to most other disciplines. Given enrolment trends, and pressure on some geography departments to take more students, there are particular challenges in the provision of undergraduate education relating to laboratory facilities and to fieldwork, given costs and class sizes. Teaching staff note disconnects between entering students' expectations and course content, particularly in terms of the conceptual/theoretical base and numerical/statistical skills needed and this needs monitoring as the new A-Level curriculum beds in.

A new A-Level geography curriculum was introduced to schools in England in autumn 2016. This includes more physical geography, more fieldwork and embedded skills training. It will be important to monitor the impact of these changes to see if/how it encourages increased student interest in physical geography and subsequently influences UCAS course choice, as well as how it prepares students in terms of fieldwork and numerical skills, GIS and spatial data handling. Students with this qualification will enter universities in autumn 2018. This is important as in recent years incoming undergraduate students often perceive physical geography as 'difficult' relative to human geography, based in part on their pre-university experiences that often include limited physical geography content at A-Level. Physical geographers in HE need to engage with initiatives to support and upskill teachers to deliver the new Geography A-Level.

The health of PGT courses is more mixed. The number of PGT programmes in physical geography has decreased in the last decade, partly because of the withdrawal of NERC support for some programmes, but also with the increasing trend towards MRes, MGeog, and the four-year integrated PGR degree. Existing physical geography PGT programmes tend to cluster around the themes of environmental management, river management and GIS.

6.6 Postgraduate Research

Postgraduate research creates the next generation of university academics as well as feeding highly trained individuals into non-academic activities in private and government sectors. Departments across the UK are preparing students for postgraduate study, with postgraduate student cohorts supplemented considerably by students from across the world. While about two thirds are trained in geography, environmental science and geology, students admitted to physical geography postgraduate programmes come from a wide range of other disciplines including mathematics, physics, engineering, biology and archaeology. More than half of those physical geography postgraduates surveyed wish to pursue a research career, with a third of these wanting a career in academia. A lack of suitable postdoctoral research opportunities can make progress in academia difficult.

In the RAE2008 assessment period (2001–2007),1648 doctoral degrees were awarded in UK geography departments (not exclusively physical geography). From 2008 to 2013 this figure changed to 1485. However, the mean number of awards per year per institution rose between these periods, from 5.6 to 7.1. PGR numbers are unevenly spread across different geography departments, with funding sources for doctoral students also varying between institutions. The current 15 NERC Doctoral Training Partnerships include multi- and single-institution models but all are multi-disciplinary. Geography departments play a significant role in many, but no post-1992 universities are partners in any NERC DTP.

7 Ten Challenges

The independent review of this report by a panel of eminent overseas experts confirms that "it is beyond doubt that UK physical geography is a leading force worldwide as evidenced by all the metrics discussed in this report". Nonetheless, the challenges detailed within the report would benefit from further expert opinion, to ensure the global reputation of UK physical geography is enhanced. Ten challenges are highlighted below. It is recommended that a working group representative of constituent bodies within UK physical geography is set up, under the auspices of the RGS-IBG, to take forward the issues associated with these challenges.

1. With the undoubted value of physical geography in answering big scientific and applied societal questions, there is a need to monitor the shifting nature of the discipline as it both leads and links with others. The benefits and successes of engagement need to be assessed alongside any challenges that might emerge from this to both the uniqueness of physical geography and its relationships to other parts of geography. It could be particularly revealing to map any growing gaps at the interface of physical, environmental and human geography.

2. The 21st century has seen a de-siloing of science as a response to the emergence of big 'whole world' science questions and problems, and possibly too as a response to the increasingly thematic nature of the demands of research funders and governments. It would be instructive to chart how UK physical geography sits within this evolving domain and how it maintains its ability to conduct fundamental or blue-skies research in the more traditional, building blocks of physical geography, which are essential to its future health and distinctiveness.

3. It will be valuable to monitor the research impact of physical geography beyond academia, in political and consultancy spheres, including through enrolment as Chartered Geographers. This can be undertaken by assessing the contribution of physical geography to different impact types in REF2021 case studies but also monitoring the visibility of physical geography in the political sphere.

4. With increasing pressure in HEIs to develop internal 'demand management' policies for research grant applications, it is important to monitor if physical geography benefits or loses from this degree of selectivity at source and whether this then translates into increased leverage of external funding.

