Institution: Middlesex University

Unit of Assessment: Unit of Assessment: 14 – Geography and Environmental Science

1. Unit context and structure Unit context and structure

Our UoA14 undertakes internationally leading research which has a direct impact on policy, practice and society. Within geography and environmental studies, our research is organised within two, internationally-facing research centres: the Flood Hazard Research Centre (FHRC) and the Urban Pollution Research Centre (UPRC) founded in 1970 and 1978, respectively. Increasingly working together to deliver integrated solutions to complex challenges, the FHRC and UPRC consistently deliver impactful research and knowledge exchange activities through active engagement with policy developers, environmental regulators, public and voluntary organisations at national and international levels. 100% of our REF2014 impact case studies were rated 4*/3* and our REF2021 submission builds on and further develops this solid performance.

Our research focuses on the risks and hazards (FHRC) and environmental assessment and resource management (UPRC) aspects of managing urban surface water quality and quantity from multiple perspectives, combining theoretical, methodological, practice and policy-related research on flood risk, diffuse urban pollution mitigation, urban ecosystem services, sustainable remediation technologies and public health and safety risk research. The co-location of these two established research teams within one department (Natural Sciences, within the Faculty of Science and Technology) facilitated the development of inter-disciplinary research approaches, with groups sharing research spaces and support infrastructure leading to, for example, our emerging expertise in urban geography. The success of this approach is evidenced both by our publication record (180 papers in peer review journals; 77% of which include authors from other institutions demonstrating the national and international reputation of and demand for our researchers and 34% are classified interdisciplinary. Since 2014, we have secured £3.3M of competitive funding, enabling us to expand our FTE by 21% (to 18.8FTE enterable), from a total of 25 members of staff together with post-doctoral researchers, 60 Doctoral students and dedicated analytical and IT support teams. Our research environment is strengthened by collaboration with professional practice pathways colleagues, who contribute via their networks e.g. (identification of research needs and dissemination of outputs) as well as through supervision of doctoral students. Over this REF period, the University has continued to invest in laboratory capability, including refitting laboratories in our £36M Hatchcroft Building and purchase of state-of-the analytical equipment (£750k) and supporting software.

Research and impact strategy

Our research and governance structure is established in our Departmental research and impact strategy (2018; renewed every three years; co-chaired by Head of Department and Research and Impact Lead) and aligns with the University Research priorities of strengthening the impact of core areas, exploiting synergies and strengthening internal and external collaboration. A particular highlight of internal collaboration is the recent award of £2.8M covid-response funding from the Department of Health and Social Care (DHSC) to evaluate the use of wastewater monitoring for SARS-CoV-2 as a public health tool within schools and prisons, involving researchers from environmental, biomedical, social and public health spheres. Looking forwards, our department has actively contributed to the development of the University's 2030 strategy, where our research is at the centre of the core theme 'Environment and sustainability'.

Our strategy facilitates the delivery of international-level impactful research through a focus on three key activities:

1. Increase intellectual capital

Evidence of achievement: increase in FTE of 21% and 9 members of staff achieved promotion over this REF period. Mechanisms to support career development include a mentoring strategy between senior, mid-career and junior researchers to ensure and enhance succession. Internal funding (an indicative £2,500 per person per year) is available to support staff in developing new research ideas which lead to grant application/research papers), with opportunities for junior staff



to 'buy out' from teaching time to complete and develop research activities. All staff have access to a staff development fund to enable annual participation at international conferences.

2. Extend our international reach and reputation by enhancing our networking activities

Evidence of achievement: We continue to work with key UK agencies such as the Construction Industry Research and Information Association (CIRIA), the Environment Agency for England, National Resources Wales, Department for the Environment, Food and Rural Affairs, and the Scottish Environmental Protection Agency (see also impact case studies) as well as develop new collaborations with the Natural History Museum, Network Rail, DHSC, the Royal Institution of Chartered Surveyors, non-governmental organisations (e.g. Thames21, Skye and Wester Ross Fisheries Trust), Tesco, Whirlpool, Yorkshire Water and Local Authorities (e.g. Barnet, Enfield, Westminster). Internationally, our success is evident by our lead roles in European research networks and international consortia (e.g. IUPAC, Water Europe, LAND4FLOOD and the NORMAN network). The latter includes our lead role in the development of a SARS-Cov-2 in sewage database to facilitate the rapid, open-access sharing of data.

3. Build capacity for growth through increased funding and good use of existing resources *Evidence of achievement:* we have secured £3.3M of competitive research funding, re-fit laboratories to increase our specialist capabilities (e.g. establishment of a state-of-the art laboratory to determine SARS-CoV-2 in wastewater) and increased our analytical capabilities (investment of £750K in analytical instrumentation). Our laboratory facilities are fully maintained by dedicated analytical and IT support teams.

Moving forwards, our vision 2021-2024 is to develop closer links between social and environmental research teams to undertake fundamental and applied interdisciplinary research and to facilitate the translation of research outputs into practice by working with policymakers in national (e.g. UK Government) and international (e.g. delivery of the UN Sustainable Development Goals) arenas. Our strategy for this is to use the mechanisms identified (above) to focus on specific areas for collaboration including:

- Flood economic assessment and broader assessments of flood risks, particularly in international contexts and to continue to extend the scope of flood impacts considered.
- Continued investigation of the socio-economic consequences of flooding and flood risk, in particular focussing on implications for flood risk governance.
- Contaminants of emerging concern (CECs) our roles in European Working Groups has enabled our research to contribute to the EU water legislation fitness check. Building on its key findings, our research will focus on how to robustly assess the risks CECs pose to receptors and to facilitate its use with national / international policy development.
- Sewage surveillance as a tool to support public health teams in understanding occurrence and behaviour of infectious diseases at a building level.

