

Institution: Manchester Metropolitan University
Unit of Assessment: B7 Earth Systems and Environmental Science
<p>1. Unit context and structure, research and impact strategy</p> <p>Environmental Science at Manchester Metropolitan University has seen a sizeable increase in the quality, depth and volume of research and knowledge exchange.</p> <p>Who we are: UoA7 research is based within the Ecology and Environment Research Centre (EERC). EERC brings together our expertise in physical and biological environmental research and comprises 43 academic research staff, three academic KE staff, and 12 post-doctoral fellows, and is supported by 28 technical staff. The centre provides a dynamic and supportive environment that empowers early career researchers and provides training for 70-80 PGR students to understand critical environmental issues more fully. Excellent global research networks exist with conservation organisations, government and policy bodies, charities, companies and academic institutions. These ensure our ability to undertake international research with wide impact.</p> <p>Located within the Department of Natural Sciences, EERC is one of fourteen new centres established by Manchester Metropolitan University in 2017. As highlighted in the Institutional narrative, this recent establishment of new research centres has been accompanied by a refocusing on our core strengths and strategic investment in key facilities.</p> <p>Distinctive features: EERC's research is both proudly Mancunian and purposefully international. We have a strong heritage in applied research, addressing society's 'grand challenges' of climate change and biodiversity loss. Sixty per cent of our PhD studentships are co-funded or co-supervised by external partner organisations from our global networks (e.g. Chester Zoo, the James Hutton Institute, the RSPCA, Moors for the Future, Natural England, WWF, INVEMAR (Colombia), Kenya Wildlife Service and the Smithsonian Institution).</p> <p>Key Accomplishments since 2014:</p> <ul style="list-style-type: none"> • Internationally-recognised discoveries reported in high profile journals (<i>Nature</i>, <i>Science</i>, <i>PNAS</i>). • £2.6M investment in facilities, including genomics, environmental chemistry and earth observation. • Transformational investment in new staff (22 new appointments including nine ECRs). • £6.9m in external research funding including all major UKRI councils, European and International bodies. • Impactful outreach and industrial partnerships (e.g. BBC, DEFRA, DfT). <p>1a. Organisation and Structure: The research of EERC is focused on two major themes:</p> <p><i>The Ecology and Conservation</i> research theme brings together 31 staff and encompasses applied biological and environmental conservation, animal behaviour and welfare, landscape ecology and environmental microbiology.</p> <p><i>The Global Environmental Change</i> theme is home to 12 staff and encompasses physical environmental change, urban environments, low carbon and sustainable futures, and aviation impacts.</p> <p>Each theme is structured into research sub-groups, comprising researchers with affiliated interests (Conservation Ecology and Evolutionary Biology; Environmental Change; Environmental Microbiology; Low Carbon and Sustainable Futures; and Urban Environments). Considerable overlap among the sub-groups facilitates multi-disciplinary projects and promotes cross-disciplinary supervision of PhD students, essential to our goal of providing solutions to current environmental issues. The Centre is managed by a leadership team composed of a</p>

director, two assistant directors, five sub-group leads, a post-graduate liaison officer and a research and knowledge exchange manager.

1b. Research and impact strategy

The strategic vision of EERC is to promote and develop world-class, applied ecological and environmental research that prevents further decline in ecosystems and creates solutions that mitigate existing environmental pressures.

In 2014, we set ourselves ambitious strategic goals. Through substantive investment in research staff and reimagining of research groupings, our aspirations have been met during the REF period.

Our aim: ‘to ensure the sustainability of Environmental Science research through developing and retaining outstanding staff and attracting new world-leading researchers’ has been met.

This strategic goal was achieved through re-focusing of the Research Centre structure, strategic appointments, and the retention and promotion of excellent staff.

Our Research Centre was re-focused to establish groups around key areas of research excellence and provide better alignment with Environmental Science. We have made 22 strategic appointments from ECR to Professor to extend the expertise and to ensure sustainability. Professor Julia Fa and 11 other PIs have been appointed to develop Ecology and Conservation, and Professor Walter Leal and nine PIs have joined to support Global Environmental Change. Professors Malcolm Press (Vice-Chancellor – not included in the submission) and Jenny Watling are senior staff within the university. Both are experienced ecologists and actively involved in Research Centre activities, providing a wealth of leadership experience. Professor Richard Preziosi joined in 2016 from the University of Manchester with a group of 12 ECRs and assumed leadership of the Research Centre.

The sustainability of the research environment is evidenced by the retention, and current submission, of the majority of staff who were returned to REF 2014 (85% of staff returned in REF 2014, although two are returned to B12, and four have retired during this period). Focused staff development activity for ECRs (e.g. £70K research priming funding) has ensured retention and promotion of all five ECRs, returned in REF 2014. Development of our more experienced staff is evidenced by promotion of Professors Marsden and Caporn.

Our second objective: ‘to further extend internationally excellent research activity in Environmental Science’ has been successfully achieved.

This strategic goal was met through increased support for research publications and grant applications.

The number of research outputs has increased substantially since REF 2014, with over 700 peer review publications since January 2014 (23% in the top 10% most cited papers, 53% in the top 10% of journals (Scival)). This has been achieved through peer mentoring, research writing retreats, and publication incentivisation schemes (e.g. best paper awards and seed funding), and through the appointment of new researchers.

Income has increased to £6.9M, with current awards during this REF period of £8.9M to support a continued increase of future income. We have increased bidding active staff (from 24 to 39) and diversified funding streams to all UKRI Councils (£1m), charities (£350K), government and industry (£3.25M), and European and international sources (£2.2M), ensuring reliability and sustainability of awards. To support this, we have significantly expanded our dedicated support staff (Research Development Managers and Business Engagement team). We have established robust peer review that has substantially improved grant success rates, and we have targeted

enhanced support for ECRs in the areas of publication and citation strategies. We have increased our engagement with funders and have arranged visits from both small charity funders, e.g. People's Trust for Endangered Species (PTES) and UKRI panels, e.g. NERC. Our monthly Centre meetings stimulate a supportive environment where staff are able to identify internal collaborators and share bid preparation strategies.

Our third major goal: 'to develop and lead research programmes with international impact' has been delivered.

This strategic goal was achieved through the expansion of our global research networks and the organisation of international conferences.

We have continued to build on the success of the Centre for Aviation, Transport and the Environment (CATE), which now forms the core of the Low Carbon and Sustainable Futures group. This group continues to receive international recognition for work, which feeds directly into the Intergovernmental Panel on Climate Change (IPCC), and works with the airline industry and DfT to inform policy and reduce emissions from transport. We have several international projects investigating aircraft noise (e.g. ANIMA, £700K EU), emissions (e.g. AVIATOR, £500K, RAPTOR £104K) and air quality (e.g. Airbus £51K), and these are featured in two of our impact case studies. We are leading fundamental research into climate change and the global importance of UK bog habitats (Interreg £307K). We are working closely with international conservation authorities to protect our natural resources, including conserving wildlife in Africa with the Kenyan Wildlife Service, supported by The Global Challenges Research Fund (GCRF), protecting and restoring tropical forests with the Brazilian government, e.g. BNP Paribas Climate and Biodiversity Initiative, BIOCLIMATE project, and protecting fisheries in Ecuador, Colombia, Belize and The Bahamas, e.g. Newton-Caldas Pescando para la Vida project. We have also focused effort on organising outreach events and hosting high profile international research conferences, e.g. Royal Society Chemistry, Society for Environmental Geochemistry and Health, Amphibian Conservation Research Symposium.