5. There is a need to assess the impact of leaving the EU on physical geography research including absolute funding levels and staff and student mobility.

6. Gender and ethnicity imbalances pervade staffing in the cost centres within which university physical geography is carried out. These patterns require attention at the highest levels with the UK university system, both for reasons of fairness and to benefit the discipline from the wider experiences that inclusivity brings. There is a need to increase the representation of highly skilled females and underrepresented ethnic groups, especially in more secure appointments.

7. With the increased presence of physical geography in revised School A-Level curricula in England and Wales, there is a need to support teachers to deliver and promote physical geography skills and fieldwork. There is also more scoping work required to better prepare students to recognise the benefits of studying physical geography. It will be important to monitor how the recent upsurge in growth in Geography A-Level students translates into the volume and quality of students enrolling onto geography degrees and to map whether there is an accompanying shift in career pathways for physical geographers.

8. It is necessary to ensure sufficient core funding for laboratories, equipment and fieldwork in HEIs for both physical geography research and teaching. Monitoring recent capital expenditure on facilities and equipment, as well as provision of professional support staff and field teaching, would provide a benchmark against which current and future needs, and institutional imbalances, can be assessed.

9. While DTPs and CDTs are geared towards skilling postgraduate students to meet national needs, a significant proportion of PGR students wish to pursue academic careers, and opportunities are limited. It is recommended that further consideration be given to the aspirations of entering PGR students and the final outcomes of their advanced training in terms of skill sets gained, and career opportunities.

10. There is a need for benchmarking analysis of the global reach and impact of UK physical geography at a regular interval to assess the continuance of the health and influence of the discipline.

Appendix A School Level Geography in the UK

What is taught in geography in England, Scotland, Wales and Northern Ireland, and increasingly within them (by school type and by examination board), differs. As context for this review, this Appendix provides a short overview of school-level education in the UK, the current policy landscape and recent and expected changes.

Since devolution school-level education policy in England, Scotland, Wales and Northern Ireland has diverged and students can arrive at university with quite different educational experiences, knowledge, skills and understanding. In terms of UK students studying in UK higher education, approximately 82% of the students are school-educated in England; 10% in Scotland; 6% in Wales and 2% in Northern Ireland. EU students and other international students while common at postgraduate level (8% and 32%, respectively) are a small minority (4% and 9%, respectively) in undergraduate programmes.

In England up to Key Stage 3 (KS3; age 14) the subjects and standards are governed by a national curriculum. This stipulates what is taught by all local authority schools, although it is also often followed closely by many independent schools and academies because it prepares students well for GCSE examinations. In Scotland, the Curriculum for Excellence (CfE) is transforming all aspects of education. The curriculum comprises a broad general education up to the end of S3, followed by a senior phase of learning from S4 to S6. Increased emphasis is placed on inter-disciplinary learning, skills development and encouraging personal achievement. Wales and Northern Ireland also have their own structures and curricular. Students arriving at university will have followed different pathways and in terms of geography may have experienced quite different course content, exposure to fieldwork, and different modes of assessment.

Geography remains a popular subject in UK schools. As noted above, in England geography is compulsory through KS3 (age 14). For GCSE ∼250,000 students annually take the exams; at AS 55,000; and A-Level ∼33,0000.