Progress in these actions will not only increase our impact but also directly contribute to our strategic aims of building further staff capacity, income, and attracting post-graduate students.

Open science and research integrity

We strongly support Open Science initiatives including ORCID registration (all submitted staff are registered), and all publications are green/gold open access. Where possible we make research outputs and tools publicly accessible. Examples of this are tools created as part of EU-funding (e.g. RISCKIT; **Viavattene** and **Priest**) and the UrbanAPP produced by **Juntti** and **Lundy** as part of the ADEPT project. Additionally, high-level depth-damage functions from FHRC's Multi-Coloured Manual are publicly available to communities at risk via a bespoke website. The University has a comprehensive Code of Practice for Research, ensuring the highest standards of research conduct and integrity are fully integrated. All research must be submitted to our independent reviewers and research activities cannot commence until approval is secured. If an application requires more work, the applicant receives detailed written feedback and support to develop understanding of the requirements of ethical research practice. For more complex issues, including human subjects, we follow internationally agreed codes of conducts. In terms of

environmental samples, we are fully compliant with the Defra code of practice (e.g. movement of plants and soil) and the Nagoya Protocol, (for equitable sharing of genetic materials). Our researchers have access to established laboratory methods, and are supported by a dedicated team of well-trained technical tutors ensuring the highest quality observations, and reliable and repeatable results.

Our long-term strategy is to further develop our multidisciplinary expertise and profile nationally and internationally, enabling us to develop innovative proposals for EU, research council and GRF funding as well for governmental organisations and private companies. Indicators to benchmark our progress in achieving these objectives over the next 3 years include:

- Increase and diversify sources of external funding through active networking and consortium building.
- Support and enhance the capacity of mid-career and younger researchers: staff promotion through continuing mentoring (e.g. paper writing, inclusion in research applications and appointment to leadership roles).
- Recruit new research active staff: enabled by the development of a new suite of environmental programmes (strongly linked with Mauritius campus).
- Continue to increase postgraduate research student recruitment and completion through a focus on funding applications that incorporate studentships

Middlesex has prioritised research through investment in research active staff and supporting infrastructure, enabling us to sustain our strong success of research impact apparent in REF2014 (100% of impact was rated as $4^*/3^*$).

2. People

Staffing Strategy: Our staffing strategy is closely aligned to our research strategy, particularly with regard to developing our 'newer to research' staff members and ensuring a successful transition towards a new generation of research leadership. This strategy is informed by the objectives of promoting an inclusive approach to staff development which enhances individual and collective research capacities, and retains research leaders and staff. This has seen the internal promotion of 36% of staff in the intervening REF period. Of note are **Lundy** and **Purchase's** promotion to Professor and Priest's appointment to Associate Professor and Head of the Flood Hazard Research Centre. Additionally, **Viavattene** and **McCarthy** were promoted to Senior Research Fellow and Watt and Jones to Associate Professor. These internal progressions are testament to our strategy for career development, succession planning and strengthening the research leadership from within. This strategy is complemented by the creation of several new appointments since October 2013 at junior and senior levels, to enhance the research excellence of the Unit and in particular grow the environmental research areas of conservation and bioinformatics (**Ropiquet**), environmental genomics (**Timmermans**), environmental risk and microbiology (**Cossu**) and housing and urban studies (**Stewart**).

The UoA collectively has had a low turnover of staff (two non-retirement leavers) in this REF period which has permitted continuity of research relationships and a strong collegiate atmosphere as well as ensuring the sustainability of the research environment. The majority of staff entered (13.6 FTE) are based within the Department of Natural Sciences in the Faculty of Science and Technology, however recognising the breadth of Geography and Environmental Studies and Middlesex University's emphasis on collaborative research, staff entered also include those based in other departments: Department of Design Engineering & Maths (**E. Ball, Shayesteh, Yang**), the School of Law (**Juntti**) and Centre for Work-based Learning (**Weller**).

Also characteristic of the staff strategy is its close alignment with the research culture of the university. The majority of the entries are full-time members of staff, with only three staff on fractional contracts (**Penning-Rowsell**, **D. Ball** and **Watt**), all of whom are moving towards retirement. All are still fully embedded in the research of the unit and contribute to research outputs, the support and mentoring of junior colleagues and supervising research students.



Middlesex University focusses on a well-rounded approach to research, which benefits all students, with research-informed teaching a core focus. Middlesex University's people mission is *"transforming potential into success"* for both students and staff. In 2014, the University undertook an institution-wide staff mapping exercise to ensure staff were aligned in terms of allocated level and development pathways. These pathways comprise either "teaching & research", for those with a significant responsibility for research (returned in our REF submission), or "teaching & professional practice", for those with a key focus on engagement with practice and their professional bodies. All are part of our inclusive research culture; we do not have teaching-only contracts. The need to balance research within the wider academic commitments of staff are recognised and built into the UoA staffing strategy and the workloads of staff. All staff are recognised as contributing to teaching, research and administration, although the balance may vary depending upon other roles. Careful timetabling of teaching provides staff with distinct time in which they are able to research, and the strong collegiate culture within the UoA provides the basis for a robust, flexible and supportive environment (e.g. cover for sabbatical leave, conferences, secondments, etc.)