Our final aspiration: 'to improve engagement and influence with policy-makers, practitioners and the public', has been exceeded.

This strategic goal was achieved via the provision of increased support for policy, practice and public engagement.

We have created strategic job roles with local and national organisations, e.g. Greater Manchester Combined Authority, joined policy-relevant networks (IUCN, Transport Systems Catapult, Heathrow Advisory Group and COP26 Universities), undertaken placements and fellowships with nationally-recognised bodies, e.g. DEFRA, Natural England and the British Ecological Society, and joined international panels advising on global issues, e.g. IPCC, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and The International Union for Conservation of Nature (IUCN). This has enabled us to influence policy, practitioners and the public at the *local, national and international* levels.

We take our responsibility as a Greater Manchester Research Centre seriously. We value our engagement with local policy-makers and practitioners, and our research is deeply rooted in our community. To leverage *local* opportunities better, a member of the Manchester Metropolitan Professional Support staff was appointed to work jointly at Transport for Greater Manchester. This greatly enhanced knowledge exchange and we are now leading a group of universities (University of Manchester and Salford University) and public bodies, e.g. the NHS, schools and churches, implementing the largest global, real time air-monitoring network to inform transport policy better. EERC staff are active board members of local policy committees, including the Manchester Green and Blue Infrastructure Strategy Group (Cavan; successfully winning a National CIEEM Chartered Institute of Ecology and Environmental Management Award for Knowledge Exchange in 2018), Manchester Climate Change Committee (Dunk), and Chair of the Greater Manchester Wetlands Partnership and Technical Steering Group (Field). We have

secured NERC public engagement funding to run national school and public engagement events.

We have undertaken funded fellowships and placements with government bodies (DEFRA and Natural England) and the media (BBC) to enable the transfer of knowledge between our research, policy-makers and the public. Cavan is a Steering Committee member of the DEFRA Urban Pioneer Strategy Group, delivering the UK Government's 25-year Environment Plan. EERC is leading delivery on Greater Manchester's climate change strategy by improving the carbon literacy of residents and businesses, training over 1,000 community members and 56 carbon literacy trainers, who have subsequently trained >2,000 people nationally. Our award-winning Carbon Literacy for Students (CL4S) programme has trained 32 trainers and >1,000 students, and was recognised by the national 2019 Green Gown awards.

We have been informing policy and practitioners on a *global* scale through positions on policy boards, including the British Standards Institution and International Organization for Standardization (Megson). Our staff also lead the International Civil Aviation Organisation's Impacts and Science Group (Lee), and Emissions Technical Working Group (Owen).

1c. Strategic aims (2021-2028)

We aim to build on our strengths and encourage interdisciplinary research that enables us to lead projects with international relevance, especially in the areas of climate change and biodiversity loss. We have set out the following three aims to improve our outputs, impact and environment:

- 1) To enhance the quality and influence of our research **outputs** by drawing upon our established international collaborations and further developing interdisciplinary research networks.
- 2) To extend the reach and significance of our research **impact** by ensuring benefits to the environment, society and economy, through a focus on the UN Sustainable Development Goals.
- 3) To develop the vitality, sustainability and inclusivity of our research **environment** through investment in our staff and research infrastructure.

Delivering on the strategic aims

Support of our research staff to ensure their development, retention and promotion.

2014-2020 has been a period of significant expansion for EERC, particularly in the hiring of ECRs. The sustainability of the Centre will be ensured through continuous development and promotion of our colleagues in line with the Concordat to Support the Career Development of Researchers. We will retain the core management structure of EERC, supported by an external advisory board. We will continue to make strategic appointments to strengthen our core research areas, whilst also providing support for existing staff to retain our internationally-excellent ECRs.

Internal funding will support ECRs and those returning from career breaks, whilst also providing seed funding for larger research grant applications, enhanced business engagement and the development of wider impacts. We will continue to offer match-funded PhDs to leverage opportunities to collaborate with industrial partners, provide funding for writing retreats and workshops, and support networking events and weekly research seminars. We will ensure ECRs meet the Director on a quarterly basis to review progress, discuss plans and identify any additional support. ECRs will be included on the supervisory team of all new PhD students to provide leadership opportunities.

EERC is committed to creating a positive environment where all staff are treated fairly and with dignity and respect. We will strive to maintain gender equality, and ensure equal opportunities for career progression and appointments for people from diverse backgrounds. We will make all researchers feel welcome and supported. This ethos will be embedded into our culture and

supported by targeted training and mentorship opportunities.

Investment in our research facilities

We are embarking upon the construction of a new £150M Science and Engineering building, including ocean acidification facilities, an *ex situ* Amphibian Research Facility, bespoke cold rooms for glacial core analysis, and new areas for microscopy, environmental chemistry and ecological genetics and genomics. The provision of these facilities will enhance our ability to conduct world-class environmental research, attract new international collaborations and support the retention of excellent staff.

Creation of a professional engagement network to connect better with policy-makers, practitioners and public stakeholders.

EERC excels in initiating truly collaborative links with national and international partners. We are an established partner of choice, especially for development efforts in less advantaged countries. We are currently one of the preferred research partners for Kenya Wildlife Service; have developed links with the Danube Delta Research Institute as part of the DANUBIUS programme; and support bird conservation research efforts in South East Asia.

Our professional networks will be expanded by inviting high profile leaders from NGOs, government and industry, to deliver presentations and discuss how EERC can provide research to meet their needs. Specific strategies will include:

- Improving our KTP success by organising events to demonstrate our equipment, facilities and expertise to potential partners: this includes a dedicated demonstration lab in our new science building plans.
- A dedicated marketing campaign to promote our research achievements and capabilities.
- Encouraging and facilitating staff to take on policy placements and fellowships.

Enabling Impact

Dedicated support staff promote the impact of our research at research centre-, faculty- and university-levels, including a media communications centre. 'Impact Generator' funding (~£10k) is available for the development of high-quality research impact. For example, Marsden received travel funds to engage with the Peruvian Service for Natural Protected Areas, resulting in the incorporation of EERC research into the 5-year management plan of protected regions in Peru. Mossman received funds to improve salt marsh restoration outcomes by engaging engineering consultancies and conservation NGOs. This cemented relationships with WWT and resulted in a DEFRA Green Recovery Challenges Fund grant. Two EERC staff members (Mossman and Adamson) have won 'Science Communication Champion' awards during the current REF period.

1d. Open Access and Data Management

Tackling the environmental grand challenges requires the generation, storage and sharing of high-quality data and analysis tools, and the marshalling of global data. In EERC, we ensure all staff members have access to the tools and services necessary to manage complex and heterogeneous environmental and ecological datasets.

Our research is fully compliant with the REF Open Access policy and the Concordat for Open Research Data. We incorporate Research Data Management (RDM) to ensure high standards of research integrity, and improve transparency and reproducibility. Our Research Data Management Policy (2017) states that we 'firmly believe that good research data management is the foundation of good research, since it allows for the verification of findings and supports digital preservation'.