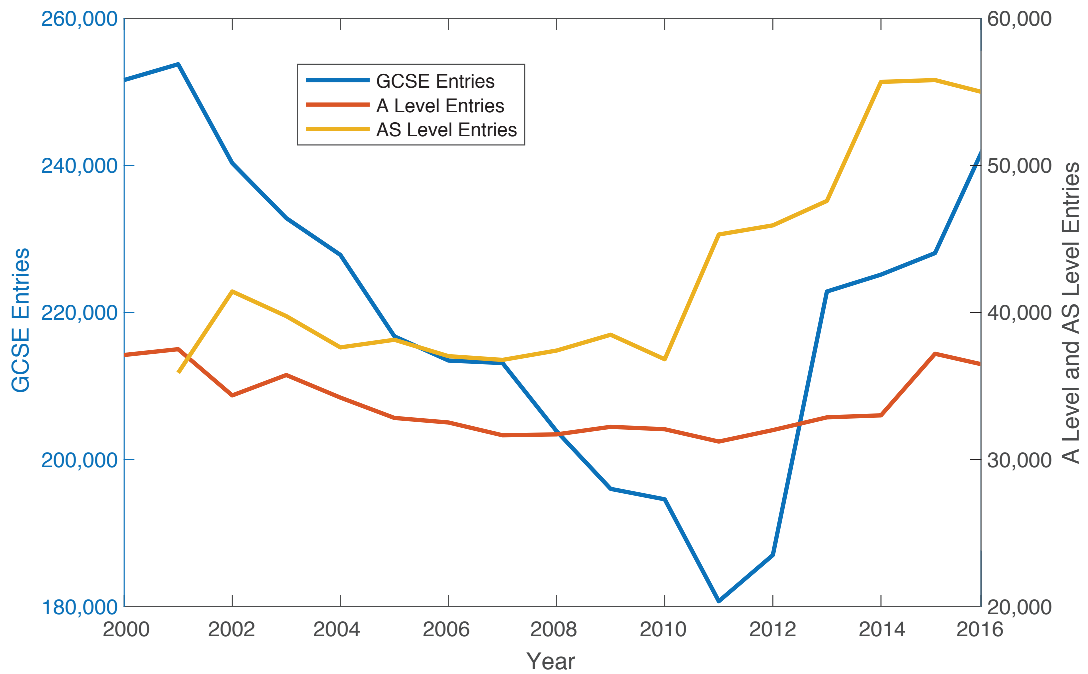

Figure A.1: *GCSE, AS and A-Level entries in geography, 2000–2016 (Source: JCQ).*

Of these, ∼7000 enter HE to study geography each year. Owing to recent policy changes, notably the inclusion of geography in the English Baccalaureate (EBacc), numbers studying the subject at GCSE and A-Level have jumped significantly (17% to 20%) in the last three years. At school, geography is the

A-Level subject with the closest gender balance (just very slightly more males than females; with females overall performing slightly better). Generally, the subject is stronger in independent schools than state schools, and rates of uptake are lowest amongst students of Asian descent. The classroom teaching standards reported by Ofsted for geography are more polarised than for other foundation subjects; with many examples of good practice but equally too much relatively poor practice.

At A-Level significant changes are occurring in content (notably in physical geography), assessment and inclusion of fieldwork. New AS- and A-Level courses are being taught from September 2016. Recognising reduction in the physical geography taught in schools, and fieldwork content, following lobbying by the RGS-IBG and Geographical Association, an A Level Content Advisory Board (ALCAB) was convened, chaired by Professor Martin Evans (Professor of Geomorphology; University of Manchester). Other physical geographers on the panel were Professor Pippa Chapman (University of Leeds), Professor Anthony Long (Durham University) and Dr Rita Gardner (RGS-IBG). The advice published by the group in December 2014 was largely adopted by the Department for Education and has been embedded in the A-Level specifications of the four main examination boards. The intent is to reduce duplication from GCSE, increase 'stretch and challenge', ensure a more equal emphasis on physical and human geography in a common core (50%) curriculum across all examination boards, specify the need for fieldwork and for a teacher assessed independent field-based investigation (worth 20% of the overall mark)[38]. The field-based investigation is a particularly significant achievement given the move in the UK to examinations in most other subjects (including lab-based science subjects). This new curriculum will have important implications for the knowledge, skills and expectations of geography students entering university in 2018.

The two new physical geography core modules at A-Level are on the Water and Carbon Cycles and Landscape Systems. The latter focuses on drylands, coastal or glacial systems; rivers and flooding are a major focus in earlier stages of the curriculum. There is also a stated aim for greater rigour in terms of understanding physical systems and processes and more emphasis on data and data analysis.

Concerns have been expressed by some teachers about their preparedness to deliver some this content, and there is an urgent need for training and new resources. There are real opportunities for physical geographers in higher education to engage in this, with the RGS-IBG and Geographical Association, directly with teachers and through their undergraduate students who will go on to be teachers. Challenges for existing teachers are likely to be compounded by the emerging shortage of specialist geography teachers more generally (formally defined in 2016).