Post-doctoral Researchers (PDRAs), Research Assistants (RAs) and Visiting Researchers all bring additional vitality and research excellence to UoA14. PDRAs and RAs, employed on specific research projects, play an active role in departmental research; giving research seminars, producing of papers and seeking grant income. On leaving the university some of those employed have continued their academic journey in roles at other universities (Alexander, Owen) and others have moved into practice or public roles (Micou, Pardoe). Furthermore, in this period, **Priest**, **Viavattene and Penning-Rowsell** secured two competitively-funded EU Marie Curie Early Career Research positions as part of the SYSTEM-RISK project (676027), providing the researchers (Cumiskey, Holz) with the resources to work on dedicated research in the socio-economics of flood risk and Lundy was seconded as Guest professor to Lulea Technical University, Sweden.

The support network for teaching and administration has been significantly redeveloped since REF2014. The roles of Departmental Administrators and Programme administrators have been created to assist with administrative requirements of teaching. The Department of Natural Sciences has also appointed six (Senior) Graduate Academic Assistants (SGAA/GAAs) and Associate Lecturers with nine Technical Tutors to assist with teaching roles, in particular in the laboratory environment. This additional resourcing has offered staff greater support with the delivery of teaching and not only impacts on the wellbeing of staff, but also has released time for research-related activities. Furthermore, the appointment of the SGAAs and GAAs, many of whom are also undertaking postgraduate research degrees (MRes or PhD) has added to the vibrancy of the research environment and provides a support and progression route for these junior appointments.

In addition to the administrative support around teaching, research support is available at University level. Staff make full use of the Middlesex University's Research and Knowledge Transfer Office when preparing research grant proposals, supporting staff through project set-up and post-award reporting. Furthermore, the FHRC has a dedicated research administrator (0.8 FTE) funded principally by research income who provides additional research administrative support, mainly for FHRC research, but also to large projects within the UoA (e.g. DHSC funded TERM project).

Staff research development and resources: Effective staff development has been achieved by a structured and inclusive approach which supports all colleagues' development. Staff development occurs in two directions with top-down centralised University resources and courses as well as internal, bespoke development which is more aligned to the staff members' research experience and needs. From the top-down perspective, all university staff have access to a comprehensive staff development programme which can be tailored to their own personal and professional needs. Research-oriented courses include topics such as: writing for publication; preparing funding applications; managing research projects, and ensuring that research has impact beyond academia. Additionally, there are also longer term (up to one year) programmes



(e.g. *Aurora*, *Future Leaders*, *Leading with Excellence Programme; Enabling Manager*) which develop relevant leadership skills; a fifth of UoA staff have participated in one or more of these longer initiatives between 2014 and 2020.

Staff complete a Research Plan, reporting on outputs, research income, engagement with practice, and other research activities and plans to build upon them. Individuals are offered development packages to meet identified needs and the focus is on assistance and mentoring, rather than monitoring. All academic staff meet with professors to discuss research ambitions, set goals, discuss progress, development needs and also to identify and address barriers to their research. This has proved fruitful for the mentoring of more junior staff (hence the high retention rates), the establishment of research collaborations and joint publications and the development of a strong environment, supportive of all researchers. On this basis relevant targets for the coming year are identified and research allowances allocated. The newly introduced Clear Review approach, implemented in 2019 and based on a frequent, continuous process of review and revision of staff objectives, has the potential to improve research potential as barriers to effective research are identified and resolved more quickly and research opportunities maximised. All staff receive dedicated research time and Department and Faculty travel research funds are available for all to attend conferences, which are allocated on a case-by-case basis. New members of staff are also provided with bespoke resources, particularly those developing areas of new research.

Research student support: Research students are integrated fully into our research environment and we strongly value their contribution as part of the research community. They have dedicated open-plan office space to work on campus. Laboratory access during the week and at weekends (pre-COVID) is available for those students who require it for their research, providing a flexible approach to the access of resources for PhD students. Our PhD students are active contributors to the departmental weekly research seminar series, as both invited presenters (providing an opportunity for peer-review) and as participants. Middlesex University doctoral students are supervised by a panel of academics with clear individual and collective responsibilities for assisting the student. Each student has an allocated Director of Studies (DoS) and typically one to two other supervisors. This not only provides the student with the benefit of supervision with different expertise and ensures the availability of a supervisor, but also permits junior staff within the UoA to gain experience and training in supervision under the guidance of a more experienced colleague. Staff new to supervision or examination arrangements attend a structured training programme before being appointed to a supervisory panel. This ensures a high level of understanding of the processes of supervision and Middlesex University's requirements and Research Degree Regulations.

Between mid-2014 and mid-2020, 13 doctoral students completed their studies, with another 15 currently in their writing up period or undertaking revisions post viva and on track to submit or complete by end 2021.

Туре	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	Total
Professional Doctorates	1	0	1	0	0	0	0	2
PhD	1	0	3	3	1	1	2	11
Total	2	0	4	3	1	1	2	13

Awards by year and type

The UoA has been successful in attracting external funding from private companies and students with competitive-scholarships from their home countries or students self-funding. As part of our international focus, staff are also engaged co-supervising doctoral students either internally with staff from other UoAs (currently 36) (e.g. Law, Psychology), but also students based externally to Middlesex University in a range of collaborative scenarios. Staff have co-supervised doctoral students with other UK universities (Garelick), France (Ropiquet, Viavattene), Italy (Viavattene) Germany (Priest, Viavattene), Austria (McCarthy), Sweden and Australia (Lundy), Kazakhstan



(**Jones**) and India (**Purchase**) and alongside visiting PhD students all contribute positively to, and benefit, this collaborative research environment.