Support for RDM/OA is provided by the University Library and we have substantial resources to ensure that our outputs are accessible via green or gold routes. Since 2016, EERC members have received ~£70k for article processing charges and we have targeted this towards high-

profile, externally-funded research.

Research data deposited in the Institutional Data Repository (e-space) are securely archived for a minimum of ten years, or the minimum period stipulated by legal, contractual, ethical or regulatory requirements, whichever is longer. Data are accompanied by a metadata record indicating method of collection, creation or acquisition, and whether the data are to be made openly available, to assess re-use potential. Back-up data storage is provided through our Research Data Storage (RDS) platform, which facilitates storage of large datasets (e.g. images, videos, 3D-models and genomic data).

1e. Research Integrity

EERC researchers abide by the Concordat to Support Research Integrity. All staff and PGRs are required to obtain ethical approval for all research projects. Our online system for conducting ethical reviews (EthOS) focuses on the ethical conduct of research and data protection, legal requirements, insurance, and research communication. Each application undergoes academic review before approval by the Faculty Research Ethics and Governance Committee. EERC has taken a leading role to ensure that the wider University is aware of, and compliant with, international research agendas relevant to environmental science. For example, in 2019 we became a UK CITES Registered Scientific Institute and have developed robust procedures for Nagoya Protocol compliance. EERC has ensured that ethical reviews include non-ASPAs animal research and field-based data collection.

Our Contracts team provides specialist support including reviewing, drafting and negotiating agreements (i.e. non-disclosure agreements, collaboration agreements, consortium agreements, contracts for services, funder terms and conditions, contract research agreements and material transfer agreements), ensuring compliance with relevant legal standards. Research involving personal data of living individuals, including staff, students, contractors, research subjects and customers, is regulated by the Data Protection Act 2018 (DPA) and the General Data Protection Regulation (GDPR). All staff must comply with the DPA and the GDPR whenever processing personal data held by the University or on behalf of the University. An Essential Data Protection Training Module is undertaken by all staff.

In line with the San Francisco Declaration on Research Assessment (DORA), we have revised our policies and practices for recruitment, promotion and internal funding decisions to avoid the problematic use of journal impact factors and h-indices as a means of evaluation. Instead, we promote responsible metrics and alternative tools that enable consistency and transparency in decision-making, including an appreciation of all outputs (code, software, datasets, etc.) and the inclusion of qualitative metrics of research impact, e.g. influencing policy and practice. We encourage EERC members to prioritise the publication of papers and data in venues most readily accessible to their target audience, including zoos, conservation charities and NGOs.

1f. Interdisciplinarity

EERC actively encourages interdisciplinarity as core to addressing environmental 'Grand Challenges', but also as a means of promoting research integrity through the exposure of researchers to other disciplinary norms and standards. We consider interdisciplinarity when evaluating individuals for hiring and promotion, especially where such work does not conform to 'traditional' metrics.

EERC staff also belong to Manchester Metropolitan's Centre for Place Writing and its Research Centre for Social Sciences. In collaboration with Manchester Metropolitan's Applied Image Engineering (AIE) group, EERC members (Brassey; Grant; Pedley and Lees) have each received three months funded software developer support enabling efficient coding in the fields of computer vision and deep learning. Additional internal collaborations exist with healthcare (reproductive physiology; neuroscience and cognition; and microbiology); sports science (biomimetics and biomechanics); engineering (biorobotics; additive manufacturing; advanced functional materials and catalysis; and environmental monitoring); business (economies of disease; place management; and KTP development); and education (civic engagement). Three

EERC members have also partnered with composers at the neighbouring Royal Northern College of Music in the '8 Cubed' project, to create new musical pieces inspired by our research, and performed during the British Science Week 2018. These interdisciplinary links are essential in our mission to address major issues, such as climate change and biodiversity loss, and to communicate our work broadly.

Securing funding for interdisciplinary research has historically been a challenge, yet EERC researchers have had considerable success collaborating with other disciplines. Grant was awarded an EPSRC grant with mathematicians and roboticists to model the mechanics of animal whiskers. Brassey secured a Royal Society Apex Award for remote damage assessment of built heritage in conflict zones, in association with archaeology and heritage conservation experts from the University of the West England, the University of Newcastle, and Menoufiya University, Egypt. Megson was awarded ~£500k of in-kind industry funding (AirSensa) in collaboration with infrastructure engineers to combine big data and environmental monitoring, establishing one of the world's largest real time, air quality monitoring networks in Manchester.

2. People

Introduction

The current assessment period has seen an unprecedented expansion in the number of our staff with a significant responsibility for research. Excellent researchers are at the heart of EERC and, in line with the Researcher Development Concordat (RDC), our policies and practices are explicitly designed to ensure that researchers achieve their full potential. Manchester Metropolitan is committed to the principles of the RDC and received the EU's HR Excellence in Research Award in 2013.

Section 2a. People: Recruitment strategy

Our recruitment strategy has been to target experienced researchers from research-intensive backgrounds alongside ECRs with excellent potential. We require new academic appointments, including PDRAs and ECRs, to have a proven track record of high-quality outputs and competitive funding awards. When considering candidates we are sensitive to the diverse career pathways travelled by applicants, including career breaks and time spent outside academia. Academic interviews are chaired, either by the Vice Chancellor (Professorial level), or the Faculty Pro-Vice Chancellors (all other academic appointments). The Faculty Head of Research and Knowledge Exchange sits on all interview panels for new academic appointments to evaluate alignment to the Research Centre priorities. All members of interview panels undergo unconscious bias, and equality and diversity training.

As a direct consequence of our recruitment strategy, the number of research staff returned has increased from 24 in 2014 to 43 in 2021. These strategic appointments range from ECR to Professor and have reinforced the sustainability of our Centre. EERC has attracted and retained high-quality candidates at every stage of their academic career, as reflected in the staff contract level of our REF2021 submission.

Professor	Principal Lecturer and Reader	Senior Lecturer	Lecturer, Research Fellow
15%	4%	55%	26%

The high number of ECRs (23%) highlights our commitment to searching for talented staff at the beginning of their research careers. EERC has also hosted three H2020 Marie Skłodowska-Curie Postdoctoral Research Fellowships (Kelly; Symeonakis; Arnau-Rosalén) and a BBSRC Future Leader Fellowship (Brassey) in this time frame, an additional marker of our growing reputation as a research centre.

At the professorial level, Preziosi joined us in 2016 from the University of Manchester and

additional professorial appointments (Fa and Leal) have proven fundamental in the shaping of research clusters. The alignment of Professors Press (Vice-Chancellor) and Watling (Pro-Vice-Chancellor International) as both experienced ecologists, and senior university leaders has afforded EERC a unique opportunity to benefit from their wealth of experience.

To minimise job insecurity and to support long-term staff development, we avoid the use of short, fixed-term contracts (we have no staff on these contracts and only one member of staff on a fixed-term contract >two years), and have phased out associate lectureship positions. New staff undertake induction programmes, providing a valuable overview of processes and support available at University-, faculty- and Centre-level, and providing key information on research conduct, integrity, ethics, and equality and diversity policies. Tailored inductions are provided for relevant research and laboratory areas, *i.e.* health and safety, procurement and grant management. Our Graduate School provides mandatory training for research staff taking on postgraduate supervision and examination responsibilities.

