

Institution: University of the West of England, Bristol

Unit of assessment: 13 Architecture, Built Environment and Planning

Section 1. Unit context and structure, research and impact strategy

Context and structure

Architecture, Built Environment and Planning research at UWE is carried out by a large interdisciplinary research grouping with some sixty-eight staff, external grant-funded research income averaging £2m per annum over the REF period and a vibrant culture of collaborative, challenge-based research with impact.

Research activity submitted under Unit 13 is focused in five University Research Centres:

- Air Quality Management
- Transport and Society
- Water, Communities and Resilience
- Sustainable Planning and Environments
- Architecture and the Built Environment

The five Centres mainly map onto the Department of Architecture and the Built Environment (ABE) and the Department of Geography and Environmental Management (GEM) in the University's Faculty of Environment and Technology. Distinctive in focus, the five Research Centres share a common commitment to the holistic, collaborative and interdisciplinary approach needed to understand, transform and manage our built and natural environments to meet the challenges of the 21st Century.

Air Quality Management Resource Centre (AQMRC)

Professor **Hayes** (Director), Professor **Longhurst, Barnes, De Vito, Williams, B.**

The Air Quality Management Resource Centre operates at the interface between air quality science and policy, concentrating on the experiences and challenges of stakeholders and practitioners in the field of air quality and carbon management. Research addresses air quality management, the policy context and the development of tools to enhance AQM and outcomes. Under the theme of air pollution and citizens (**Hayes, Barnes, De Vito**), the focus is on relationships between air pollution, health and social-economic status to address impacts on citizen health and well-being alongside more equitable policy implementation. Shifting from a techno-centric narrative around AQM to a more citizen-focused, social-practice approach creates a new awareness of the role of citizen behaviour in the generation of air pollution, giving citizens greater ownership and advocacy around pollution challenges and solutions (**Hayes, Chatterton, Longhurst**). AQMRC promotes a public health-led approach to air quality management, identifying the impact of citizen behaviour on reaching our carbon reduction commitments and generating independent advice for cities on climate mitigation and adaptation (**Longhurst, De Vito**). Other work has focused on improved understanding of emerging pollutants such as ammonia and bioaerosols (**Hayes, Williams**) to advice on better regulation for public health and ecosystem protection for regulatory authorities such as the Environment Agency (EA).

Centre for Transport and Society (CTS)

Professor **Parkhurst** (Director), Professor **Lyons, Parkin, Chatterjee, Clark, Clayton, Crawford, Jain, Melia, Paddeu, Ricci, Shergold.**

The Centre for Transport and Society is one of the largest transport research centres in the UK, recognised internationally as a centre of excellence on mobility, travel behaviour, transport policy analysis and technological change in the transport sector. The Centre aims to improve and promote understanding of linkages between lifestyles and personal travel in the context of social, political and technological change. CTS is at the forefront, globally, of critical assessments of societal change, technology and mobility futures (**Chatterjee, Lyons, Paddeu**), influencing both research and policy agendas. As the transport system evolves, CTS contributes to new understandings of the social impacts of transport and mobility for different population groups (**Chatterjee, Clayton,**

Jain, Lyons, Parkhurst, Shergold). Through projects funded by ESRC, CTS has continued to advance understanding of travel behaviour, lifestyles and the life course and in particular has developed new theoretical perspectives and evidence on behavioural change (**Chatterjee, Clark, Crawford, Jain**). CTS has collaborated with public sector, third sector and industry partners to trial and evaluate sustainable mobility policies and solutions (**Clayton, Melia, Parkhurst, Parkin, Ricci**). Over the REF period, it has also evolved its research remit for transport infrastructure and design and has increasingly contributed to safer road design for cycle traffic, while also looking ahead to future road use with an expanding portfolio of collaborative projects on the design of Connected Autonomous Vehicles.

The Centre for Water, Communities and Resilience (CWCR)

Professor **McEwen** (Director), Professor **Staddon, Bell, Chatzirodou, Cole, Everard, Gopinath, Horswell, Mol, Mourne, Quinn, Wanke, Williams S-J**.

The Centre for Water, Communities and Resilience promotes world class, interdisciplinary research into extreme weather and water risk, vulnerabilities and what makes communities resilient. Its distinctiveness lies in an innovative interdisciplinarity, strong community focus and creative participatory methods for co-production with diverse stakeholders. CWCR explores research at the intersections of four themes: i) security, policy and governance, ii) water/earth science and engineering, iii) community/stakeholder development, vulnerability and resilience, and iv) representation, perception and behaviour. Research has delivered new conceptual framings, new understandings of evidence to support decision-making and creative tools for knowledge exchange. The two main strands of work are; i) community resilience to changing and extreme weather risk, particularly floods and drought, critical infrastructure and extreme weather events (**McEwen, Quinn, Horswell, Mol, Bell, Williams, Gopinath**), and ii), the impacts of household water insecurity on human well-being and ecosystems, including gendered impacts of water insecurity, sustainable off-grid drinking water in the Global South, community-based groundwater and rainwater harvesting, and data-driven approaches to water demand management (**Staddon, Everard, Wanke, Chatzirodou, Cole**).

Centre for Sustainable Planning and Environments (SPE)

Sinnett (Director), Professor **Boddy**, Professor **Atkinson, Buser, Foroughmand Araabi, Hall, Hickman, Hoyle, Ludlow, McClymont, Tallon**.

The Centre for Sustainable Planning and Environments aims to develop understanding of how to achieve places that are environmentally sustainable, socially just and economically competitive. Research themes include; planning theory, policy and practice; sustainable urban environments; governance of place; and smart cities. SPE is also home to the cross-faculty World Health Organisation-accredited *Collaborating Centre for Healthy Urban Environments*. This coordinates work under the cross-cutting themes of healthy urban environments and has members from disciplines across the University. SPE has a portfolio of funding from sources including UKRI, European Commission, Innovate UK and Wellcome Trust. It contributes directly to planning policy and practice, including for the Royal Town Planning Institute, National Infrastructure Commission, Power to Change, CPRE (formerly Campaign to Protect Rural England) and Public Health England (PHE). Research has focused on contemporary issues in planning including soft densification, cemetery planning, green infrastructure, community-led housing, informal development, urban regeneration, European spatial policy and the quality of place (**Hickman, McClymont, Sheppard, Sinnett, Foroughmand Araabi, Ludlow, Atkinson**). SPE research on governance of place has focused on strategic planning, governance and localism (**Hickman, Boddy, Hall**), and on communities engaged in cultural and environmental activism (**Hall, Buser, Atkinson**).

Centre for Architecture and Built Environment Research (CABER)

Professor **Lamond** (Co-Director) Professor **Mahdjoubi** (Co-Director) Professor **Gething**, Professor **Olomolaiye, Adkins, Appleby, Archila-Santos, Badarnah, Booth, Burch, Chatzimichali, Deza, Dragojlovic-Oliveira, Everett, Lavaf Pour, Mahamadu, Mason, Mawle, Organ, Rice, Sierra-Fanlo, Tahsiri**.

The Centre for Architecture and Built Environment Research seeks to develop innovative approaches, procedures, and technologies that support the design, construction and management of buildings, their fabric and their environmental settings. In digital design and construction research

it has examined the processes and competencies associated with implementing digital technologies in construction (ontology, competency) (**Mahdjoubi, Mahamadu**), the development of digital tools to improve health and safety in construction, and the application of digital technology in emergency planning, heritage buildings and the process of digital design (**Mahamadu, Tahsiri, Chatzimichali**). Research on transforming real estate in a changing world incorporates adaptation to climate change and climate hazards (**Lamond, Booth, Everett, Organ**) and emerging social and political changes; the impact of Brexit and environmental legislation on marine real estate and fisheries (**Appleby**); valuation and infrastructure development in Sub-Saharan Africa (**Lamond, Booth**); and the evolution of digital retail and work (**Mason, Lamond**). Research in sustainable design and performance has focused on energy efficiency and overheating in buildings in the UK and overseas (**Gething, Dragojlovic-Oliveira, Adkins, Sierra-Fanlo, Deza**), and sustainable building materials and eco-design (**Archila-Santos, Badarnah, Lavaf Pour**). The Centre has a developing theme of place and society that explores the user perspective encapsulating social meaning of architectural space, participation in design and buildings in context, and social responsibility (**Rice, Everett, Mawle, Burch**).