In addition, there are significant changes occurring in post-16 mathematics provision[39]. A new qualification, Core Maths, has been introduced (approved December 2014). This is for students in post-16 education who hold at least a C grade at GCSE level but are not formally studying AS- or A-Level mathematics. The qualification is intended to extend students' mathematical and statistical knowledge, deepen and strengthen existing knowledge, and (importantly) build confidence in using and applying mathematics. The focus, in particular, is on the application of mathematics to solve problems, building skills in mathematical thinking. Students in the social sciences, biology and geography specifically have been identified as the target group for this qualification. Concurrently, departments are being encouraged to signal clearly expectations about mathematical content of their degrees.

In Scotland more concern has been expressed about recent changes and decreases in physical geography content by the Scottish Association of Geography Teachers (SAGT). This has particularly focused on the lack of physical geography in the new Scottish Higher qualification, with implications for the preparation of future intakes to university geography departments where geography is classified as a science and also to the restricted choice of subjects at National 5 (S4) and therefore at Higher and Advanced Higher, which impacts uptake of geography, especially in state schools. In Northern Ireland entries for geography remain popular and the revised curriculum does include physical geography (tectonics, tropical ecosystems, dynamic coastal environments, and climate change, past and present)

[38] https://www.gov.uk/government/publications/gce-as-and-a-level-geography and http://www.geography.org.uk/news/alevelreform/

[39] The Smith Review comments on these and makes recommendations (https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response).

at the advanced level.

The degree of specialism in schools by students in the UK (less so in Scotland) is unusual in an international context. It does mean that students entering university to study geography (through the A-Level route) do so with a small number of subjects studied post-16. There is also a trend that this range of subjects is narrowing, with a concentration on what are termed 'facilitating subjects' (those preferred by Russell Group universities) and the decoupling of AS- and A-Levels[40]. Virtually all of those studying geography at university have a geography qualification ($>$ 99.5% A-Level geography for those who have studied A-Levels). The next most common subjects are biology (24%), mathematics (20%) and then a broad mix of subjects including history, English, psychology, chemistry etc. (based on analysis of 2013 A-Level admissions by the RGS-IBG). Changes in geography A-Level syllabi are seeing a range of environments (desert, coastal and glacial), that had limited inclusion in outgoing syllabi, being introduced for study. While these environments are being used to explore linkages between wider elements of global systems, this may in due course alter the physical geography knowledge base of students entering university to read the subject. In addition, modules on water and carbon cycles also are being taught. This might require or lead in due course to adjustments to first year physical geography university courses.

[40] https://www.gov.uk/government/publications/get-the-facts-gcse-and-a-level-reform/get-the-facts-as-and-a-level-reform

Appendix B Undergraduate Physical Geography Dissertation Prizes

***Table B.1:** RGS-IBG Alfred Steers Prize, 1999–2017**

Year	Recipient	University	Dissertation Title
2000	N. Rosser	Durham	A flume investigation into the influence of rock fragments on scour and deposition characteristics
2001	K. Wilson	Edinburgh	The spatial variability of nitrogen dioxide in Mumbai, India
2003	G. Davis	Edinburgh	Light pollution as an environmental hazard
2004	G. Schumann	Dundee	Application of a degree-day model on a Swiss glacierised catchment to determine snow depth
2008	H. Wright	Oxford	The avifaunal biogeography of the Blackdown Hills, England: A comparative evaluation of incidence functions
2010	J. Jenkinson	Southampton	An exposé of the critically endangered palm Dypsis saintelucei endemic to the littoral forest mosaic of South East Madagascar
2011	F. Hinks	Sheffield	Modification of the urban climate by small parks in Sheffield
2013	W. Rosser	Bristol	Hydrochemical and hydrological profiling of Leverett Glacier, Greenland
2015	C. McKenna	St Andrews	A reconstruction of water mass distributions in the Faroe-Shetland Channel
2016	R. Meunier	Cambridge	Bridging Urban Divides? Clichy-Batignolles Urban Development Project, Paris
2017	A. Henry	Oxford	Dimensions and characteristics of low-level jets in the central-western Sahara during boreal summer