Research Students are supported through a newly-revitalised comprehensive Researcher Development Programme. Students are able to access a mix of face-to-face and online workshops covering topics aimed at preparing students for specific PhD milestones (e.g. Planning your Application for Ethics Approval, Preparing for your Viva), research and design oriented (e.g. From research question to design, Issues in Research Design), methodological (e.g. Interpreting and working with data sets.), writing (e.g. Writing a Literature Review, Writing and Editing a Doctoral Thesis) specific skills (e.g. Learning Python, Interview Recording and Transcription), more generic skills (e.g. Publishing in academic journals, Developing a career in academia, Intellectual Property) and for student wellbeing (e.g. Isolation and Alienation). These sessions run multiple times annually allowing students to attend according to their study needs. This flexibility permits the development of a bespoke package of training tailored to each student. Furthermore, there is also the opportunity to follow, as required, a wide range of modules from the taught university provision to supplement knowledge. Student progress is formally monitored by dedicated Research Degrees Administrators working closely with a specified UoA Research Degrees Coordinator (Garelick), supervisory staff and doctoral students to ensure the prompt removal of barriers to effective research. All UoA14 students are expected to participate in all relevant internal research seminars and training workshops, often presenting their work. They also participate and present at the University's annual Research Student Conference which is a great opportunity to obtain, and give, feedback. The majority of FT doctoral students submit within a four year timeframe many with journal publications already published. The environment provides students with excellent training and launches them into successful careers. For example, Cumiskey secured a competitive post-doctoral fellowship from the Japanese Society for the Promotion of Science to continue and extend her research at the University of Kyoto, Thaler is Research fellow at University of Natural Resources and Life Sciences, Vienna, post-graduation Tuckwell joined the British Antarctic Survey as an analytical chemist and Popoola is a Public Science Engagement Officer at the Wellcome Trust.

Equality and diversity

Staff diversity inclusion and equality of opportunity for research:

Middlesex University is committed to ensuring staff diversity and robust arrangements exist for ensuring equality of opportunity. University-level equality and diversity policies are implemented and all staff are required to undertake development training in this area. Middlesex University was the first UK university to receive Corporate Gold/Embedded Charter Mark from UK Investor in Equality & Diversity. UoA14 closely aligns with the University's EDI mission and supports is delivery. Overall, we are committed to a non-discriminatory approach and provide equal opportunity for employment and advancement for all of our staff within the UoA.

We have committed time and resources to ensure we benefit from a diverse leadership within our staff and committees and have a positive gender balance. 67% of professors within the UoA are female (considerably higher than the AdvanceHE 2020 sector average of 26.7%) and 17% are from BAME backgrounds, above the 10.4% AdvanceHE average for BAME professors. This highlights that policies and practices to support internal female and BAME progression to the highest levels is working. We strengthened our research leadership pipeline by creating and supporting policies and initiatives that foster leadership that reflects the diversity of our staff. We require all staff to complete training on intentional and unconscious bias prior to involvement in the process of hiring and promotion.

The research environment is enriched by the experience and expertise from our large contingent of international staff (non-UK nationality); which comprises half of the UoA staff submitted. We respect and value diverse life experiences and heritages and ensure that all voices are valued and heard; this supports research addressing global problems and the avoidance of UK-centric thinking. We created a diversity and inclusion network where research groups engaged staff at all levels in the supervision of research students (e.g. **Purchase** mentoring **Wildeboer** and **Cossu**)



and knowledge exchange to promote EDI awareness. Our research students are also highly diverse, 62% of completed doctoral students are female, with 50% of completed and 61% of current doctoral students from BAME backgrounds (compared to 45.4% and 18.5% respectively for the 2020 Advanced HE SET sector average for research postgraduates). We offer formal publication advice to early career researchers who are identified as first author in collaborative work they lead. Where an undergraduate/Masters' research project is of publishable quality, they will also do so as first author (e.g. Legall, Kett and Timmermans, 2016; Lekesyte, Kett and Timmermans, 2018). University procedures support and protect research students from disadvantage. For example, up to 12 month extensions and/or interruption to studies can be applied for by students who have suffered from significant disruption (e.g. due to ill health or other circumstances, such as the COVID-19 pandemic).

Provisions and clear and robust policies exist across the university for flexible working to accommodate family, health or other circumstances, as well as opportunities to reintegrate staff on their return. Family-friendly policies exist across university functions including an on-site nursery for staff and students. All university staff with caring responsibilities can input these commitments into the timetabling process to avoid times which impinge on these obligations. Furthermore, staff development opportunities are scheduled with childcare responsibilities in mind, offering times which ensure availability of access.

Equality, diversity and inclusion in the REF submission:

Our commitment to EDI is reflected in our REF submission. 84% of staff have been submitted; of those not entered, three are on professional practice pathways, with the remaining one member of staff member not eligible (as below 0.2 FTE). There is almost a complete gender balance with those submitted being 52% male and 48% female; a more inclusive division than the AdvanceHE 2020 sector subject-area (Geography, Environmental Studies) benchmark of 59.9:40.1%. Gender distribution of submitted outputs (47% female) is also near gender representative. Additionally, both of the UoA14 ICS were led by women. 14% of submitted staff are from BAME backgrounds (above the AdvanceHE 2020 average for Geography of 11.8%) with their selected outputs contributing 11% of the total number of outputs.

The selection of publication outputs was conducted by a UoA Working group composed of five members. It was led by co-coordinators (a Professor and Associate Professor) appointed by Faculty following a competitive process, in addition to another Professor (promoted from Associate Professor during the REF preparations), and two mid-career researchers; one of whom acted as an independent and is entered into another UoA. Four members of this group were female, one was BAME and two white European. All undertook specific REF-related *Unconscious Bias* training and adhered to the selection principles and specific EDI guidance provided by the University's REF Equality and Diversity Panel.