Research and impact strategy

Strategic objectives for the current REF period were set out in the 2014 submission and were framed by the *UWE Research Strategy 2020*. Similarly, future strategy is framed by *Transforming Futures: UWE Research Strategy 2030* launched in 2020 (see Institutional-level Statement). Key objectives for the current assessment period, as set out in the 2014 REF submission, are summarised here along with evidence of achievement against the objectives.

- *To continue to invest in, and develop, our internationally excellent research in terms of outputs, impact and reputation.*

External research income totalled £13.8M over the REF period, averaging nearly £2M per annum, up from £1.6M over the previous REF period. Indicative of quality and breadth, 33% of external research income was secured from across four different Research Councils (up from 26% in the previous REF period). The number of staff whose work has been submitted in this Unit increased from 30.7 fte in REF 2014 to 64.7 fte, focused across the five Research Centres. In part this reflects the integration and increasing alignment of air quality and water research within UoA 13 (returned to UoA 17, Geography, Environmental Studies and Archaeology, in 2014, 13 ftes) but for the most part (at least 20 ftes) reflects an increase in the numbers of research active staff in the Unit. Unit members produced nearly 700 refereed journal articles, just under 100 commissioned reports, 44 books and over 120 book chapters within the assessment period.

Since 2014, there has been an increasing volume of impactful research activity and outputs focused across all five core research centres. Work on floods, water and drought was brought together in the Centre for Water, Communities and Resilience (CWCR) in 2018. The Centre for Architecture and Built Environment Research (CABER) was established in 2016, evolving from the former Centre for Construction and Property Research, integrating work on building design and performance with delivery and management of the built environment. There was increasing emphasis in the Centre for Sustainable Planning and Environments (SPE) on research on green infrastructure, low-impact development and urban design and, in collaboration with the Faculty's Computer Science Research Centre, on smart cities. The Centre for Transport and Society's (CTS) research focused increasingly on the integration of engineering and behavioural approaches, autonomous transport and safer road design. Work in the Air Quality Management Resource Centre (AQMRC) expanded to focus on air quality and carbon policy, air pollution and citizens and better regulation through public health approaches.

- *To develop our multi-disciplinary and trans-disciplinary research by securing further external funding and supporting existing collaborations*

Trans-disciplinarity is embedded in our thinking through a focus on cross-cutting built environment themes, such as climate change, transport, and public health and through the focus of research in multi-disciplinary centres. As detailed below (in section 3, Income), many of the Unit's large scale,

collaborative projects involved multi-partner, cross-disciplinary research. Examples of such projects include: a £5M EU project on '*Citizen Led Air Pollution Reduction in Cities*'; a £3.3M NERC-funded project on '*Developing a Drought Narrative Resource in a Multi-stakeholder Decision-Making Utility for Drought Risk Management (DRY)*'; a £500k ESRC-funded '*Driverless futures: Anticipatory governance for self-driving cars*' project; a £1.4M AHRC-funded '*Hydrocitizenship*' project; and ESRC-funded projects in CTS and SPE on '*Collective urban governance, innovation and creativity in the face of climate change*' (£223k) and on '*Commuting and Well-being*' (£160k). Evidencing strong cross-disciplinary working, Centre members secured 36 UKRI grants from ESRC, NERC, EPSRC, AHRC and Innovate UK over the assessment period along with multiple EU awards. Centre members also secured internal awards for explicitly cross-disciplinary research through the Vice-Chancellor's Challenge Fund. For example, **Mahamadu** collaborated with the Machine Vision Lab at UWE on '*Consafe-VR - Measuring Construction Workers' Visual Attention and Cognition using Virtual-Reality*' and **Rice** worked with colleagues in the Faculty of Arts, Creative Industries and Education (ACE) on the '*Integration of Social Robots into School Settings for Children with Autism*'.

- *To improve the quality of our PhD provision by building on previous success achieved in improving the quality and quantity of PhD provision*

The Unit has placed increasing emphasis on the quality and timely completion of PGRs in the context of the University-wide Graduate School, along with increasing alignment of PhDs with existing centres of excellence and priority research themes. Reflecting this, annual doctoral completions increased from 2016/17 through to the end of the assessment period. Indicative of the Unit's research quality, as demonstrated in REF 2014, it has co-led the University's membership of the ESRC South West Doctoral Training Partnership with the Universities of Bath, Bristol, Exeter and Plymouth, and participates in the EPSRC-funded FARSCOPE Robotics DTP (joint with the University of Bristol). It has also secured increasing numbers of students through the International Water Security Network and increasing numbers of Partnership PhDs part-funded by external partners. Overall satisfaction in the latest Postgraduate Research Experience Survey (PRES) was 93%, well into the top quartile (see section 2, below).

- *To pursue a pro-active impact and advisory strategy, capitalising on our track record and existing reputation in this area.*

With research impact a key strategic goal for the Unit and the University as a whole, our pro-active approach is based on: securing follow-on funding for key projects; internal investment in impact activities; partnership and co-creation of impact with stakeholders; provision of expert advice and guidance; and targeted dissemination and communication aimed at research users and beneficiaries. The quality and scope of our achievement in terms of impact, advisory and policy work across different research themes is evidenced by the five impact case studies included in the submission, covering Transport Planning, Marine Environment Protection, Cycling Infrastructure, Flood Resilience and Green Infrastructure Planning. Other impact highlights beyond the case studies include CWCR's role in a range of international projects aimed at providing safe water supply and sanitation for multiple agencies, AQMRC research impacting and informing government policy and mitigation across UK and European contexts, and work in SPE impacting UK policy on use of 'brownfield' land for housing and EU urban cohesion policy. Further, wide-ranging examples of impact and engagement are detailed in section 4.

- *To drive business and public engagement, innovation and enterprise support, and the role of UWE as an 'anchor institution' in the city-region and beyond.*

As a locally embedded, civic university, we have strong links with local government, the Local Enterprise Partnership and a wide range of other regional organisations (see section 4). In this REF period, our long-standing associations in the field of Air Quality Management have extended into local planning (SPE), transport planning (CTS), energy (CABER) and water (CWCR). Research activity across the Unit drives extensive engagement with multiple partners through collaborative research, knowledge exchange and public engagement. Examples detailed in section 4 include

contributions to policy development in the Bristol city-region on climate change, air quality, mobility, planning and local industrial strategy by AQMRC, SPE and CTS. The EU-Replicate project and Clair City projects were carried out in close partnership with Bristol City Council. CTS has provided critical evidence for the Council to take forward progressive policies in cycling infrastructure. AQM researchers are working closely with Bristol City Council and South Gloucestershire Council to enhance the policy and practice links between their research and local carbon management efforts. **Longhurst** (AQMRC) is co-chair of the Bristol Advisory Committee on Climate Change (BACCC) and is a significant contributor to Bristol's One City Climate Strategy. Two further Unit staff (**Clayton, Gething**) support the BACCC. AQMRC staff also chair the South Gloucestershire Climate Emergency University Advisory Group and provide technical advice and guidance on strategies, plans and policies for carbon neutrality.

- *To enhance our capacity to recruit and retain high quality staff, and to promote extensive employee engagement, career opportunities and job satisfaction.*

As noted above, there has been significant growth in numbers of research-active staff whose work has been returned in the Unit across all five Centres, more than doubling over the REF period. Reflecting strongly the vitality and sustainability of the staff base, 40% of staff whose work is featured are new to the University since 2014 and 31% are Early Career Researchers as defined for REF purposes (see section 2.1 below). Reflecting a pro-active approach to career development over the assessment period, three members of the Unit have been promoted to professorial roles, nine to Associate Professor, nine members on research contracts have been promoted to Research Fellow or Senior Research Fellow. Equality and inclusion across all five Centres are promoted by pro-active leadership including three female and one BAME Centre Director.

Open environment

Activity across the Unit is fully aligned with the University's statement on open research, and with policy and practice on open access as set out in the Institution-level Statement. Data management and associated software have been implemented in line with good research practice. Nearly a thousand outputs produced across the five Research Centres have been made accessible via the University's Repository. Central funding supporting open access costs for UKRI projects, and selected outputs from other research has been supplemented by additional faculty-level investment. The University also has a growing number of gold open access agreements with publishers.