*Awarded by the RGS-IBG and open to submissions across the breadth of geography

***Table B.2:** BSG Marjorie Sweeting Prizes, 2008–2015**

Year	Recipient	University	Dissertation Title
2008	E. Flint	Cambridge	Natural and anthropogenic controls on salt marsh accretion history: the Dee Estuary, NW. England
2008	H. Miller	Edinburgh	What is the estuarine sedimentation of Waiwera River Estuary since the Early Holocene Epoch
2009	A. Lane	Southampton	A study into the extent of variations in channel morphology associated with a geological transition along the River Meon, Hampshire
2009	S. Tyldesley	Sheffield	Balance-velocity modelling of the spatial complexity of Antarctica ice sheet flow
2010	S. Brown	Durham	Using web-based media for assessing the physical nature of landslide hazard and impact on a global scale
2011	C. Checkley	UCL*	An evaluation of wave conditions and coastal deatures around the Isles of Scilly utilising: wave refraction modelling and coastal system mapping
2012	B. Bedford	Edinburgh	To what extent is evidence from the last stadial a proxy for the long-term pattern of glaciation in Scotland?
2013	E. Washington	Durham	Landslide susceptibility and risk along the Mugling-Narayanghat highway, Nepal
2014	B. Chandler	QMUL*	Glacial geomorphology of Ben More Coigach, N W Scottish Highlands, implications for Loch Lomond stadial glaciation and palaeoclimate
2015	H. Mallinson	UCL*	Glacial isostatic adjustment of the British Isles: A study of coastal response in Western Scotland and Southern Wales

*UCL = University College London; QMUL = Queen Mary, University of London

Table B.3: *Quaternary Research Association Prize, 2004–2016*

Year	Recipient	University	Dissertation Title
2004	V. Panizzo	UCL*	Recent environmental change in the Rwenzori Mountains
2005	M. Bullen	RHUL*	The sedimentology of the West Runton Freshwater bed (cromerian sensh stricted type site
2006	No award		
2007	H. Houghton	Nottingham	Evaluation of the evidence for glacopmere deposition at Aber Bach, Northern Pembrokeshire
2007	M. Riding	Lancaster	Are the till fabric indicators of the Lake Devensian diamictons in south-west Cumbria consistent with ice flow indicators or glaciotechtonic deformation?
2008	H. Milne	Aberdeen	Climate of the Loch Lomond stadial in Perthshire and the Cairngorms
2009	M. Grosvenor	Exeter	Palaeoclimatic implications of tephra at a new site within the Menteith moraine of the Loch Lomond Readvance glacier
2010	E. Daniels	St Andrews	A study of the potential of Arctica islandica as a proxy for the oceanic 13C effect
2010	C. Darvill	Exeter	Palaeoenvironmental and climatic reconstruction of Late Devensian and Holocene Change in Skye: a multiproxy approach
2011	R. Smith	Southampton	Surface sediment Chironomidae (Insecta: Diptera) analysis and
2012	C. Frew	Dundee	their potential link to methane content within 30 Alaskan lakes
2013	H. Smith	Oxford	Using species distribution modelling to understand the mid-Holocene
2014	J. Kitchen	Stirling	Hemlock decline in North America
2015	T. Dunn	Sheffield	Greenland Ice Sheet supraglacial lakes: their relationship with bed topography, ice thickness and ice flow velocity
2015	N. Adams	RHUL	A palaeoenvironmental analysis of the early pleistocene siliceous member at Westbury Cave, Somerset, UK
2016	T. Sim	Leeds	The environmental impact of European settlement in Australia: influences on a patterned fen ecosystem

*UCL: University College London; RHUL: Royal Holloway, University of London

Appendix C Employment Outcomes for Geography Graduates

Students who are “Unemployed at time of survey” includes those describing their employment circumstances as “Unemployed and looking for employment, further study or training” or “Due to start a job within the next month”. Physical and geographical sciences (brown) and human geography (green) have amongst the lowest levels of unemployment.