Section 2b. People: Development strategy

Membership in all research centres is based on characteristics set out in a university charter that was widely consulted upon. Staff considered to be full members of EERC are allocated a minimum of 20% (up to a maximum of 50%) of their workload to research. EERC members are supported to produce high-quality outputs, submit funding applications, supervise postgraduate students, and engage in impact generation or knowledge exchange. The extent to which staff achieve these expectations is monitored by the EERC leadership team and the Head of Department via the Performance Development Review (PDR) process (see below). Since its establishment, EERC leadership has worked hard to identify and mentor those colleagues who were initially unable to meet membership requirements and were not previously returned to the REF2014. By combining the PDR process with targeted mentoring, five individuals have subsequently produced quality research outputs, and are now core EERC members and included in our REF return.

We encourage colleagues to engage in at least ten days of Continuing Professional Development (CPD) per year. We run writing retreats and grant-writing workshops, and a member of our leadership team (Rowntree) has undergone bespoke Retreat Facilitator training. We provide sessions on postgraduate supervision, budget management, knowledge exchange and impact generation through our monthly research group meetings, and additional funding is made available for staff to attend external workshops and conferences.

Our policy of recruiting research-active academics has resulted in a large proportion of Early Career Researchers within the Centre (within five years of their first permanent employment). ECRs need additional support to transition successfully to being independent investigators, and EERC provides this in several ways. Importantly, our EERC leadership team includes academics actively involved in ECR funding and policy development decisions across UKRI research councils. Associate Director, Brassey, is a current member of the BBSRC ECR sub-group of the Careers Strategy Advisory Panel and is the EERC lead for ECR development. Rowntree is a member of the EERC leadership team and has recently joined the NERC IRF panel.

Several internal funding opportunities are primarily aimed at ECRs. The Research Accelerator Grant (£5k) provides funding to pump prime larger external applications. The Research Development Fellowship (three months, £5k) provides an opportunity to undertake research within another academic sector or with non-academic organisations. The International Collaborative Fund allows ECRs to host meetings in the UK or internationally around a specific theme that aligns to external funding opportunities. For example, ECR Rivett was awarded an Accelerator Grant to establish his research, which has resulted in his securing additional external funding from the Microbiology Society. ECR Megson was awarded an Accelerator Grant for match-funding equipment that resulted in a new industrial collaboration with Waters to create a trace-level organic mass spectrometry facility.

Postdoctoral fellows are highly-valued members of our research community and are considered full members of EERC. Our 12 current postdoctoral researchers are funded from internal and external awards. Postdoctoral fellows are provided with the same opportunities and support as full-time permanent staff, and are mentored to develop their skills in grant-writing, analysis and PhD supervision. In accordance with the RDC, postdoctoral fellows are encouraged to engage in ten days of CPD per year.

Research leadership development is provided through Manchester Metropolitan's Future RKE Leaders Programme, which is designed to advance the academic development of candidates and enhance their leadership skills. The programme is aligned with the Vitae Researcher Development Framework and is delivered to small, interdisciplinary cohorts; it encourages collaboration and peer support. Progress is supported through mentoring and a £5k funding allowance for bespoke development activities. Seven EERC members have taken part in this scheme during the census period.

Mentoring is core to staff development in EERC. Every staff member has regular meetings with the directors to discuss their plans for research, and to provide two-way feedback between the leadership team and group members. Staff are also encouraged to take part in the faculty mentoring scheme.

The Professional Development Review (PDR) process is central to the monitoring of staff performance. We ensure PDRs are constructive, and provide staff with an opportunity to reflect on their performance and identify development needs. In PDRs, staff reflect on recent research achievements and present five-year research plans including potential grant applications, planned PhDs, and KE activities. These inform EERC membership and significant research responsibility in line with Manchester Metropolitan's Institutional Code of Practice for Research. PDRs offer the opportunity to recognise the outstanding achievements of staff formally, and to further their career development by providing motivation and direction.

Excellence in research is primarily recognised through our promotions system. Clear and consistent promotion criteria are openly available to staff to assess their own progression and inform development. Potential applicants are encouraged to discuss their research profile, including their external funding success and evidence of research impact, with the Centre Director. Manchester Metropolitan's dedicated Professor and Reader Promotion Process (PRPP) comprises two distinct strands and recognises outstanding contributions to research and education/pedagogy. The PRPP is overseen by the Pro-Vice Chancellors for RKE, and for Education, with mentoring provided by the EERC leadership team. Information sessions supporting BAME and female colleagues are designed to encourage the pursuit of leadership roles. Twenty-one members of EERC have been promoted during the current census period, including one colleague to Reader and two colleagues to Professor.

Sabbatical opportunities are supported when they closely align with the strategies and goals of research centres. There are no restrictions concerning who may apply and various funding routes exist, including central strategic opportunities and Faculty and Department budgets. Engagement and exchange between other HEIs, business, industry and public sector bodies is a strategic priority. EERC encourages exchanges with business, industry or public sector bodies through sabbaticals and Business Engagement Seed Funds (£5k) designed to identify collaborative opportunities. The Innovation and Industrial Engagement Fund provides matched funding of up to £40k to foster long-term industrial partnerships. For example, Megson has been awarded £4.5k to pursue an opportunity with the British Geological Survey and >£250k in matched funding of analytical equipment with Waters Corporation.

Staff have undertaken fellowships and placements with government bodies and the media to enable knowledge transfer with policy-makers and the public. Mossman won the British Ecological Society Policy Fellowship and worked in DEFRA's Environmental Land Management & Wildlife Evidence Team (Whitehall) for seven months. Megson spent a six-month placement at the Ontario Ministry of the Environment, Canada, developing methods for the Ministry to monitor

emerging pollutants. Two EERC staff (Lees and Brassey) were awarded British Science Association Media Fellowships and undertook one-month placements at the BBC science desk, contributing to live television pieces and online news articles. Exchanges have also taken place between EERC and other HEIs. Clarke engaged in reciprocal visits with senior researchers at the Siberian Branch of the Russian Academy of Sciences in 2020 (funded by the NERC Arctic Office UK-Russia Arctic Bursary) and Symeonakis was seconded to Wageningen University and Research, Netherlands and the Humboldt University of Berlin, Germany.

Section 2c. People: Post Graduate Students

We have a large and diverse community of PGRs including international, mature and part-time students. Forty-five EERC PGRs have completed their PhDs within the current REF census period. Our PGRs publish high-quality research, valuable policy documents, book chapters and software. Many have subsequently taken up positions in other HEIs, as PDRAs (University of Pretoria, CRNS France, University of Freiburg, University of Manchester, University of French Guiana, and Kansas State University); and faculty members (University of Durham, Umm Al-Qura University Saudi Arabia, Visayas State University Philippines, and the Federal University of Technology Nigeria). Others have moved into research organisations (British Geological Survey, Tyndall Centre for Climate Change Research, and the National Research Council of Canada); business and innovation (Blue Prism Software Development, and Aldi Energy and Environmental Strategy); conservation and education (Kew Gardens, Blackpool Zoo, and PAMS foundation Africa) and local government (Liverpool City Combined Regional Authority).