Research integrity

Unit activity is fully aligned with University culture and practice of research integrity set out in the Institution-level Statement including compliance with the *Concordat to Support Research Integrity* and UWE's *Code of Good Research Conduct*. Researchers are required to maintain a Research Governance Record (RGR) for all projects to ensure that risks are identified and managed, and support is given, for example, for managing sensitive and confidential research data. Ethics training (on-line) is mandatory for all staff undertaking research or supervising PGR students with completion centrally monitored. Ethics approval and support for good practice is provided for by the Faculty Research Ethics Committee within a policy framework developed and overseen by the University Research Ethics Committee. This is reflected in an equitable approach to the subject and process of our research where we seek to work in partnership with external researchers and research users. For example, the participatory methods favoured by all our Centres recognize the validity and equity of the views of all research participants.

Future strategic aims and goals – Research Strategy 2030

Looking forwards, research strategy for the Unit is framed by the University mission adopted from mid-2020 to:

“... prioritise and grow internationally excellent and world-leading research with real-world impact, build on our strengths, prioritise challenge-based research, drive innovation and enterprise, and enhance the student experience” *Transforming Futures: UWE Research Strategy 2030*

We share the University ambition that:

“... through our research, we will transform the future, advance knowledge, support sustainable economic growth and development, enhance social and cultural development, promote health and well-being, equality and diversity, and the quality of built and natural environments (ibid)

Building on the more detailed strategic priorities set out in the UWE Research Strategy 2030, our future goals are to:

- *Shape our ambition and reputation around the University's Research Beacons*, further strengthening alignment with priority themes by channelling investment in people (recruitment, training and opportunities) towards the four Beacon areas:
 1. *Digital Futures* - embedding digital technologies in the built environment and transport systems to improve lives in smart future cities but also to transform construction efficiency and safety (CABER, CTS, SPE);
 2. *Health and Wellbeing* – addressing ongoing health inequalities in cities, planning for access to clean water, air, green space and transport and healthy architecture (CTS, SPE, AQMRC, CABER, CWCR);
 3. *Creative Industries and Technologies* – research into design of new products and processes such as modular housing, and communication through design to engender equality and diversity in place (CABER, CTS);
 4. *Sustainability and Climate Change Resilience* – mitigation and adaptation research in energy and transport, land use and planning, regeneration and investment, water and flooding in the built environment, improved resilient infrastructure and social value (CWCR, CABER, SPE, CTS, AQMRC).
- *Encourage and enable interdisciplinary approaches and contributions* that combine to address effectively the key challenges of the future. We will collaborate across the institution to consolidate cross-disciplinary thinking under the Beacon themes. This will be enabled by cross-faculty working groups such as the Transforming Construction working group and the Climate Resilience working group.
- *Achieve outstanding and far-reaching research impacts* working with business, government, other stakeholders and communities. For example, building on recently completed RCUK-funded projects, the DRY project and Urban Flood Resilience project, follow-on work will target impact in water management, in collaboration with water companies, Defra and the EA. Findings from the EU-funded Clair City and Replicate projects will inform post-COVID transformations towards healthier and more breathable cities. Our recently formed partnership with the Health Foundation and Sustrans will mobilise the transport sector to ensure that the needs of young people are given due attention.
- *Develop and support research that drives outstanding, research-enabled, learning and skills development*. For example, we will continue to offer support based on our research expertise for professional partners in the development of training and guidance.
- *Combine local focus and global reach across our research activities and impacts*, working with world-leading partners and stakeholders in the UK and internationally. We will build on existing, and form new, strategic partnerships related to the challenges identified. We will deepen these partnerships to facilitate industry and society-led research agendas that lead to learning in partnership, relevant evidence-based knowledge and true impact through, for example, increasing the number of KTP projects and external secondments.
- *Promote and support the development of postgraduate research and doctoral studies* in support of our strategic research priorities. We will continue to align postgraduate research to our Centres, and increasingly to the Research Beacons, thereby increasing the involvement of PGRs in our wider research activities.
- *Work to address the need for inclusion of groups and individuals under-represented across our research activities and to oppose discrimination in all its forms*. We will aim to exceed UKRI expectations in this area. This will be achieved through increasing the visibility of our diverse community and the diversity of our research and by promoting open access and engagement via our web presence and social media. Members of the Unit will engage pro-actively with University governance including our new Pro Vice-Chancellor: Equalities and Civic Engagement (**Olomolaiye**).

Section 2. People

Staffing strategy and development

Since REF 2014, there has been significant growth in research-active staff at all grades as a result of our recruitment strategy and staff development. The Unit is submitting outputs and impact from more than twice the number of FTE equivalent staff than in REF2014, up from 30.7 to 64.7 (68 heads). Strategies have included the appointment of lecturers with strong research track records and potential, the appointment of research grade staff to an expanding volume of externally-funded projects, and the appointment of Graduate Tutors under a faculty scheme to recruit to lecturing roles that includes full support in time and fees to achieve a PhD, with the expectation of progression to permanent academic contracts. Demonstrating vitality and sustainability for the longer term, as noted above, almost 40% of staff whose work is submitted have been recruited during this REF period, and some 31% of all staff with outputs submitted are Early Career Researchers by the REF definition.

Overall responsibility for research staff recruitment and development strategy lies with the Associate Dean (Research and Knowledge Exchange), supported by a Faculty Director of Research and an Associate Head of Research (AHoD) in each department. These staff work closely with the Faculty Research and Knowledge Exchange Committee that includes Centre Directors and representatives of the Graduate School, research grade staff and PGR students. Centre Directors input to staff development in collaboration with the relevant Head(s) of Department and Human Resources.

The Unit has approximately 15 dedicated technical support staff who provide a range of services in support of laboratory work, workshop manufacture, engineering design and fabrication, procurement, graphics, reports and other media. The University and Faculty were founder members, and have been fully committed to progressing, the national Technician Commitment (see Institutional-level Statement). Support is also provided by the Research, Business and Innovation unit's range of services including bid preparation and costing, and post-award finance and contract management.

Staffing investment is built into departmental business planning processes and discussed at University annual planning meetings. Recruitment has increasingly targeted talented researchers at early and mid-career stages that align with current and emerging research priorities.

The five Research Centres in the Unit provide the focus for growth in research capacity through new staff appointments, including ECRs, new externally-funded projects and career development opportunities. The University also support a number of 50:50 research and teaching positions including Wallscourt Fellows, an institutional initiative to invest in areas of priority and strength.

At Centre level, CTS has maintained a vibrant cohort of 15-20 staff and postgraduate researchers over the period. **Parkin** was appointed to a chair in Transport Engineering, ECRs (**Crawford**, **Paddeu**) were appointed with expertise in data analytics and freight transportation and two research staff (**Clark**, **Clayton**) were appointed to permanent appointments as Senior Lecturers. CABER expanded in membership from 9 to 21, with Professors **Mahdjoubi** and **Lamond** appointed as joint Directors and newly-appointed staff expanding disciplinary reach in; Building Information Modelling (BIM) and Artificial Intelligence (AI) (**Boguslawski**, **Deza**); building physics, energy and engineering (**Dragojlovic-Oliveira**, **Sierra-Fanlo**); and sustainable buildings through a new 50:50 Wallscourt fellow (**Adkins**). Two research grade staff secured permanent academic posts at UWE (**Sierra-Fanlo**, **Dragojlovic-Oliveira**) while others successfully secured roles elsewhere (**Baffour Awuah**, **Bhattacharya-Mis**, **Adekola**, **Boguslawski**). SPE was led by Professor **Williams** until she had to retire for health reasons in January 2020, with **Sinnett**, promoted to an Associate Professorship, succeeding her as Centre Director. SPE expanded through recruitment of new research active lecturing staff (**Foroughmand Araabi**, **Hickman**) in sustainable urban environments and capacity in green infrastructure was supported through a 50:50 ECR post (**Hoyle**). Investment in CWCR has included several new research active lecturing staff (**Mol**, **Chatzirodou**, **Bell**, **Wanke**) and the promotion of **Staddon** to Professor. **Hayes**, head of AQMRC,

was promoted to a Chair and externally-funded projects supported growth in staff numbers (**De Vito, Williams**).