The selection process for outputs was transparent and decision criteria identified and published. The selection of papers followed a series of steps: (1) Staff undertook an initial review and self-ranking of their papers based on the REF panel criteria (supported by more experienced colleagues where necessary). (2) All papers (including those from former staff members) were reviewed and ranked independently by at least two of the working group. Internal peer-review was considered appropriate due to the wide subject-area scope and the incomparability of metrics (such as impact factors) between areas. (3) The staff self-ranked and UoA working group scores were combined to firstly assign the top-ranked paper to each staff member and secondly to allocate other papers into ranked groups. (4) Papers in the top two groups (e.g. the highest scoring) were entered (c. 89% of outputs). (5) Those in the next grouping were re-reviewed and discussed by all working group members and final selections were made on the basis of (a) alignment to scope of geography and environmental studies, and (b) significance as demonstrated by policy or societal relevance, high citation-levels or outputs in high ranking journals. ICSs were chosen based on the strength of their documented impact and underlying research base.

3. Income, infrastructure and facilities



Research Income: The research environment has enabled us to maintain our successful track record of attracting competitive research income. Between mid-2013 and mid-2020 £3.3M in research income was awarded; an average of c. £470K per year or £176K per FTE. Similar to the total funding reported in REF2014, this indicates the maintenance of income set against an increasingly competitive research environment. Project income has been awarded from a range of sources including: UKRI, European, government departments and other organisations. In particular, applied, impact-focused projects are a key strength. Research income generation is led by individuals and UoA Research Centres (e.g. FHRC, UPRC), but is strongly supported by the centralised Middlesex University *Research and Knowledge Transfer Office* (RKTO). The RKTO ensures all staff are made aware of funding opportunities, assists the application process and provides high quality post-award support.

Collaborative research and the maintenance of long-standing relationships is another important feature of our research with income being part of wider research projects totalling £32.6 million. This underlines the reputation and research experience that UoA14 researchers contribute. Research projects are often interdisciplinary and focus on answering scientific issues with direct relevance to society. Research projects have included a wide range of collaborative partners with a total of 163 different organisations across 43 countries (of which 67% were universities/research institutes, 12% from the private sector and 9% government/public-sector organisations). Internal collaboration is also key to income generation with staff often bidding for funding cross-departmentally. Furthermore, the income generation strategy also aligns to the research mentoring ethos with collaborations developed between more and less experienced researchers to widen participation in funded research. All applications are discussed by UoA senior colleagues and are internally reviewed; providing a demand and quality control mechanism.

Of particular importance between mid-2013 to mid-2020 is the award of competitive European research income principally in the areas of flood and water quality management. High-esteem funding has been awarded from EU FP7 projects (including, THESEUS: Grant agreement no. 244104; EPI-Water: 265213; RISC-KIT: 603458; STAR-FLOOD: 793558; WeSenselt: 308429) and latterly Horizon 2020 projects (SYSTEM-RISK: 676027) and CEDR-funded PROPER (31131229).

Priest and now-retired (**Tapsell**, **Green**) won an €870K EU FP7 grant to investigate institutional settings in flood risk management. Part of a wider consortium of six EU countries the STAR-FLOOD project, *Strengthening And Redesigning European FLOOD risk practices* (€5.4M), analysed the effectiveness and legitimacy of flood risk management for delivering societal resilience. Following on in this area, FHRC won a competitively-awarded Environment Agency R&D project (£89k) Evaluating the effectiveness of flood risk governance which and has subsequently be re-commissioned to undertake additional funded work to provide practical tools to embed governance findings into practice in England and Wales.

UoA14 staff (**Viavattene**, **Priest**) were part of a EU FP7 consortium (2013-2017) awarded a grant totalling €7.65m entitled *Resilience-Increasing Strategies for Coasts – toolkit* (RISC-KIT); €606K was awarded to MU. The project focused on producing open-source and ready-to-use methods, tools and management approaches to reduce risk and increase resilience to low-frequency, high-impact hydro-meteorological events. **Viavattene** and **Priest** focussed on improved methods for regional scale vulnerability and risk assessment; a scale often overlooked but essential for efficiency of resource allocation (see also impact case).

McCarthy and **Viavattene** were key researchers of the €6.9m EU FP7 consortium *WeSenselt: Citizen Observatory of Water* Project (with MU receiving €377K) which brought together innovative low cost sensor systems, social networks and mobile devices to develop local 'citizen observatories' for flood risk management. They evaluated whether citizen science can encourage public (and wider) stakeholder participation and leads to more informed decision making.

Priest, **Viavattene** and **McCarthy** were awarded €547K from the €3.89m H2020 SYSTEM-RISK project, a prestigious Marie-Skłodowska-Curie European Training Network developing and

implementing a systems approach for large-scale flood risk assessment. Two Early Stage Researchers were funded for three years to evaluate the interconnections and interdependencies between flood management interventions and to investigate the indirect impacts of floods with a focus on businesses and supply chains.

Lundy secured €179k (from a total of €516K) from the Conference of European Directors of Roads (CEDR) for the PROPER (*Runoff Pollution Management* and Mitigation of Environmental Risks) Project. In collaboration with partners from seven European countries, the project improved the state-of-the-art understanding of the impacts of road runoff on receiving waters, assessed the efficacy of sustainable treatment systems and developed prediction tools for use by stakeholders to mitigate negative impacts.