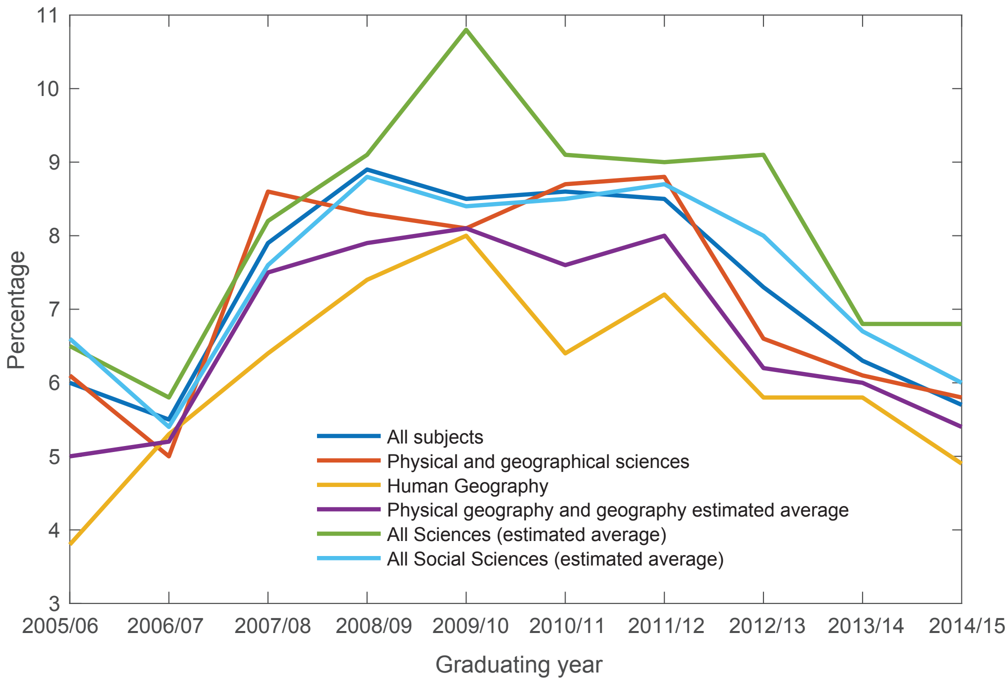

Figure C.1: *Six-month post-graduation unemployment rates. Source: Higher Education Careers Services Unit (HECSU) / Association of Graduate Careers Advisory Services (AGCAS) ‘What Do Graduates Do’ 2006–2015, using HESA Destinations of Leavers from Higher Education (DLHE) survey.*

Appendix D Physical Geography PGR Research Topics, School of Geography at the University of Leeds, 2014/15 Intake

Table D.1: *Research Topics of the 2014/15 Physical Geography PGR Intake in the School of Geography at the University of Leeds*

PhD studentship title	Funding source
Spatial-temporal reconstruction of Amazon flood pulse and dry season length over the past century using tree rings and isotopes of floodplain tree species	Science without Borders
Impacts of REDD+ on ecosystem services provision, management and dependence: a Brazilian case studies comparison	Science without Borders
Geoinformation for spatial planning and risk management	Indonesian Government
Ice cliff, supraglacial pond and water storage dynamics in the Everest region of Nepal	University Research Studentship
Application of remote sensing and GIS for sustainable forest carbon stock monitoring in the Korean Peninsula	Self-funded
The cerrado biome in transition	NERC DTP
A socio-spatial analysis of ecosystem services in England	NERC DTP
Understanding plant-soil feedback effects impacted by peatland fire	NERC CASE
Rainsplash and overland flow erosion processes in blanket peatlands	University of Leeds Chinese Scholarships Council
Probabilistic assessment of geogenic arsenic exposure and attributable health risks	University of Leeds International Research Studentship
Early detection of Himalayan glacial lake development using remote sensing methods	NERC DTP

Appendix E Editorial Groups of UK and US physical geographers

Table E.1: *Editorial position at ISI top 30 'physical geography-based' journals, January 2016*