Staff development

The University operates a points-based workload management model which identifies time allocated for research alongside other activities. Time allocated for research in externally-funded projects is identified and allocated through the workload model. All staff are also allocated 5 weeks of time for scholarly activity including research over the course of the year (pro rata for part-time staff). Research-active staff can also bid annually for an additional workload allocation based on their track record and planned activity to carry out internally-funded research and might, typically, be allocated between 10% and 20% of their time under this scheme. Professors and Associate Professors have an automatic allocation of protected research time and can bid for additional time on an annual basis. Staff new to an academic role are typically awarded protected time for research (20% per year for two years) to assist them in establishing their research career. An increase in the total time allocated to research across the Unit during the period has been made to meet this commitment.

Staff development needs are assessed formally through a Personal Development Review (PDR) process that includes annual review and interim progress meetings. For new staff, an initial probationary period includes support from an experienced research mentor. Research active staff become members of a Research Centre, a process that is supported by the Associate Heads of Department (Research). Staff can also put themselves forward to participate in REACH, UWE's talent management programme which has been created to develop and retain staff seeking posts at a higher level. Research leaders took part in a 360° leadership programme including self and peer assessment, training and individual coaching. Research Centre staff also enroll where appropriate in a Faculty-based mid-career accelerator scheme offering training and time allocation for the development of ambitious research proposals.

Research leaders have been promoted from within the staff base in this Unit (three Professors and nine Associate Professors over the period) and staff development has enabled nine internal promotions to Research Fellow and Senior Research Fellow positions. We have also seen staff supported through our development schemes secure promotions to research posts elsewhere, for example Sara to a Professorship at Birmingham City University, Manu to a Readership at University of Manchester, Squires to Associate Professor at Massey University, New Zealand and Hill to a Professorship at University of Gloucestershire.

Support for Research Centre members is provided through:

- Centre meetings to develop bidding strategy and facilitate collaborations.
- Development workshops allied to the Vitae Researcher Development Framework.
- Meetings with our external-facing networks such as the CWCR annual local agency partners meeting and the SPE RTPI annual partnership meetings.
- Residential writing retreats, which provide dedicated writing time, mentoring of ECRs and partnered authoring, and reading groups to enhance the quality of submissions.
- Seminar programmes, both externally and internally facing.
- A formal internal peer review process for UKRI applications and informal review for other bids.
- Skills development through feedback on internal bidding schemes.
- Centre updates celebrating the role of research, and Faculty newsletters highlighting research successes.

ECRs can bid for Vice-Chancellor's Early Career Researcher Awards which combine a time allowance and financial resources to support research activity with a view to laying the foundations for bidding, often collaboratively, for significant external funds. This operated throughout the REF period with 16 ECR staff from across the Unit successfully securing awards to the value of £0.25M.

The Vice-Chancellor's Challenge Fund, initiated in 2019, provides resources through competitive bidding for cross-disciplinary research including cross-faculty projects. These are intended as seed funding to support small-scale pilot projects and encourage further bidding and research outputs.

Unit staff secured five awards under the scheme, which, again, provide a combination of research time and financial resources.

Professorial staff are appointed on a criteria-based merit pay scale introduced in 2014/15 and can apply annually for re-grading based on their performance. Criteria include a range of research-based achievements including grants secured, outputs, impact and leadership.

All researchers are supported through the University's central Research, Business and Innovation service. This includes support for staff training and development, bidding, collaborative engagement and impact. Staff on research grade contracts are supported through a Researchers' Forum designed to represent and assist with the career development of this staff group. Support is underpinned by the commitment of the University and the Unit to the *Concordat to Support the Career Development of Researchers*.

Staff on research contracts can apply, with support from Centres and Faculties, for promotion through the University Research Review and Progression Panel. This is a criteria-based scheme providing for promotion from Research Associate to Research Fellow or Senior Research Fellow. The Panel meets twice a year. As noted above, nine staff on research grades were promoted through this process over the REF period.

Equality and diversity

The Unit has followed rigorously the University's Code of Practice for REF2021 developed in collaboration with the University's Equality, Diversity and Inclusivity Unit and involving extensive staff consultation. Staff involved in the preparation and submission for this Unit attended mandatory equalities training with respect to the identification of staff with significant responsibility for research (SRR), determining research independence and selecting outputs. Principles applied include output selection on the basis of rigorous review of self-nominated outputs, regardless of topic area, disciplinary focus or geographical scope, and with no expectation about how many outputs would be submitted for any one individual, including ECRs, part-time staff and those taking career breaks. Where time allocations were used to designate SRR, part-time staff were assessed pro-rata. Impact case studies have been selected based on significance and reach from a wide pool of self-nominated examples.

Reflecting this, the inclusion of female staff in the Unit increased markedly from 27% of staff submitted to REF 2014 to 37% of staff with SRR in 2021. The proportion of staff included who were from BAME groups increased from 13% in 2014 to 18% in 2021. Seven percent of staff represented in the 2021 submission self-declared as disabled compared with 6% in departmental staff overall.

On an ongoing basis over the REF period, all staff involved in recruitment, performance review and career development underwent mandatory equality and diversity training as well as unconscious bias briefing. Staff with responsibility for overseeing or recruiting staff attend recruitment and management training to embed UWE's equality and diversity ethos and policies, for example the two-ticks policy to ensure appointable individuals with disabilities are offered an interview, now subsumed by our Disability Confident employer accreditation. The Unit proactively engages with the Athena SWAN Charter with the two supporting departments at different stages in the journey; ABE has achieved, and GEM is working towards, a departmental bronze award with researcher representation on the respective working groups

The Unit participates in the University-wide Women in Research Mentoring Scheme, which promotes equality and facilitates professional development for women researchers, helping them achieve their potential and to reach senior roles. **Lamond** and **Sinnott** serve on the Scheme committee which has, since 2014, supported 11 female mentees in the Unit. Additionally, eight Unit staff (male and female) have been Scheme mentors.

We provide appropriate support to staff with registered disabilities, making reasonable adjustments and providing appropriate supporting equipment such as bespoke furniture. Requests are reviewed and adjustments implemented promptly, typically going beyond legal requirements to ensure staff

have long-term and appropriate support. For example, staff with mobility impairments have been offered support with transport and adapted wheelchairs to carry out fieldwork for their research. Staff with other long-term health issues have been provided with flexible working, reduced working hours, remote working and standing desks. We support staff in negotiating their timetabled working pattern to accommodate caring responsibilities. Flexible retirement schemes enable colleagues to reduce their hours and access some or all of their pensions in preparation for retirement. As noted in the Institutional-level Statement, UWE is a Mindful Employer, a UK wide initiative providing employees with easy access to professional workplace mental health training, information and advice, as well as being a Stonewall Diversity Champion.

Research students

The Unit has a vibrant population of PGR students who are closely integrated with the research activities and culture of the five Research Centres. Centres collaborate in ESRC and EPSRC Doctoral Training Partnerships and have developed a portfolio of Partnership PhDs part-funded by, and based on collaboration with, external partners. As indicated earlier (section 1) doctoral completions increased from 2016/17 through to the end of the assessment period.

PhD students are supported centrally through the UWE Graduate School that also co-ordinates recruitment, progression and examination processes with assistance from the International Office for our overseas students. Students have access to a programme of training courses mapped against the Vitae Researcher Development Framework. Faculty and Departmental support focusses on academic support and standards, and pastoral care. We follow a Code of Practice closely aligned to that of the QAA. Research student progress is monitored through the Faculty Research Degrees Committee, which has representation from both Departments and our PGR community.

Key features of our PGR provision include research bursaries awarded in areas of identified research strength or ambition such as flood risk management, sustainable buildings and BIM. Since its inception in 2013, the International Water Security Network has supported more than 15 PhDs across the three key partner institutions, including 7 registered at UWE, the lead institution. We have also received funding from international programmes such as the Ghana Education Trust, the Nigerian Tertiary Education Trust Fund and the Nigerian Delta Development Corporation to support capacity building in academic communities in Sub-Saharan Africa.