A series of projects (FLOOD-CBA: ECHO/SUB/2012/638445; ECOSHAZ: ECHO/SUB/2014/693711; FLOOD-CBA2: ECHO/SUB/2015/713849/PREV32 and FLORIS: 826561) with income totally €508K (total project values €2.2million) were awarded from EU DG-ECHO between 2013 and 2019. These all involved end-user partners and informed Civil Protection and Humanitarian Aid Operations about flood risk assessment and management and better improved the flood preparation and response of local authorities in 10 European countries.

Many of these aforementioned projects have built on the success of European research projects and networks established since REF2014 and before. They have built on the well-established international reputation of the FHRC and UPRC, in particular, and their strong integration into academic, policy and practitioner networks. In turn, this has raised the research profile of the University as an international leader in flood and water management.

National-level funding sources are also important to UoA14's research profile and projects designed to have a more immediate impact on policy and practice. These include long-standing research relationships and income generation from Scottish Environment Protection Agency (SEPA), the Environment Agency (EA), Welsh Government, Department for International Development (DFID) and National Institute for Health Research (NIHR). Since mid-2013, 22 projects have been undertaken for, or in conjunction with, UK government organisations, principally concerning flood risk management, sustainable drainage and green infrastructure with income totalling over £630K.

Retired FHRC colleagues (**Sultana**, **Thompson**) received total funding of £568K from the CoCooN programme of NWO (Netherlands Organisation for Scientific Research) to lead a project empowering communities to better manage their natural resources. The CALCNR: *'Community based Adaptive Learning in management of Conflicts and Natural Resources in Bangladesh and Nepal*' involved participatory action research in 70 sites with local community-based organisations, mainly in Bangladesh floodplains, and in community forests and hill areas of Nepal.

There is also continued momentum in research income with an additional c. £1M funds in ongoing UoA14 research projects; highlighting the continued trajectory of competitive research income. For instance, this figure includes DHSC TERM (*School wasTEwater-based epidemiological suRveillance system*) Project. This £2.8M project led by MU (UoA14 Co-I's Lundy, Garelick, Wildeboer, Priest) is looking for traces of SARS-CoV-2 virus in the wastewater of schools and prisons to establish whether this could provide a useful 'early warning' system of infection levels and provide new evidence on the safety of school reopening.

In addition to the reported grant income (REF4b), Continuing Professional Development (CPD) programmes continue to bring additional income and is a critical pathway from research to impact. This includes c. £70K from the NEBOSH programme, c. £174K from FHRC flood training courses and since 2019, £60K from CPD training in *Advanced Private Sector Housing Regulation* (see Section 4).

Infrastructures and Facilities: Middlesex University has continued to consolidate and expand its resources within the Hendon Campus, a process started in 2008 and continuing throughout this REF period; investing £250M since the mid-2000s.

Around £12.7M has been invested in the current period (between 2013 and 2020) specifically to support research with a further £35.3M in dual use investments; from which researchers and students both benefit. This has been used to create one of London's most impressive and largest HE facilities, providing an environment conducive to both research and teaching.

UoA14 researchers are served by high quality and state-of-the-art facilities. They benefit from access to specialist infrastructure housed in our £36M Hatchcroft building and laboratories (opened in 2008). The building is the home of world-class science research at Middlesex University. In particular, staff and research students have access to State-of-the-Art analytical suites (for organic and inorganic analysis) as well as molecular, bioengineering, cellular pathology, oncology and Class II microbiological laboratories. Laboratory resources are overseen and maintained by a team of specialist technicians and a dedicated Technical Manager. Researchers therefore have direct access to a wide range of cutting-edge mass spectrometry and analytical facilities to analyse biotic and abiotic samples, including those obtained from environmental sampling. Instruments that are available include guardrupole-orbitrap mass spectrometry for the measurement of proteins and small molecules, liquid chromatography (LC)-mass spectrometry (MS), LC-MS/MS, ion trap time of flight (ToF)-MS, triple guadrupole-MS, matrix-assisted laser desorption/ionization-MALDI-ToF-MS for the identification of bacteria and antibiotic resistance related products, gas chromatography-MS and flame ionisation detection for the detection of environmental pollutants, inductively coupled plasma optical emission spectroscopy to measure elements including heavy metals, and MS and graphite and flame atomic emission spectrometry (equipped with a hydride generator) for the detection of trace elements. The advanced analytical facilities and research environment have supported a wide range of intra- and interdisciplinary research underpinning 19% of the submitted outputs. For example, in measuring contaminants of emerging concern within a range of environmental compartments, studying the impact of the pollutants on biota at cellular and proteomic levels and evaluating the efficacy of various sustainable remediation technologies.

UoA14 has built expertise in the emerging fields of evolutionary, ecological, and environmental genomics. To support research within these areas investments in Next-Generation Sequencing technology were made and several NanoPore devices and an Illumina sequencer acquired. These sequencers allow high throughput and/or real time analyses of, for example, environmental DNA for biodiversity assessment or the characterisation of bacterial communities for antibiotic resistance genes. The equipment has stimulated interdisciplinary research, with members of UoA14 now collaborating directly with Biomedical Scientists and Microbiologists (e.g. £2.8M DHSC-funded TERM project). To ensure high-quality data is obtained, equipment for nucleic acid quantitation and quality control is available. This includes an Agilent TapeStation, Qubit fluorometer and NanoDrop spectrophotometer. Computation resources (Linux servers) are available for data analyses. These servers are maintained by a dedicated Server Support Technician. There is also shared access to a high-performance LightCycler real-time PCR system. The running costs of these laboratories are met through a combination of dedicated research funding and ring-fenced University funding.