Rank & Journal		Editor-in-Chief			Associate Editors			Editorial Board		
		Total	UK (geog)	US	Total	UK (geog.)	US	Total	UK	US
1	*Global Ecology and Biogeography*	5	2(1)	1	47	6(2)	11			
2	*Cryophere (EGU)*	5	2(1)	0	32	4(3)	7			
3	*Journal of Biogeography*	5	2(1)	1	49	9(0)	11			
4	*Quaternary Science Reviews*	1	0(0)	0	7	3(3)	0	30	3	8
5	*Landscape Ecology*	1	0(0)	1	1	0(0)	0	63	3	32
6	*Journal of Quaternary Science*	5	2(2)	1				39	15	5
7	*International Journal of Digital Earth*	6	0(0)	1	30	2(0)	8			
8	*Journal of Glaciology*	1	0(0)	0	17	6(5)	5			
9	*ISPRS Journal of Photogrammetry and Remote Sensing*	2	0(0)	1	13	0(0)	2	35	1	7
10	*Landscape and Urban Planning*	2	0(0)	1	4	0(0)	2	47	4	19
11	*IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*	1	0(0)	0	18	0(0)	3			
12	*Earth Surface Processes and Landforms*	1	0(0)	0	7	3(3)	3	40	7	13
13	*Geomorphology*	3	1	1				73	11	22
14	*Global and Planetary Change*	5	0(0)	1				12	1	5
15	*Quaternary Geochronology*	1	0(0)	0	6	2(1)	2	28	5	9
16	*Boreas*	1	0(0)	0	1	0(0)	0	24	6	3
17	*Progress in Physical Geography*	4	2(2)	2	3	2(0)	0	26	9	7
18	*Quaternary Research*	4	0(0)	4	19	2(2)	11	14	1	8
19	*Annals of Glaciology*									
20	*Palaeogeography, Palaeoclimatology, Palaeoecology*	5	0(0)	2				51	9	9
21	*Aeolian Research*	2	0(0)	1	3	6	3			
22	*The Holocene*	1	1(1)	0	10	6(6)	3	28	4	8
23	*Permafrost and Periglacial Processes*	1	1(1)	0	2	0(0)	1	10	0	2
24	*Quaternary International*	1	0(0)	0	5	1(1)	0	50	6	4
25	*GIScience & Remote Sensing*	1	0(0)	0				24	0	20
26	*International Journal of Geographical Information Science*	7	1(1)	1				36	3	18
27	*Photogrammetric Engineering & Remote Sensing*									
28	*Antarctic Science*	5	1(0)	3				19	2	4
29	*Arctic, Antarctic, and Alpine Research*	2	0(0)	2	19	3(3)	12			
30	*Journal of Geographical Sciences*	1	0(0)	0	4	0(0)	0	17	1	3

Table E.2: *Historic UK geography-based editors (REF2014 data with 2 or more entries, [RAE2008])*

Journal	Editor-in-Chief	Associate Editors	Editor*	Editorial Advisory Board
Advances in Environmental Monitoring & Modelling	[1]		[1]	
Aeolian Research		2		
Annals of Glaciology		[2]		
Artic, Antarctic and Alpine Research				2 [1]
Biodiversity and Conservation	[1]	[1]		
Boreas			[1]	[3]
Canadian Journal of Remote Sensing		1		1 [2]
Catena	[1]		1 [1]	1 [4]
Ecohydrology				3 [3]
Ecohydrology and Hydrobiology			[1]	[2]
Ecological Informatics		1		1 [1]
Earth Surface Processes and Landforms	1 [2]	1 [1]	1 [2]	1 [2]
Geology			2	[4]
Geomorphology	[1]	1	1	4 [10]
Global Ecology and Biogeography	[1]	1 [1]		[1]
Global Environmental Change			2	1
Hydrological Processes	1		1 [1]	[1]
Int. J. of Applied Earth Observation and Geoinformation		[1]	[1]	1 [1]
International Journal of Remote Sensing	[1]		[1]	1
International Journal of River Basin Management	[1]			[1]
International Journal of Wildland Fire			1	1 [2]
Journal of Geophysical Research		[3]	4	2 [1]
Journal of Arid Environments		1	[1]	1 [1]
Journal of Biogeography	1 [1]		[1]	[1]
Journal of Coastal Research				1 [2]
Journal of Glaciology			3 [3]	[1]
Journal of Hydrology		[1]	[1]	[3]
Journal of Maps		1		1 [2]
Journal of Palaeolimnology		1		1 [4]
Journal of Quaternary Science	1	[1]	[2]	1 [6]
Landscape Ecology		3		[1]
Marine Geology				[2]
Meteorological Applications	[1]		1	[2]
Nonlinear Processes in Geophysics	[1]		[1]	
PLoS ONE			2	
Progress in Physical Geography			1	1 [2]
Quaternary Geochronology			2 [1]	[1]
Quaternary Science Reviews	[1]		2 [3]	2 [10]
Remote Sensing Letters			1	1
River Research and Applications			1	1
Sedimentary Geology	[1]			[1]
Sedimentology	2 [1]	[2]	[1]	1
The Holocene	[1]		3 [1]	1 [1]
Water Resources Research			1	1
Weather			[1]	1 [2]

*Unspecified