Over the REF period, Unit staff collaborated, regionally, to secure funding for the second phase of the ESRC South West Doctoral Training Partnership with the Universities of Bath, Bristol, Exeter and Plymouth. Staff in the Unit lead for UWE on the interdisciplinary pathway 'Sustainable Futures' and the University provides an associated, interdisciplinary MRes. DTP PGR projects in the Unit have included studies of contested urban street space, planning for rural sustainability, and community-owned renewable energy. The Unit also collaborates in the EPSRC FARSCOPE Robotics DTP, run jointly with the University of Bristol (renewed in 2019) focused on Robotics and AI and including, for example, research on building information systems, driverless cars and other topics relevant to the Unit.

Induction and training for PGRs includes Faculty-based welcome events to encourage cohort identity, detailed orientation by the supervisory team, centrally organised induction training and familiarisation with University support and facilities. Doctoral students have access to Masters Level taught provision including central, cross-faculty and Faculty level modules, chosen in discussion with supervisory teams.

Students are supported to attend conferences and given training support and opportunities to present their work within the University at Centre, Faculty and departmental PGR seminars, colloquia and roundtable events, as well as at regional fora.

Our emphasis on quality is reflected in the satisfaction of our PGRs. In the latest PRES survey (2019), our provision (Geography, Archaeology and Built Environment) was ranked in the top

quartile of HEIs with an overall satisfaction level of 93%, significantly up on the second quartile score of 82% for overall satisfaction in 2015.

Section 3. Income, infrastructure and facilities

Income

Research income from external sources over the REF period totalled £13.7M (REF 4b). Income averaged just under £2M pa, up from £1.6M pa over the previous REF period. This included £4.6M from UKRI (33% of total income, including Research Councils and Innovate UK), £2.6M (19%) from the EU, £3.6M from UK Government (26%), £2.0M from UK charities (15%) and £0.6M from industry (4%). Indicative of the cross-disciplinary reach of our research, significant UKRI funding was secured through 36 grants across four Research Councils - EPSRC (7), NERC (16), AHRC (6) and ESRC (7). This diversity and scale of funding also reflects the vitality and sustainability of the funding base across the Unit as a whole, and the multidisciplinary, challenge-based approach to research with impact. Alongside research funding, staff in the Unit secured £1.75M of expert consultancy and knowledge exchange income.

Larger scale, collaborative, interdisciplinary projects led by UWE have included the £5M EU '*Citizen Led Air Pollution Reduction in Cities*' project (led by **Hayes**, AQMRC), and the £3.3M NERC-funded '*Developing a Drought Narrative Resource in a Multi-stakeholder Decision-Making Utility for Drought Risk Management DRY*' project (led by **McEwen**, CWCR).

Large scale projects with UWE as a collaborator include the EPSRC-funded '*UK Centre for Research on Energy Demand*' (£19.4M, value to UWE £46k) led by **Chatterton**, SPE; the £19.5M EU-funded '*Renaissance of Places with Innovative Citizenship and Technologies*' project (£182k to UWE, led by **Parkhurst**), CTS; the ESRC-funded '*Driverless futures: Anticipatory governance for self-driving cars*' project (£500k, £58k to UWE), and the AHRC funded '*Hydrocitizenship*' project, (£1.4M, £232k to UWE) led by **McEwen**, CWCR.

Substantial EU-funded projects include '*Inequality, Urbanization and Territorial Cohesion: Developing the European Social Model of economic growth and democratic capacity*' (£2.6M, £532k to UWE); '*Evidence of the Proven Economic Benefits of Sustainable Transport Initiatives to Facilitate Effective Integration in Urban Mobility Plans*' (£1M, £125k to UWE); '*Copernicus for Urban Resilience in Europe*' (£2.3M, £295k to UWE), '*Citizen Observations of Urban Transport (WECOUNT)*' (£272k), '*Sustainable Urbanisation Global Initiative Food-Water-Energy Nexus*' (£189k). CABER also received EU funding for '*Predicting the Deterioration and Service Life of Bridges*' (£657k, £217k to UWE), while the Dutch Research Council supported '*Public accountability to residents in contractual urban redevelopment*' (£266k).

Other significant UKRI-funded projects included '*Residential building energy demand reduction in India*' (EPSRC, £167k, CABER), '*Urban Flood Resilience in an Uncertain Future*' (£282k ABE), '*Construction safety for the Construction Sector*' (£101k, CABER). ESRC projects for CTS and SPE include '*Collective urban governance, innovation and creativity in the face of climate change*' (£223k), '*Commuting and Wellbeing*' (£160k), '*Providing insights into multi-day traveller behaviour to inform sustainable transport policy and practice*' (£80k). NERC funded AQMRC and CWCR to explore, respectively, air quality and water in built environments through '*Detection and characterisation of inflammatory agents associated with bioaerosol emitted from biowaste and intensive agriculture*' (£1.1M), '*Clean Air for Delhi Through Interventions, Mitigations and Engagement*' (£368k), '*Impacts of droughts and water scarcity*' (£110k), and '*Engaging diverse stakeholders and publics with outputs from the UK Drought and Water Scarcity programme*' (£424k). SPE also received NERC funding for '*In-situ recovery of resources from waste repositories*' (£131k).

Charity-funded projects included 26 grants over the period from organisations including the Wellcome Trust, Leverhulme Trust, Sustrans, the Ove Arup Foundation, the Health Foundation, and the National Museums and Galleries of Wales. For example, **Sinnott** explored the '*Availability of brownfield land for development in England*' for the Campaign for Rural England, **Mol** carried out

research for the Leverhulme Trust on '*Ballistic damage of stone heritage structures in conflict areas*' (£200k), and **Melia** worked on the '*Evaluation of car clubs in new developments*' for the Rees Jeffrey Road fund (£20.5k).

Projects funded by government departments, agencies and independent foundations, many of which fed directly into policy, were secured from the Department of Transport, Department for International Development, Rail Safety and Standards Board, Welsh Assembly Government, National Institute of Health and Clinical Excellence, Public Health England, Department for Business, Energy & Industrial Strategy, Department of Energy and Climate Change, Department for Communities and Local Government, Transport Scotland, and Highways England.

Applied and industry-engaged research projects have been funded by Innovate UK, for example, CTS has looked at behavioural and social issues resulting from the introduction of new transport technologies (£310k for '*Mobility on Demand Laboratory Environment*'). Funding has also come directly from industry and industry bodies (21 projects) including the Investment Property Forum, Flagship Group, Green Blue Urban, Springfield Supplies & Projects, Arup, Flood Re Ltd, Grosvenor Group, Great Western Rail, and Touche NFC Ltd.

Knowledge exchange activity evidences the strong impact of research activity across the Unit. Highlights of knowledge exchange and consultancy (returned as HEIF metrics) over the REF period include the extension of the Environmental Technologies iNet (2013-2015) hosted at UWE (£350k), training provided to Laing O'Rourke (£186k) on construction in regulated controlled and licensed environments, and staff secondments such as Carmichael to the London Borough of Tower Hamlets (£138k). Over 100 other KE activities have involved organisations such as Cornwall County Council, Heathrow and Gatwick Airport, Flood Re Ltd, Mott MacDonald, Transport Focus, World Bank, South Gloucestershire Public Health Team, Port of Milford Haven, Council for the Protection of Rural England, RAC Foundation, Aquarian Cladding Ltd, Stride Treglown Plc, C & J Blacks Solicitors, Ardagh Community Trust, Reach Robotics and Buro Happold.

Infrastructure and facilities

The five Research Centres included in the Unit are co-located, with open plan PGR workspace adjacent to this. Other facilities available for researchers in the Unit include the University's new engineering building, opened in 2020, a £33M investment including facilities for a wide range of research including composite manufacturing and machining for product design, masonry and concrete testing laboratories, metrology and wind tunnels. Our Departmental building houses expanded laboratories for geotechnics, including physical wet/dry ground analysis, and an environmental change lab for masonry and other materials analysis.

Staff also collaborate with the nearby Bristol Robotics Laboratory, a joint facility with the University of Bristol, and part of the Faculty of Environment and Technology. BRL is located in dedicated premises which include extensive laboratory and specialist spaces along with staff offices and teaching spaces for PGR and Masters-level programmes. Collaborative work with BRL includes interdisciplinary built environment research in transforming construction, and projects with CTS using dedicated facilities for live, on-campus simulation and testing of autonomous vehicles and full-vehicle immersive driving simulators for testing systems and driver interactions.