Studentships from major funding bodies

In the current census period the majority of our doctoral funding stems from charities and external organisations; however, some support has come from major funders, such as NERC and the Leverhulme Trust. Full studentships have been awarded by the Commonwealth PhD Scholarship fund, the Newton Fund and National Geographic, and funders including CBS (Saudi Arabia), COLCIENCIAS (Colombia), CONACyT (Mexico), Guatefuturo (Guatemala) and PTDF (Nigeria). EERC hosts many match-funded (> 50% external funding) studentships with partners including research organisations (James Hutton Institute; and the French Agricultural Research Centre for International Development); conservation charities (the Marine Megafauna Foundation; and World Animal Protection); zoos (Blackpool Zoo; and Knowsley Safari Park); regional councils (Lancaster City Council) and software developers (Noldus Information Technology). Chester Zoo is a major strategic partner supporting nine PGRs who are Conservation Scholars at Chester Zoo, and were funded partly or entirely by the zoo. Through these, EERC has contributed to the conservation management of a diverse array of taxa, from salamanders to African elephants.

Recruitment of doctoral research students including those with protected characteristics

EERC leadership is heavily involved in the recruitment and appointment of PGRs. All interview panel members undergo unconscious bias training, and interviews are always conducted by a mixed gender panel. Interviews are considered two-way conversations, and applicants are encouraged to ask questions regarding the supervisory arrangements, access to facilities and to identify any specific training needs. Interviews also provide an opportunity to discuss reasonable adjustments that may be required. We work hard to ensure our PhDs are accessible to the widest range of students, including those often excluded from postgraduate study. During the current REF census period, 24% of our PhD students were from a BAME background, compared to ~15% nationally (HESA 2017/18 'Natural Sciences'). We offer flexible PhD pathways, including part-time learning, breaks to support caring commitments, distance learning and PhDs by publication.

Monitoring and support linked to evidence of progress and successful completions

Each PGR has a supervisory team consisting of a principal supervisor and at least one other internal supervisor. The supervisory team must have a minimum of three PhD completions between them, ensuring PhD candidates benefit from an excellent supervisory experience. PGRs have a two-day induction event that includes a range of talks, workshops and social

events. Topics include: 'The Student Journey', 'Science Communication', 'Links between Research and Business Development', 'Research Ethics & Governance' and 'Health and Safety'. The social elements include lunch with supervisors and a social, where all students, existing and new, are invited to attend.

PGRs each have their own desk and university-provided laptop to enable flexible and remote working. EERC encourages interdisciplinarity and PGR offices contain mixed discipline groups. Progression is monitored via the online platform 'SkillsForge', where detailed records of student-supervisor meetings and annual reviews are kept. The PhD journey comprises a project proposal and an ethical and risk assessment in the first three months, followed by a formal project progress report and viva at the end of Year 1, designed to prepare PGRs for their final viva examination. Progression is dependent upon ethical approval for their project and completion of an online module establishing awareness of the Concordat for Research Integrity. Annual reviews provide pastoral support, and identify training and support needs. Monthly supervisory meetings are documented and agreed by all parties, ensuring continued high-quality student support. All students are expected to submit their thesis within four years (pro-rata). All PGRs have access to University Wellbeing and Disability Services. Internally-funded students are entitled to receive Maternity, Paternity and Adoption funding in line with UKRI-funded students.

Skills development provided to research students

On arrival, PGRs work with their supervisor to complete a training needs analysis (based on Vitae's Research Development Framework), and identify any support they require and further development opportunities. Within EERC, we also support our PGRs through the development of individual Career Development Plans, similar to staff PDRs. PGRs automatically become full members of the research centre to which their supervisor belongs and are invited to participate in centre activities. EERC has a PGR-led weekly seminar series where internal and external researchers are invited to speak. These seminars ensure exposure to the full range of research carried out within the Centre, and integrate PGRs into EERC's culture and mission.

Faculty and University PGR conferences are organised annually. Students are also encouraged to attend external conferences and training courses, and are supported through a Conference and Training Fund. PGRs are also encouraged to host their own conferences. For example, the 2018 Progressive Palaeontology conference (sponsored by the Palaeontological Association) was hosted at Manchester Metropolitan by an EERC PGR and attracted 90 PGR delegates from 20 HEIs, including international students. Likewise, a group of EERC PGRs organised the 2019 Royal Geographical Society PGR conference, attended by 56 delegates from 31 institutions. EERC PGRs have organised sessions on remote sensing at the 2016 international EGU conference, convened 'science storytelling' workshops at EGU2018 and 2019, organised and chaired sessions in the UC Davis Aviation Noise and Emissions Symposium in 2020 and 2021, and developed interdisciplinary field courses between UK and Russian ECRs working on Arctic natural and social sciences as part of the UK Polar Network.

PGRs are encouraged to publish their work, and financial support is available to facilitate this. We provide writing retreats and guidance in research methods, statistics and transferable skills through dedicated training sessions. Excellence in science communication is encouraged through our annual 'Peer Reviewed Publication' and 'Images of Research' competitions. Public engagement training is provided for PhD students with little experience, and our PGRs attend externally-organised training courses, such as the Media and Engagement course run by SciConnect. PGRs have taken responsibility for organising events for the Manchester Science Festival, Earth Day and European Researchers Night, and the monthly SciBar Manchester events.

Section 2d. People: Equality and Diversity

EERC is committed to providing a collegiate research environment, in which all staff and students are treated with dignity and respect. Manchester Metropolitan's commitment to Equality

and Diversity is recognised by an Athena Swan Bronze award, and our membership of the Race Equality Charter. Our commitment to equal opportunities is set out in our Equality and Diversity policy. The University is a Disability Confident Leader, and in 2017 we became the first university to receive the highest rating of Gold for the Business Disability Forum's Disability Standard. We are proud of our support of LGBT+ staff and students, and rank second in the English education sector for the Stonewall Workplace Equality Index.

All shortlisting and interview panels are gender-balanced and disability access aware, as are any associated campus tours, lunches or staff meetings. We are a Disability Confident employer, which ensures that any disabled candidate who meets the essential criteria for a vacancy will be guaranteed an interview. EERC is committed to addressing gender inequality and increasing diversity at management and policy-making levels. Roles within the leadership team are three-year fixed terms, and EERC members are recruited to these positions through a transparent application and interview process. ECRs and staff with protected characteristics are particularly encouraged to apply. Several EERC leadership positions are currently held by women (two Associate Directors, two Group Leads and a Postgraduate Lead) and the demographic profile of our submission is 40% female and 60% male. Three members of the EERC leadership team have taken parental leave during the current census period. Succession planning is achieved by nurturing internal talent, and by giving associate directors the opportunity to make key decisions and represent the Centre at high-level meetings, mentored by the director when necessary. EERC staff are encouraged to attend workshops to support female applicants for promotion to reader and professor, and the university has supported three EERC leadership staff (Rowntree, Cavan and Potgieter) through the Advance HE's Aurora Leadership Development Initiative for women and those who identify as a woman.

Internal funding calls are frequent and well-advertised, allowing colleagues to manage workloads and plan applications in advance. Manchester Metropolitan is moving towards continuous, rolling deadlines for internal awards to increase flexibility for applicants with diverse responsibilities. When internal peer reviews are sought for external grant submissions, we adopt a model of early intervention. EERC staff are asked to provide feedback to their colleagues far in advance of final deadlines, ensuring applications are given sufficient time to revise drafts whilst also balancing additional work and family commitments. Any internal triaging of grant applications is overseen by the Research Development team and EERC leadership, both of which attend frequent information days and briefing webinars to remain up-to-date with sponsors' requirements and E&D initiatives. For staff with caring responsibilities, any internal funding distributed by EERC for conference attendance or other research-related travel may include a component for carer's expenses to cover additional costs.