Staff and research students all have dedicated office space, equipment and administrative support, some provided at a Departmental or Faculty level and others (e.g. RKTO, legal and IPR advice, doctoral support) provided centrally. For example, UoA staff have benefitted from the over £7.2million spent on upgrading staff computers between 2013 and 2020. Our largest research centre, FHRC, has also relocated into new office space within this REF period.

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

The impact of our research is evident at both national and international levels with a strong contribution to academia (for research; see outputs) and direct links to policy support, changes in practice and which impact directly and indirectly on society (see impact case studies). Between



2013 and 2020, UoA14 staff have collaborated with thousands of researchers, policymakers, environmental protection agencies and practitioners from 163 organisations located in 43 countries over five continents. 77% of our c. 180 journal research outputs were collaborative of which 64% are with international partners. This level of networking has been directly supported by our staff development programme which supports conference attendance and our mentoring programme encouraging senior and junior colleagues to work together on emerging initiatives. Collaboration with colleagues on professional pathways has also played a key role in developing closer links and further impact with professional bodies and sectoral trade associations (e.g. IOSH, CIRIA).

Contribution to the research base, economy and society: Members of the unit have long lasting international collaborations which have led to major projects (see also section 3) with colleagues in the unit in a leading or co-leading role (see Table 1). We collaborate with many national universities (e.g. Bath, Cranfield, Cambridge, Imperial, Oxford, Sheffield, UCL) and international institutions. We also work closely with academics in emerging research contexts such as Central Asia, Eastern Europe and Latin America, contributing significantly to research capability-building through research collaboration, in line with our mission of extending, synthesising and considering knowledge as a public (shared) good.

PI/Co-I	Partners	Funder	Project name	
Priest, Tapsell & Green	Belgium, France, Netherlands, Sweden, Poland	EU FP7	STARFLOOD	
McCarthy & Viavattene	France, Italy, Poland, Netherlands, Switzerland, Spain, UK (Sheffield)	EU FP7	WeSenseIT	
Lundy, Garelick, Jones, Watt and Purchase	Spain, Germany, Cyprus, Kazakhstan	EU TEMPUS	I-WEB	
Viavattene & Priest	Belgium, Bulgaria, Germany, Italy, Netherlands, Portugal, Spain, Sweden, UK (Cambridge)	EU FP7	RISC-KIT	
Priest, Viavattene & McCarthy	Austria, Germany, Netherlands, Italy, UK (Bristol, HR Wallingford),	EU Horizon 2020	SYSTEM RISK	
Juntti & Lundy	Brazil	UKRI-CONFAP	ADEPT	
Lundy & Revitt	Denmark, Netherlands, Portugal, Sweden, Czech Republic, Slovenia	CEDR	PROPER	
Lundy & Priest	UK (Bath, Centre for Ecology and Hydrology, Cranfield, Joint Biosecurity Centre)	NHS Track and Trace	TERM	
Penning-Rowsell	Germany, Greece, Spain, Portugal, Romania	EU DG ECHO	Flood-CBA	
Penning-Rowsell	Greece, Spain, Poland, Italy	EU DG ECHO	ECOSHAZ	
Penning-Rowsell	Greece, Portugal, Spain	EU DG ECHO	Flood-CBA-2	

Table 1. Major projects in which MDX takes a lead role together with partner countries.



McCarthy, Viavattene &	Albania, Bosnia and	EU DG ECHO	FLORIS
Priest	Herzegovina, Italy		

Other collaborative projects where UoA colleagues play a key role (i.e. as chairs or named leads) include the EU NEREUS, LAND4FLOOD and NOTICE Cost Actions, Water Europe, the NORMAN network, the EU sewage surveillance feasibility study, Biocementation (Network Rail), Environmental and Health Challenges of e-waste (IUPAC) and Private landlords in England (ESRC).

Professional associations and other bodies/organisations

Indicative our strategy towards applied research, where we have a strong track record, our staff impact numerous national and international professional associations. Internationally, for example, Garelick is President of the Chemistry and the Environment division and Purchase Co-Chair of Chemical and Biophysical Processes in the Environment sub-committee of the International Union of Pure and Applied Chemistry (IUPAC) and both play a lead role in a project with the Organisation for the Prohibition of Chemical Weapons. Lundy was scientific and technical advisor to the European Commission on water reuse (2018-2020), is UK representative on the IWA/IAHR Joint Committee for Urban Drainage and was a member of the BSI mirror panel contributing the development of the ISO urban water management standards. Nationally, Purchase is an executive member of the Committee of Heads of Environmental Science and member of the Policy Subcommittee of the Society for Applied Microbiology, and as such contributes to statutory consultations on a number of environmental research, practice and policy issues. Lundy was also a corresponding member of the academic panel supporting revision of the CIRIA Sustainable urban Drainage Systems (SUDS) manual. Priest, McCarthy and Penning-Rowsell are members of the Environment Agency's Thematic Advisory Groups on Flood Incident Management and Modelling, Assets Management and Policy, Strategy and Innovation, respectively as well as being invited experts on the revision of the National Flood and Coastal Erosion Risk management Strategy for England. D. Ball is a Fellow of the Institute of Physics, Charted Fellow of the Institute of Occupational Safety and Health and member of the Society of Expert Witnesses. He was also chair of the Play Safety Forum. Kett is a Fellow of the Linnaean Society, secretary of its London Freshwater Group and member of the Institute of Fisheries Management. Stewart is a member of Chartered Institute of Environmental Health Housing Panel, Associate Member of the Chartered Institute of Housing, Fellow of the Royal Society of Health and co-chair of the London Public Health and Housing Network. McCarthy is a member of the Institute of Civil Engineers and the Institute of Civil Protection and Emergency Management. Watt and D. Ball (Chair of the Scientific Committee) were members of the Collaboration to explore new avenues to improve Public Understanding and management of Risk (CAPUR). Timmermans is Scientific Associate of the Natural History Museum. Involving academia-industry R&D partners (e.g. natural and environmental sciences, engineering innovation and management, ecoentrepreneurship, global business strategy), Yang works with private companies in the Architecture, Engineering, Construction and Operations (AECO) sectors to verify and validate the collective impacts from net zero operational carbon impacts of buildings. In partnership with the Charter Institution of Building Service Engineers (CIBSE), Yang also supported development of the Research Roadmap for the W098 Working Commission on Intelligent and Responsive Building for The International Council for Research and Innovation in Building and Construction (CIB).