BRL is co-located with the University's *Future Space* facility which provides office space, laboratories, workshops and co-working facilities for new and growing tech-based businesses. Operated on a commercial basis, this provides multiple opportunities for collaborative research and student placements. The UWE Exhibition and Conference Centre, the largest of its kind in the South West with a flexible space of over 4,000m² (currently acting as a Nightingale Hospital) is used to host major conferences and industry outreach events.

Research bidding, post-award support and research impact in the Unit are supported by the University's Research, Business and Innovation service. This includes identification of funding opportunities, bid preparation, costing and submission and post-award management through faculty business partners and other common, central services. Postgraduate research is supported by the

University Graduate School and Graduate Office (see above) which includes recruitment, induction, training, annual progression, welfare and support, and the examination process.

The Faculty also has 45 technical staff supporting facilities distributed across multiple buildings and facilities, in support of multidisciplinary research. The University subscribes to multiple data services including those for modelling and simulation of built environment performance and value, GIS and architectural design.

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

Research collaboration, interdisciplinary research, responding to national and international priorities

The majority of projects secured over the REF period involve interdisciplinary collaboration with, in many cases, multiple partners, including joint working with academic colleagues in other HEIs, nationally and internationally. Large-scale consortia projects led by UWE, or with UWE as a partner, have been identified in section 3 above. Here, we provide details of a selection of the collaborative projects conducted by each of our research centres, many commissioned directly to support national and international priorities and challenges by wide-ranging governmental bodies and other agencies.

In the EU-funded Clair City project, AQMRC (**Hayes**) led a consortium of 16 partner organisations which engaged directly with the public in six European cities or regions seeking to improve air quality (Amsterdam, Bristol, the Aveiro Region, the Liguria Region, Ljubljana and Sosnowiec). UK partners included Imperial College, Cranfield University, Open University, Plymouth University, Public Health England and the Environment Agency.

Three of the Unit's Research Centres (AQMRC, CTS and CABER) collaborated with multiple partners on the EU-funded Replicate project which tested new energy and transport-related technologies for smarter streets and homes in Bristol, Florence and San Sebastian. This involved a collaboration of 39 organisations including the Universities of Florence, Exeter, Bristol, Oxford and the Esade Business School, Barcelona, alongside municipalities and industrial partners.

In the Innovate UK-funded £16M '*Transport Infrastructure Efficiency Strategy (TIES) Living Lab*' project, CABER (**Mahdjoubi, Gething and Mahamadu**) collaborated with the Department for Transport and 30 other strategic partners, including Costain, Transport for London, and the Universities of Leeds and Dundee.

CABER was part of a consortium of 25 international research organisations in the DFID-funded (£3.5M) '*Urbanisation Research Nigeria*' project in which UWE (**Lamond**) led on urban land planning and management. UWE researchers worked with six Nigerian universities, while partnering with planning consultancy ICF GHK, the University of Pretoria and University College London.

The UKRI-funded DRY project led by CWCR (**McEwen**) involved the Universities of Dundee, Exeter, Harper Adams, Loughborough, Sheffield and Warwick. Stakeholders included the Canal and River Trust, Chartered Institute of Building, Climate Outreach and Information Network, Emergency Planning Society, Environment Agency, Federation of Small Businesses, Natural England, Natural Resources Wales, National Allotment and Leisure Garden Society, Public Health England, Scottish Environmental Protection Agency, Scottish Natural Heritage, Scottish Water, The Eden Project, The National Trust and UK Water Industry Research.

In work on Flood Memory funded by EPSRC, CWCR (**Lamond**) collaborated with the Universities of Newcastle, Aberdeen, Swansea, Liverpool and Southampton (National Oceanographic Centre), Nottingham, Queen Mary London, Cranfield and Heriot Watt. CWCR (**Mol**) has partnered with heritage organisations to explore weathering and water damage to masonry, including Leverhulme Trust-funded research in collaboration with researchers from different disciplinary backgrounds at the Universities of Cardiff, Manchester Metropolitan and Oxford on ballistic impact damage

sustained by built heritage during conflict.

CTS, led by **Parkhurst**, provided social science input and expertise for four Innovate UK-funded projects (Venturer, Flourish, CAPRI, MultiCav) on connected and autonomous vehicles, alongside the Bristol Robotics Laboratory. For example, the CAPRI project brought together 20 organisations, including four Universities (Bristol, Loughborough, UWE, Warwick), to trial new autonomous and connected pods on-demand at Filton Airfield, Bristol, and London's Queen Elizabeth Olympic Park. The MultiCav project is led by FirstGroup to test shared autonomous vehicles at a business park in South Oxfordshire.

In the EPSRC-funded '*cycle BOOM*' project, CTS collaborated with Cardiff, Oxford Brookes and Reading Universities to understand barriers to cycling among the older population. CTS also led a study for the Department for Transport working with the University of Oxford on the decline in driving of young adults, and with UCL on an ESRC project '*Driverless Futures*'.

SPE (led by **Ludlow**) has conducted smart cities research in collaboration with UWE's Computer Science Research Centre as part of a number of EU research projects. These projects involved partners from the information and communication technology sector, end-user engagement experts and city authorities. For example, in the SUNEX JPI-Urban EU-funded project, SPE is collaborating with partners in Austria, Germany and Qatar, as well as Bristol Water, in formulating inclusive urban food, water and energy strategies.

The five impact case studies included in our REF submission (see REF 3) all provide further examples of strongly developed, multi-partner research and user collaboration leading to wide-ranging benefits.

We have been pro-active in establishing various networks to strengthen research capacity in our areas of interest. **McEwen** (CWCR), for example, led the ESRC-funded CASCADE-NET seminar series '*Increasing Civil Society's capacity to deal with changing extreme weather risk: negotiating dichotomies in theory and practice*'. CWCR also had a lead role in the *Building UK Climate Resilience Network*. **Staddon** leads the *International Water Security Network* (for which he is founder-director) initiated with Lloyd's Register Foundation funding, in collaboration with the University of Arizona and Monash South Africa.

SPE has hosted the cross-faculty WHO-accredited Collaborating Centre for Healthy Urban Environments (WHO CC) at UWE since 1995. The WHO CC is part of the WHO Healthy Cities Networks comprising 100 cities, and 10 national networks of cities from the EU and Eastern Europe. The WHO CC is also the designated NICE Centre of Excellence for Health and Spatial Planning.

The Unit encourages exchanges of expertise through visiting positions and activities at other Universities. **Staddon** (CWCR) is a Visiting Research Professor at the University of Arizona. **Parkhurst** (CTS) is a Visiting Professor at three Italian Universities (Brescia, Cagliari, Insubria). **Parkin** is an Erskine Visiting Fellow to Canterbury University (New Zealand) and a Visiting Professor to the University of Natural Resources and Life Sciences (BOKU) Vienna. **Archila-Santos** (CABER) is a Visiting Research Fellow at the University of Bath. **Mahdjoubi** (CABER) is a Visiting Professor at Robert Gordon University, Aberdeen. **Casado-Diaz** (GEM) is a Visiting Fellow at Umea University, Sweden. The Centres in the Unit have been host to 29 Visiting Fellows and 15 Visiting Professors over the REF period.

Engagement with key research users and professions

Our research is oriented to support policy makers, practitioners and civil society in managing the built environment and protecting the natural environment. As a civic university, we have strong links with Bristol City Council, South Gloucestershire Council, the West of England Combined Authority (WECA) and other regional organisations. In this REF period, our long-standing association with regional bodies in the field of Air Quality Management has extended into planning (SPE), transport planning (CTS) energy (CABER) and water (CWCR). **Longhurst** (AQMRC) is co-chair of the Bristol

Advisory Committee on Climate Change (BACCC) and a significant contributor to Bristol's One City Climate Strategy. Two further staff (**Clayton**, **Gething**) also support the BACCC. In 2019, SPE initiated a joint seminar series between SPE and Bristol City Council planning staff, including heads of service.