Manchester Metropolitan has a clear and transparent 'flexible working procedure', which allows for temporary part-time working and career breaks. Staff may also be granted a 'leave of absence' to work remotely when pursuing specific research or CPD opportunities. For longer-term arrangements, staff may request contractual changes to accommodate their individual circumstances. Career pathways and research provision for part-time staff are equitable with those of full-time staff members, with all staff in EERC provided with equal access to opportunities for funding, training and mentorship. Our promotions scheme also ensures that colleagues are not penalised for taking career breaks. All EERC meetings and research seminars are held during core working hours. Staff and PGRs can take parental leave, and upon return to the university, can take advantage of our flexible working policy. We offer a generous provision of paid 'keep in touch' days to help staff in preparing for their return to university. On return to work, members are provided with dedicated support for reintegration into the Research Centre. Applications for internal EERC funding are particularly encouraged for those returning from career breaks, thus supporting reintegration into the Research Centre as mentioned above. EERC was also host to a Daphne Jackson Trust Research Fellowship for STEM research (Dr Raly Vellaniparambil; 2016 – 2017).

The Research Centre supports members when they return from parental leave through a reduction in workload and ability to work flexibly or from home to support their partner.

Representatives from Equality & Diversity and Human Resources have attended the EERC monthly meetings to allow for direct information-sharing and discussion. Wellbeing and social cohesion are promoted through monthly socials - financially supported by EERC - and weekly seminar and group meetings. The EERC promotes engagement with a number of wellbeing resources, such as Manchester Met Moves (activity programme) and HealthyU (nutrition and wellness programme).

Supporting the wellbeing of staff and research students

We take a proactive approach to addressing the potential for bullying and harassment to occur within a research environment. PGRs are assigned pastoral, non-supervisory mentors, in order to maintain healthy power dynamics within supervisory relationships. Supervisors and line managers are required to provide access to professional development for postgraduate students and ECRs, who are also encouraged to engage in training and research outside of their core projects. We foster an atmosphere in which Centre members are comfortable in raising concerns or complaints by adhering to the 'Dignity at Work' policy, and mechanisms for complaint are made clear and transparent.

Equality and diversity in the REF submission

A Code of Practice governing the membership of research centres and the allocation of internal funding and research time has been developed by Manchester Metropolitan's RKE team, in collaboration with Human Resources and UCU. The aim of the Code of Practice is to ensure fair and consistent decision-making regarding research resource allocation and REF submission across the university. Following this Code of Practice, EERC leadership aimed to be fair, transparent and inclusive in our preparation for REF2021.

As dictated by Manchester Metropolitan's Equality and Diversity Strategy Implementation Plan, staff in EERC, with a responsibility for research management, have undertaken mandatory training in a wide range of topics aligned with E&D policy. This includes all EERC staff involved in REF preparation, including the selection of outputs and impact case studies. Courses include:

- Unconscious Bias in Recruitment and Selection Panels
- Standalone Unconscious Bias Training
- Managing Diversity
- Equality and Diversity Essentials

Outputs submitted to REF2021 were selected on the basis of quality, in line with DORA and the UK forum for Responsible Research metrics. Outputs were initially assessed by Centre members in an internal 'preREF' process, followed by consolidation by the EERC leadership team, where attention was given to ECR and gender balance. We have taken proactive steps to maximise equality and diversity in our submission.

In line with the Code of Practice, staff were encouraged to register 'personal circumstances' they considered to have negatively impacted upon their research outputs. This process was handled confidentially by the HR directorate. Results were conveyed to EERC as an estimate of number of outputs 'lost'. EERC leadership subsequently reviewed membership decisions ensuring staff were not excluded from EERC on the basis of personal circumstances. No staff were removed from our return.

3. Income, infrastructure and facilities

Income has increased (to £6.9M) with current awards during this REF period of £8.9M. This has been achieved through increasing the number of staff bidding for research funding (from 24 to 39), improving the quality of bids, and strategic diversification of funding streams that covers the full range of UKRI Councils (£1m), charities (£350K), government and industry (£3.25M), and European and other international sources (£2.2M).

Funding and strategy for research Income

EERC has invested over £1M on strategic recruitment of researchers, and £250K to recruit postdocs to support ECRs. Within our faculty, 100% of QR funding is reinvested in research, and grant overheads are used for strategic research investment. Our growth in research awards and income is facilitated by increased internal investment into new appointments in priority areas, and a successful diversification of research income specifically targeting international funders. We have continued to attract UK government funding but have also improved our collaborations with industry and charities, and undertaken a more targeted approach to attract UKRI funds.

Diversity of Income Sources

<i>Income source</i>	BEIS Research Councils	UK Charities, Open Competition & Other	UK Govt, Industry & other UK Sources	European Union	Non-EU
<i>Income percentage</i>	15%	5%	47%	28%	5%

EERC received funding from UK government agencies (e.g. Darwin Initiative, British Academy, British Council, Newton Foundation, Foreign and Commonwealth Office, and Global Challenges Research Fund); UK and international charities (e.g. Chester Zoo, Scottish Forestry Trust, Leverhulme Trust, Loro Parque Fundacion, World Animal Protection, ZGAP Zoological Society), UKRI (including NERC, BBSRC, and EPSRC); learned societies (e.g. the Royal Society, and the Royal Society of Chemistry); international funding bodies (e.g. the European Commission), and industry (e.g. Interreg Europe, and Viridor). Other smaller but notable funders include National Geographic, the Peoples Trust for Endangered Species, the Rainforest Trust, and the Save our Seas Foundation.

By diversifying our funding sources, we aim to ensure that income streams are reliable and sustainable. We have established a robust peer review system for grants that has substantially improved success rates, and we have targeted enhanced support for ECRs in developing publication and citation strategies. We have migrated our grant management system to the cloud-based Worktribe solution, which enables us to develop efficient workflows. We have increased our engagement with funders and have arranged visits from small charities (e.g. PTES) and major UKRI panels (e.g. NERC). Through our monthly research seminars we share recent publication and grant success, stimulating a supportive environment where staff can identify internal collaborators and share experiences of successful bid preparation. Manchester has a strong industrial heritage and we have partnered with the business growth hub to engage with industrial partners. This has proved successful, as we have obtained funding for scoping studies with BCR and DeWipe which have led to successful KTP applications.

Major awards and links to high quality outputs and impact

CATE leads several major international projects on aircraft noise (e.g. ANIMA, £700k EU), emissions (e.g. AVIATOR, £500k, RAPTOR £104k), and air quality (e.g. Airbus £51k). We are also leading fundamental research into climate change and better understanding of the importance of UK bog habitats from a global perspective (Interreg £307k). These projects are featured in three of our impact case studies.

Infrastructure

In 2017, a strategic decision was taken to change the organisational infrastructure to align and group our key areas of research excellence better. For REF 2021 we are returning this more-focused group with two major themes: Ecology and Conservation, and Global Environmental Change.