In addition to our impact case studies, many of our research outputs and projects have had a direct impact on **policy**. For example, the EU STARFLOOD project results (**Priest**) were used in the evidence-base for UK government *National Flood Resilience Review* 2016 and informed the commission of a joint Environment Agency/Welsh Government Project *Understanding the Effectiveness of Flood and Coastal Erosion Risk Governance* (competitively won by **Priest**) to adopt key findings and assess limitations of the current English and Welsh systems; the lessons of which are currently being implemented in flood risk management practice. Work undertaken for the Scottish Environment Protection Agency (SEPA) allowed **Viavattene** to input FHRC's State-of-the-Art research on flood risk assessment directly into the Scottish National Flood Risk Assessment 2018, enabling SEPA to meet the requirements of the Flood Risk Management (Scotland) Act 2009 and providing a key tool for Scottish flood risk decision-making. **Viavattene**



and **Priest**, in research for the Environment Agency, identified a methodology and data which allows the consideration of mental health impacts in flood risk decision-making which was implemented into policy in early 2021. UoA14 staff have also provided expert advice to the Parliamentary Office of Science and Technology's Research Briefings on Health in Private Rented Housing (**Stewart**), Chemical Weapons (**Purchase**) and the use of wastewater monitoring to detect SARS-CoV-2, (**Lundy, Garelick, Wildeboer**) and acted as expert witness in 60 legal cases on risk management (**D. Ball**).

Continued Professional Development activities are key mechanisms for our research to directly impact professionals, their practice and wider society. Examples include, the NEBOSH (National Examination Board in Occupational Safety and Health) programme which since 2015 has trained almost 80 health and safety professionals. Since REF2014 FHRC staff (**McCarthy, Viavattene**) have delivered 27 courses (e.g. Introduction to Flood Benefits Appraisal, Flood Management Benefits: A Better Appraisal in Less Time) training 499 flood risk management professionals. From 2019 Stewart has provided research-led and evidence-based training to over 60 housing officers from local authorities and the private sector. The only training of its kind, it attract participants from across the UK. Importantly, CPD courses are multi-beneficial as well as providing opportunities for our research to influence practice, they offer networking opportunities with practitioners, help identify future research needs and lead to successful research collaborations; particularly where consortia require end-user partners.

Our research has also directly impacted **society and communities.** For example, the EU-funded WeSenselT project (**McCarthy**, **Viavattene**) provided sustained engagement with communities in Doncaster UK over four years and initiated localised decision-making about flood risk management. The communities voiced their appreciation of such sustained engagement by the research team who attend to and incorporated their local concerns. Research examining approaches to creating local impact-based flood warning messages (**McCarthy, Priest**) is being utilised by the Environment Agency who are currently undertaking a national staged roll-out of the recommended changes. This is leading to communities receiving more tailored and context-specific flood messaging. Research by **D. Ball** included a review of COVID-19 and its consequences for children's play and health and was subsequently used to promote good play practice in each of the four nations. Findings by **Lundy, Revitt** and **Ellis** are identified as "directly (contributing) to more and better outcomes in enhancing surface water quality in Wales" (see impact case study).

Engagement with editorial and academic review activities and outreach

Editorial activities of UoA14 staff - as Editor, Associate Editor or Guest Editor - include Biodiversity Data Journal, Coastal Engineering, EC Bacteriology and Virology Research, Environmental Geochemistry and Health, Environmental Hazards, Environmental Science and Pollution Research, Evolutionary Ecology, Frontiers in Earth Science, International Journal of Pure and Applied Zoology, Journal of Flood Risk Management, Journal of Bacteriology and Mycology, Water Security and Water. Our staff continue to, review grant applications for national (e.g. UKRI Future Leaders Fellowships; EPSRC, NERC) and international (e.g. Danish Research Council, Canada, Newton) funders. Mid-2013 to mid-2020 UoA14 staff have co-organised 24 conference sessions, workshops and working group meetings within the annual conferences of e.g. AAG, RGS-IBG and ICUD. This includes the presentation of c. 110 conference papers of which 28% were invited keynotes. In relation to wider outreach activities, the unit has successfully delivered sessions at a range of national community science festivals including New Scientist Live (2016 -2019), SMASHfest UK (2017 - 2019) and British Science Week (2019), as well as successfully leading a UK laboratory team to a silver medal at the World Skills Fair held in Kazan Russia in 2019; providing support and development for students in primary and secondary education.

Summary

The interdisciplinary, applied nature of Geography and Environment studies research activity detailed above provides clear evidence of our impactful research and knowledge exchange activities. Since REF2014, we have continued to undertake internationally - leading research which has - through our extensive national and international networks – directly informed policy



development and underpinned changes in practice. Our strategies to support and our investment in staff and infrastructure across this current REF period, ongoing planning for the next REF period, as well as continued staff development, will enable us to continue this strong, upward trajectory.