The Unit engages fully with the professional and trade bodies associated with the built environment including the Institute of Civil Engineers, Royal Town Planning Institute, Royal Institute of British Architects, Royal Institute of Chartered Surveyors, Institute of Environmental Sciences, Institute of Environmental Management and Assessment, Chartered Institute of Builders and Chartered Institute of Water and Environmental Management. These bodies are represented through steering group membership on projects (RTPI, CIOB, RICS) or on Centre advisory or steering boards (RTPI, RICS). Government departments and NGOs are also included in partnership activities through steering groups, for example Defra and the Environment Agency support the CWCR advisory board. The Department for Transport call heavily on CTS expertise and fund multiple projects with the Centre. Close working relationships are developed through these projects to inform our research priorities and enhance routes to impact.

Williams B was seconded to the Environment Agency to contribute to the redesign of the UK's entire air quality monitoring networks (2018-2020). **Lyons** (CTS) has worked in strategic partnerships with the Mott MacDonald engineering consultancy, the Chartered Institution of Highways & Transportation, the New Zealand Ministry of Transport, and the UK DfT's Office for Science and Transport Scotland.

Beyond the research projects they undertake, our researchers provide high-level policy and practice advice in their areas of expertise. At an international level, **Staddon** (CWCR) has advised the Lloyd's Register Foundation on its Global Safety Challenges Foresight Review. **Sinnett** (SPE) has been an expert reviewer for United Nation's Global Environment Outlook for Cities Report 2020. **Parkhurst** (CTS) was invited to write a White Paper for the 5th EU-US Transport Research Symposium. **Chatterjee** (CTS) is chair of the Urban Travel Transitions and New Mobility Behaviour Working Group for OECD's International Transport Forum. **Cole** (CWCR) is an expert advisor to the UNEP Global Partnership for Sustainable Tourism.

Examples of national contributions include **Barnes**' (AQMRC) membership of PHE's Air Quality Advisory Panel, and **Hayes**' (AQMRC) appointment to the Welsh Government Clean Air Advisory Committee. **Longhurst** (AQMRC) is Climate Commissioner for UK Higher and Further Education. **Lamond** (CABER) is an invited member of Flood Re Transition Planning Group. **Lyons** (CTS) is a member of the DfT's Joint Analysis Development Panel while **Parkin** (CTS) is a member of the DfT Analytical Advice and Challenge Panel and **Parkhurst** (CTS) is a member of DfT's Roads Reform Expert Group. **McEwen** (CWCR) is a member of UK Government's Civil Contingencies - Communities Prepared National Group.

We also contribute significantly to the work of third sector organisations. For example, **Everard** (CWR) is an Ambassador and science advisor to WaterHarvest (a UK-based NGO working in Rajasthan and Gujarat) and a science advisor to the NGO Tiger Watch (Rajasthan). **Appleby** (CABER) is a Trustee of the Blue Marine Foundation, advisor to various NGOs, including the Marine Conservation Society, the High Seas Alliance, and the UK Overseas Territories Conservation Forum.

Recognition of our standing with research users is evidenced by invitations to provide high profile contributions at their events. For example, **Longhurst** (AQMRC) gave a keynote address in 2017 at the Challenge and Change: Air Quality Conference of the Chartered Institute of Environmental Health in London. **Lyons** (CTS) gave an invited talk at an event to mark 100 years of the DfT in London in 2019. **Chatterjee** and **Clark** (CTS) were invited to speak on the adverse effects of commuting to the UK Government's Social Impacts Task Force. **Parkhurst** (CTS) was invited to present to Council officers, politicians and the public in Bath on a Park and Ride proposal, which subsequently led to a change in local policy.

We also support professional bodies in our respective subject areas. For example, **Barnes** (AQMRC) is a member of the Environmental Protection UK Air Quality Committee. **Lyons** (CTS) is Trustee of the Chartered Institution of Highways & Transportation (CIHT) and Chair of its Membership and Skills Strategy Board. **Parkin** is Chair of the CIHT Individual Route Assessment Panel and Chair of the Institution of Civil Engineers Cycle Working Group. **Ricci** (CTS) has been a member of the National Steering Group of Bikeplus.

McClymont (SPE) is a member of the Expert Roundtable on 'Empowering communities to participate in planning for new communities' for the Town and Country Planning Association. **Hickman** (SPE) was appointed to the Royal Town Planning Institute's Partnership Board. **Sinnott** (SPE) is a committee member of British Land Reclamation Society and UK Urban Ecology Forum.

Gething (CABER) is Vice-Chair of BRE Global's Governing Body. **Booth** (CABER) was elected a member of the Association of Researchers in Construction Management (ARCOM) Committee. **Archila-Santos** (CABER) is a member of Technical Committee TC 165 of the International Standardisation Organisation (ISO) and a board member of the Natural Materials Association. **Lamond** (CABER) is a member of BSI committee CB/501 Flood Risk & Watercourse and a member of the Defra/Industry Property Flood Resilience Roundtable. **Organ** (CABER) is RICS Matrics UK board member. **Mason** (CABER) is Vice-Chair (Europe) of the Commonwealth Association of Surveyors and Land Economy.

Contributions to economy and society and wider impact

Impact reported in the case studies relates to our research in Transport Planning, Marine Environment Protection, Cycling Infrastructure, Flood Resilience and Green Infrastructure Planning. Other examples of impact follow.

CWCR research has advanced a new measurement tool for assessing the provision of safe, resilient and equitable water supply. The cross-culturally validated Household Water InSecurity Experiences (HWISE) scale has provided a tool to strengthen the programmes of Oxfam, Witness International and End Poverty. WHO/UNICEF and USAID are also looking to include it within their survey tools.

Research, technical guidance and training by CWCR on distributed water systems has led to around 250,000 people in East Africa and India enjoying higher levels of water security, including better water supply and sanitation services. In Peru, CWCR (**Staddon** and **Octavianti**) co-designed and co-delivered a successful 'Sustainable Water in the Andes' programme with Peruvian partners. Research by **Cole** (CWCR) has influenced policy agendas addressing the challenges of sustainable water management in Bali, including legislation to designate groundwater conservation zones, improved compliance registering and permitting, and monitoring of groundwater use and quality.

In the UK, our research on drought and water shortage has led to award-winning co-created educational materials for schools; the book *'DRY: Diary of a Water Superhero'* won the Geographical Association Publishers' Silver Award in 2020. The impact of our research on flood and drought-resilient communities (**McEwen**) has led to increased stakeholder capacity in building mutual capital and working with different types of evidence and resources that can be used in training and in horizontal dialogue with communities. The SESAME project produced a prototype e-tool to promote the flood resilience of SMEs which secured an Environment Agency Excellence Award.

AQMRC's research with Public Health Wales and the Welsh Government has enhanced the linkage between air quality management and public health, contributing to *Prosperity for All*, the National Strategy, the Well-being of Future Generations (Wales) Act 2015 and the National Clean Air Plan for Wales (2020). Its research also informed the UK Government Clean Air Strategy (2019) aiming to improve quality and public health across the UK. Internationally, its research underpinned the European Environment Agency (EEA) report on the unequal impacts of air pollution, enabled European policymakers to focus environmental policies on areas where 'particularly sensitive or

vulnerable groups of society are exposed to high levels of pollution', and informed a WHO report on environmental health inequalities in Europe. It also directly influenced the EU Clean Air Policy Package 2030, impacting on EU member states and their citizens.

CWCR research into damage sustained by built heritage during conflicts (**Mol**) has helped open a debate into 'crimes against culture' within the legal community, global media, and the wider public. The work has been translated into triage and stabilisation methods for military personnel and front-line heritage professionals engaged in conflict zones.

SPE's review of the use of brownfield land for housing, commissioned by the Council for the Preservation of Rural England, was instrumental in strengthening brownfield policy and was cited in the Briefing Paper for the *Housing and Planning Bill (2015)*. **Atkinson** was commissioned by the Polish EU Presidency to review urban cohesion policy, which subsequently helped shape EU Cohesion Policy.

Engaging with diverse communities

A key focus of our approach to research design is to increase the engagement of diverse communities in projects. For example, AQMRC's EU-funded four-year Clair City project worked directly with citizens and local authorities in six countries around Europe, engaging them in creative ways to explore air quality issues, feeding back outcomes to policy makers, citizens and influential organisations in each city and region. The project equipped local school students with PM2.5 personal exposure monitors to assess how air pollution exposure is connected to different modes of transport used for the school commute. The project interacted with 818,000 citizens.