Research Support Infrastructure: EERC is led by a director, two associate directors and a leadership team of six additional academics that lead research subgroups and support research staff across the Centre. EERC is supported by a team of dedicated RKE professionals to review

and approve grants, including a Research Development Manager, an Impact and Public Engagement Manager, an RKE Delivery Team, an Ethics and Governance Manager, and a contracts team.

The RKE Team provides pre- and post-award support, facilitates the peer review process prior to grant submission, and provides staff with information about funding opportunities. Manchester Metropolitan is subject to NERC demand management, and we operate an internal expression-of-interest procedure, which advertises and regulates submissions, ensuring that the strongest proposal is developed for each funding round. We have an Impact Team that supports the Centre through a dedicated officer, grants to help convert research to impact, and writing retreats to complete case studies. The Impact Team works with a dedicated member of the leadership team to manage and develop impact cases, and our media outreach is supported by a dedicated press officer, and a video broadcast facility.

Collaborative research with industry is supported by our Business Support and KTP teams, who facilitate meetings, and industrial networking, and administer industrial grants. Successful programmes include KTPs and match-funded PhD studentships. Wider collaborations are supported through appointments of senior staff with links to large international consortia (Professors Leal and Fa) and forestry networks (e.g. Sullivan, Lees and Brearley). Our laboratory facilities are staffed by 25 technical colleagues to support research and maintain equipment.

Facilities

Since REF2014, EERC has seen significant investment in the creation of Core Research Facilities in: Genomics, Environmental Chemistry, Organismal Maintenance, Overseas Research Stations and Earth Observation GIS. This ~£2.6M investment provides the infrastructure to support world-class research and has led to the recruitment of internationally-outstanding academic staff and high-quality outputs.

Genomic facility: The establishment of this facility has increased data generation and outputs. The facility includes Illumina MiSeq and NextSeq platforms and three Oxford Nanopore sequencers together with standard genetic laboratory appliances, including Bioanalyser, Biomek liquid handler, a range of thermocyclers for PCR and RT-PCR, Nanodrop Spectrophotometer, and Qubit Fluorometer. Researchers in this area also make extensive use of the NERC Biomolecular Analysis Facility (NBAF).

Environmental Chemistry facility: In this facility we operate and maintain a wide range of instrumentation (ICP-MS, ICP-OES, IRMS, HPLC-HRqToF, SEM-EDX interfaced with micro-Raman spectroscopy (SEMSCA), GC-MS, GC-APCI-qqqMS and NMR). We also have partnerships with a variety of instrument manufacturers, which have resulted in instrument loans (e.g. thermal desorption GC unit) and donations (e.g. GC-APCI-qqqMS) to support our research. We have access to an extensive range of air-monitoring equipment, with 30 real time air-monitoring units installed on our campus, contributing to a network of ~100 units across Greater Manchester. We also have access to a testing lab for aircraft and engine emissions, and provision for catalysis emission testing.

Organismal facility: Our suite of glasshouses (six, 9 m² glasshouses) and growth cabinets are an essential component of this facility, and are used for research in our key focal areas (ecology, conservation biology, microbiology, and food security). We also have an Amphibian Research Facility (currently three environmentally-controlled amphibian pods) dedicated to our research in amphibian conservation and husbandry, and an aquarium facility for the study of ocean acidification and climate change. Additional facilities for animal behaviour and evolutionary morphology include high-speed video cameras, custom-built filming arenas, a structured light 3D scanner and a considerable investment in high performance computing for 3D imaging and visualisation. The Henry Royce Institute's lab-based x-ray computed tomography facility is also frequently used by EERC members in this area, and is an official project partner on Brassey's

BBSRC fellowship.

Overseas Research Stations: The transfer (from The University of Manchester) of a well-established research station in Ecuador to EERC, and the longstanding relationship, and new joint MSc degree, with the Tanzanian African College of Wildlife Management provide outstanding overseas research links. Our rainforest research station in Ecuador: La Estación Científica Timburi Cocha (ECTC) is run in collaboration with Ecuadorian partners (La Universidad Estatal Amazónica (UEA) and the National Institute of Biodiversity, and an indigenous community (and was a successful REF 2014 impact case for the University of Manchester based on Preziosi's research). Recently, we have established facilities in the offices of the Colombian National Marine Parks in the Caribbean.

Earth Observation & GIS facility: Members of EERC have internationally-leading research using Earth Observation (EO) and GIS technologies. We integrate remote sensing techniques and GIS with interdisciplinary approaches to monitor and understand key environmental dynamics, and climate and disaster risks. We also use drone-collected reference data for model training and validation.

Shared Use of Infrastructure: EERC has shared use of major research facilities in the UK and overseas, including extensive facilities in Kenya and Ecuador. We also maintain shared facilities with the University of Cartagena's Ocean Acidification Lab and have access to the labs of the National Marine Research Institute of Colombia (INVEMAR).

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

Support and effectiveness of collaborations, networks and partnerships

EERC staff publish with scientists and practitioners from over 60 countries, and research on all continents across the globe. Our research collaborators are from all four World Bank income groups. EERC staff have been awarded GCRF grants via QR funding to work with colleagues in Sierra Leone, Kenya, Tanzania, Iran, Jordan, India, China, Indonesia, Philippines, Ecuador and Colombia.

Academic collaborations

EERC staff have fostered a wide range of collaborations with academic partners in a multitude of UK and international HEIs, leading to impactful journal publications and successful grant applications. For example, the EC H2020 funded ANIMA (2017-2021; £707k; 22 partners; 11 countries), and AVIATOR (2019-2022; £466k; 17 partners; six countries) projects are providing tools and guidance to reduce the impacts of aviation on airports (noise and air quality respectively); and involve academics from Roma Tre University, Cergy-Pontoise, University of Southampton, University of Manchester, University of Cardiff and University of Québec. Likewise, EERC staff are contributing to the BIO-PLASTICS EUROPE project (2019-2023; £483k; 21 partners; and 13 countries), providing sustainable solutions for bio-based plastics with partners including the Italian Institute of Technology, the University of Bologna, and Hamburg University of Technology. The EU-Interreg project Care-Peat (2019-2022; £185k; nine partners; five countries) focuses on restoring the carbon storage capacity of peatlands to address climate change, and involves EERC researchers working alongside academics from the National University of Ireland Galway and the Université d'Orléans.

Collaborations beyond academia

EERC staff collaborate in local, national and global networks with industrial partners, policy-makers, charities and practitioners. Examples of influential projects include:

- DfT funding (£3.7M) for world-leading research in aviation emissions and climate change mitigation.
- EC H2020 funding for airport impacts (ANIMA and AVIATOR; £1.2M) partners including Airbus, Rolls Royce, Iberia Airlines and Heathrow Airport.

- Long-term partnerships with conservation charities and zoos (>£400k total, including £100k from The Rainforest Trust) underpinning tropical bird conservation and IUCN species designations.
- Innovate UK KTP funding (>£200k) developing innovative construction materials to prevent weed growth.
- BBSRC Industrial Challenge Strategy Funding (£167k) to develop sphagnum farming for peat restoration with Micropropagation Services Ltd.
- UKRI-funded projects (>£90k) co-developed with local government and >10 third sector organisations informing urban green infrastructure policy development in Greater Manchester.
- Darwin Initiative funding (£302k) enabling the Baka people to attain food security, sustain health and secure biodiversity in Cameroon with the Center for Interdisciplinary Forestry Research, Indonesia.
- EERC staff are now leading a group of Universities (University of Manchester and Salford University) and public bodies (e.g. the NHS, schools and churches) implementing the largest global real time air-monitoring network to inform transport policy better.