CWCR members involved stakeholders in field research in east Africa, Indonesia and India on public accountability and decentralised control over water resources. **Cole**'s research on water and tourism in Indonesia sparked public engagement and awareness campaigns by local and international NGOs, including a manual on 'How to build your own well' and a film, 'Adopt Water'.

In the CAPRI project, CTS consulted, and used co-design methods, with members of the public, technical experts and academics. Live demonstration trials of autonomous shuttle pods in Bristol and London enabled the collection of opinions on trust and comfort from passengers, pedestrians and cyclists. Over 650 members of the public contributed to the research and a Virtual Museum was created as a legacy.

In the DRY project, CWCR researchers ran events in seven case study catchments in England and Wales including participatory workshops, digital storytelling work, river walks (e.g. science storytelling) and festivals. In the *'Deathscares and Diversity'* project, SPE worked with minority and migrant communities and partnered with RTPi and the Institute of Cemetery and Crematoria Management to produce recommendations for more inclusive cemeteries and crematoria services.

Wider influence, contributions to and recognition by the research base

Over the REF period, members of our Unit have held more than 22 roles as conference organisers, conference chairs and advisory panel members, 30 roles on journal editorial boards, 15 special issue editorships and served on 166 funding panels, advisory boards and NGO and professional steering groups and boards. They gave over 300 invited talks and were involved as peer reviewers for large numbers of journals/publishers.

Notably, **Atkinson** (SPE) is Chief Editor of Urban Research and Practice; **Tallon** (GEM) is Chief Editor of Journal of Urban Regeneration and Renewal; **Parkin** (CTS) is Chair of the Editorial Advisory Panel for the Proceedings of the Institution of Civil Engineers: Municipal Engineer; **Quinn** (CWCR) is Editor-in-Chief of Hydrology Research; **McClymont** (SPE) is book reviews editor for the Journal of Urban Regeneration and Renewal and interface editor for Planning Theory and Practice. Editorial Board membership includes Journal of Environmental Engineering & Landscape Management (**Booth**), Frontiers Sustainable Cities (**Sinnett**), Journal of Flood Risk Management (**Lamond**), International Journal of Social Research Methodology (**Gopinath**), Journal of Transport Geography (**Parkhurst**).

Contributions to grants committees includes **Longhurst** (AQMRC), Chair of UKRI's Strategic Priorities Fund Clean Air Wave 1 Assessment Panel and Deputy Chair for Wave 2. He also chaired the Portuguese Foundation for Science and Technology Natural and Environmental Sciences Panel. **Olomolaiye** (CABER) is a committee member for the Royal Society Future Leaders: African Independent Research Fellowship Panel (2018-23). **Mahdjoubi** (CABER) was Chair of the Thermal Energy Panel for EPSRC in 2015. **Appleby** (CABER) was on the ESRC Advisory Panel for its Governance After Brexit Programme (Phase 1) in 2018. **Sinnett** was commissioned by NERC to examine how green infrastructure research is influencing practice. In addition, Unit members regularly review grant proposals for a wide range of UKRI and other bodies including AHRC (**McEwen**), BBSRC (**Sinnett**), EPSRC (**Sinnett**, **Booth**, **Mahdjoubi**, **Lamond**, **Parkin**), ESRC (**Gopinath**, **Sinnett**, **Lamond**, **McEwen**), MRC (**Longhurst**), NERC (**Longhurst**, **Lamond**, **McEwen**, **Staddon**, **Sinnett**), NIHR (**Williams B**, **Sinnett**), GCRF (**Gopinath**, **Lamond**), Innovate UK (**Sinnett**), British Academy (**McClymont**), EC (**Sinnett**, **Booth**) and UKRI Future Leaders (**Lamond**).

Contributions to disciplinary and subject groups include; **Parkin** (CTS), Chair of the University Transport Study Group; **Parkhurst** (CTS) Treasurer and Executive Committee Member of the Transport Geography Research Group of the Royal Geographical Society; and **Staddon** (CWCR) is on the reviewer panel for the Royal Geographical Society Neville Shulman Challenge Award which assesses applications for funding for 'a challenging research project or expedition'. At an international level, **Williams B** (AQMRC) has been an expert valuator for the Earth Champions Awards (Air category, 2015). **Oliveira** is board member of the Serbian Green Building Council and advisor to RIBA Sustainability Future Group.

Significant conference contributions include **Longhurst** (AQMRC) as Co-Chair of the annual *International Conference on 'Modelling, Monitoring and Management of Air Pollution'*. **Mahdjoubi** (CABER) is Chair of the Bi-Annual *International 'Conference on Building Information Modelling'*. **McClymont** (SPE) was AESOP (Association of European Schools of Planning) Congress Track Chair for the '*Planning Theory and Complexity*' track (Utrecht). **Ludlow** (SPE) was Program Chair of the 4th International Workshop on '*Smart City Clouds: Technologies, Systems and Applications*' Austin (Texas) 2017. **Booth** (CABER) was Chair for the '*Sustainable, Development and Planning (UK)*' conference (2017, 2020).

National keynotes have included: **Lyons** (CTS) at the '*Modelling World*' conference for transport professionals in Birmingham in 2018; **Parkhurst** (CTS) at the Welsh National Transport Conference in 2016; and **Parkin** (CTS) at the annual meeting of the Universities' Transport Study Group in Dublin in 2017. **Jain** (CTS) gave an invited talk at the British Sociological Association Annual Conference in 2017; **Mahdjoubi** (CABER) at the International Conference on '*Heritage Building Information Modelling*' (2018); **Melia** (CTS) at the Scottish National Active Travel Conference, 2017; and **Booth** (CABER) at '*Sustainable, Ecological, Engineering and Design for Society*' in the UK in 2017. **Staddon** (CWCR) gave a public lecture for the Royal Geographical Society on the '*The Future of Food*' in February 2020. **Ludlow** (SPE) gave keynote addresses at the '*Internet of Things (IoT) Smart Cities*' Conference (Excel Centre, London) and the IoT Tech Expo Global (Olympia, London), both 2019. **Longhurst** (AQMRC) gave an invited talk to the Chartered Institute of Environmental Health, World Environmental Health Day Event in London and a keynote address at the '*Challenge and Change: Air Quality*' Conference of the Chartered Institute of Environmental Health in London, both 2017. **Lamond** (CABER) gave an invited talk to UK Construction Week (Birmingham) in 2018 and 2019. **Parkin** (CTS) gave an invited talk at the annual transport industry event '*Traffex*' in 2015.

International keynotes have included: **Staddon** (CWCR) to the 100th Anniversary of the Bulgarian Geographical Society in 2015; **Longhurst** (AQMRC) at the 27th International Conference on '*Air Pollution Modelling, Monitoring and Management*' at the University of Aveiro (Portugal) in 2019; **McEwen** (CWCR) at the 4th '*Disaster Risk Reduction*' Conference in Warsaw (Poland) in 2019; **Atkinson** (SPE) at the '*Small Towns*' conference in Budapest (Hungary) in 2018, **Gething** (CABER) at the Chinese Building Technology Committee Green Forum at the Harbin Institute of

Technology (China), 2014; **Ludlow** (SPE) at the 2017 '*Integrated Network for Social Sustainability*' Conference, Charlotte, USA; **Lamond** (CABER) at EDMIC 2019 '*Drivers and dynamics of change in the Built Environment*' in Ife-Ife (Nigeria) in 2019; **Everard** (CWCR) at the 7th International Ground Water Conference in New Delhi (India) in 2017; and **Cole** (CWCR) at the Critical Tourism Studies Asia Pacific Inaugural Conference in Yogyakarta (Indonesia) in 2018.

In support of collaborative PGR training (see section 2 above) the Unit has partnered with the Universities of Bath, Bristol, Exeter and Plymouth in the ESRC SWDTP which includes more than 300 PhD students plus postdoctoral fellows. UWE contributes as a Management Board member, to subject theme leadership, to taught modules, to supervisory teams and through mentoring post-doctoral fellows. The Unit also partners with Faculty colleagues in the EPSRC FARSCOPE Robotics DTP, in partnership with the University of Bristol, and is part of the University's initiative to develop Partnership PhDs which are part funded and co-supervised by external partners from a wide range of business, professional and community organisations.