How staff engage with or developed relationships with key users, beneficiaries or audiences

We have created strategic roles with local and national organisations (e.g. Greater Manchester Combined Authority), joined policy-relevant networks (IUCN, Transport Systems Catapult, and Heathrow Advisory Group); undertaken placements and fellowships with nationally-recognised bodies (e.g. DEFRA, Natural England, British Ecological Society); and are members of international panels advising on global issues (e.g. IPCC, IPBES, IUCN and SSCs). This has enabled us to influence policy, practitioners and the public at the *local, national and international* levels.

EERC staff are active board members of local policy committees, including the Manchester Green and Blue Infrastructure Strategy Group (Cavan; successfully winning a National CIEEM Award for Knowledge Exchange, 2018), Manchester Climate Change Committee (Dunk), and Chair of the Greater Manchester Wetlands Partnership and Technical Steering Group (Field).

On the *national* scale, staff have undertaken funded fellowships and placements with government bodies (DEFRA and Natural England) and the media (BBC) to enable knowledge transfer between our research, policy-makers and the public. For example, Cavan is a Steering Committee member of the DEFRA Urban Pioneer Strategy Group, a demonstration project for delivering the UK Government's 25-year Environment Plan.

Wider contributions to economy and society

The commitment of EERC staff to engage with diverse communities has been recognised with two NERC public engagement awards: The Science of Steart (11 researchers; five institutions) hosted interactive local community events at WWT Steart Marshes in Somerset to promote understanding of the role of salt marshes in sea defences; Climate Explorers (11 researchers; three institutions; one storyboard expert, one educational psychologist, and one radio show); and worked in seven schools across the UK to produce ten short radio shows and accompanying web-based podcasts on climate and environmental change. Science communication activities on understanding climate science through the development of games and poetry has attracted substantial funding from multiple sources (>£200k; eight funding bodies including NERC, The Royal Society, and AHRC). News appearances by EERC members occur regularly (e.g. Lee, Panorama 2019). Leal is leading the production of the Encyclopaedia of the UN Sustainable Development Goals, which will contain contributions from over 3,000 global scientists.

EERC is leading delivery on Greater Manchester's climate change strategy by improving the carbon literacy of residents and businesses, by delivering carbon literacy training to over 1,000

community members and training 56 carbon literacy trainers, who have subsequently delivered training to >2,000 people nationally. Our award-winning *internal* training programme, Carbon Literacy for Students (CL4S), has trained 32 trainers and over 1,000 students to date, achieving recognition as 'Future Employer' by the national 2019 Green Gown awards. We have also secured NERC public engagement funding to run school outreach and public engagement events across the North West and South West of England.

Contribution to sustainability of discipline

Our international status for research excellence in Global Environment Change and Ecology and Conservation is demonstrated by our activity in academic citizenship incorporating:

- 1) **Journal editorial roles.** Including Philosophical Transactions of the Royal Society B, Proceedings of the Royal Society B, Animal Behaviour, Remote Sensing, Journal of Glaciology, Frontiers in Behavioural Neuroscience, PLOS ONE, PLOS Computational Biology, Journal of Environmental Protection, Biotropica, Behavioural Ecology and Sociobiology, and Nature Scientific Data, Functional Ecology.
- 2) **Grant committee memberships.** Including NERC, ESRC, Royal Society, NSF, EU H2020, Polish and Irish Science Foundations, and the British Ecological Society.
- 3) **UK and International grant reviewers.** Including UKRI FLF, NERC, BBSRC, Royal Society, The Leverhulme Trust, H2020, Marie Skłodowska-Curie Action fellowships, Newton Fund, the US Department of Defence, the British Ecological Society and the Australian Research Council.
- 4) **Conference organisation.** EERC staff have organised >20 international conferences between 2014-2020, including the Society for Ecological Restoration (SER) World Conference, 2015 (>3,000 delegates); the World Symposium on Climate Change Communication, 2017 in collaboration with Hamburg University and the IPCC, and with funding from the EU-EDULINK programme; the International Measuring Behaviour conference, 2018 (350 delegates) promoting the latest innovations, prototypes and techniques in behavioural research; the 35th Society of Environmental Geochemistry and Health Conference, 2019 and the Amphibian Conservation Research Symposium, 2019 (>100 delegates) with funding from Chester Zoo and the Amphibian Survival Alliance. EERC staff have also held positions on the organisation committee of the International Union for Quaternary Research (INQUA) and have convened sessions at the European Geophysical Union (EGU) General Assembly.
- 5) **Invited keynotes, conferences talks and workshops.** Impact of our research is evidenced by the many invited presentations and plenaries given by EERC staff at international conferences and collaborator institutes. Selected highlights include: the United Nations Convention to Combat Desertification COP12 (2015, Ankara); the European Federation for Primatology (2015, Rome); the Geological Society of America palaeontology short course (2016, Denver); IEEE International Geoscience and Remote Sensing conference (2016, Beijing); the XIV Mediterranean Ecology and XIII AEET meeting (2017, Seville), the European Space Agency Living Planet symposium (2019, Milan), and the Scripps Institute of Oceanography seminar series (2020, San Diego).
- 6) **Membership of prestigious committees, boards and working groups.** EERC staff have held positions on panels such as the BBSRC People and Talent Strategy Advisory Panel Early Career subgroup and the board of the EPSRC National X-ray Computed Tomography National Research Facility. Staff sit on the DEFRA Urban Pioneer Steering Group, IUCN Species Survival Commission (Birds, Bryophytes) and two groups within the International Civil Aviation Organisation Committee on Aviation Environmental Protection. Additional memberships include ISO and British Standards Institution (BSI) working groups, the Manchester Green and Blue Infrastructure Strategy Group, the British Ornithologists' Union Records Committee and the Sustainable Amazon steering committee. EERC colleagues have also been called upon as expert external reviewers for the IPCC and IPBES.

Additional indicators of influence

Individuals and groups have been recognised for a range of awards including: Marie Skłodowska-Curie fellowships (2014, Symeonakis; 2015, Kelly); a BBSRC Future Leaders Fellowship (2016, Brassey) and a Daphne Jackson Fellowship (2016, Raly Vellaniparambil). Staff have also been the recipients of the British Science Association Media Fellowships (2017, Brassey & Lees), a fellowship from the Software Sustainability Institute (2014, Grant), and a British Ecological Society Policy Fellowship (2019, Mossman), supporting a secondment to DEFRA. Recognition of excellence is demonstrated by the presentation of British and Irish Association of Zoos and Aquaria Research Awards (2015 Bronze and Gold awards) and a national award for knowledge-sharing from The Chartered Institute of Ecology and Environmental Management (CIEEM) (2018, Cavan) for the development of Manchester's Green and Blue Infrastructure Strategy, endorsing this as an example of best practice. EERC staff (Preziosi) are also responsible for the provision of Home Office Licensee Training to outside HEIs and hold positions as zoo ethics panel members and board positions for a number of charities.