Institution: University of York

Unit of Assessment: 7 – Earth Systems and Environmental Science

a. Overview

The Unit comprises the Environment Department which includes academic staff and associated support staff along with the Stockholm Environment Institute's (SEI) York Group. SEI conducts research targeted towards providing scientific evidence to underpin policy making for sustainable development, which focuses on the links between the ecological, social and economic systems at global, regional and national and local levels. The Aim of the Unit is to understand the fundamental processes that underpin key environmental issues through rigorous, interdisciplinary, cutting-edge research that drives policy towards a sustainable and equitable world. Research in the Unit is structured around three **research clusters**: Health of the Environment; Earth Systems and Environmental Change; and Ecosystems and Society: '**Health of the Environment**' – Focuses on 1) understanding and developing policy to control the emissions of natural and man-made chemicals into the outside and indoor environments; and 2) the fate and transport of these chemicals; and impacts of chemical exposure on aquatic and terrestrial organisms, including humans. The cluster is known internationally for its work on indoor air chemistry and air pollution, bio-geochemical cycling and trace gas exchange between the atmosphere and the terrestrial biosphere, ecotoxicological modelling, environmental risks of pesticides and emerging contaminants and ecosystem and health impacts of atmospheric contaminants, along with feedbacks resulting from pollution damage affecting earth system functioning. '**Earth Systems and Environmental Change**' – Focuses on understanding how environmental processes have changed over time in order to forecast plausible futures and provide a framework for society to adapt to and live with the consequences of environmental change. The cluster is known for its work in three areas: 1) changing dynamics, and the resulting consequences for future mass balance changes, of thermally complex glaciers in the Arctic; 2) past sea level changes and coastal ecosystem development under fluctuating sea levels; and 3) the role of past events in shaping the present day composition and distribution, and future scenarios of tropical vegetation. '**Ecosystems and Society**' - Integrates research across the natural and social sciences to understand: 1) the dynamics of behavioural and ecosystem processes, 2) the effective management of ecosystems to ensure the sustainable provision of ecosystem services, 3) the institutional and policy mechanisms required to ensure sustainability, and 4) the behaviour of individual and societies towards the environment and the services it provides. Engagement with stakeholders, from local communities to policy-makers, is a key component of the cluster's research to develop solutions to global, regional and local environmental challenges. The cluster provides the Directorate for the NERC Biodiversity and Ecosystem Services Sustainability (BESS) programme and is a partner in the Big Lottery project 'OPAL'.

The research activities of the clusters are overseen and monitored by the **Environment Department Research Committee** (DRC) which comprises a mixture of senior and junior academic staff, postdoctoral research associates and a PhD student selected to represent the three themes. The DRC has responsibility for developing and implementing an effective research strategy, ensuring that all research is of the highest quality and that the necessary support and infrastructure is in place to perform and deliver world leading research. The Unit is now a core part of the **York Environmental Sustainability Institute** (YESI) which was launched in 2013. YESI is shared across seven Departments at York and spans the physical, natural and social sciences The formation of YESI represents a step-change in the delivery of environmental research across the University. YESI research will be centred on three key themes: Global Change; Sustainable Environments; and Future Food and Fuel. **The future strategy of the Unit will therefore be targeted at delivering YESI's aim of establishing York as a world centre for sustainable strategies for adaptation to global environmental change**.

b. Research strategy

The **overall vision** of the Unit is to be an international leader in the understanding of the natural environment, human interactions with it, and management and promotion of environmental capital and sustainable behaviours. We aim to be recognised as the partner of choice for a range of stakeholders responsible for environmental issues and to provide policy-relevant evidence for decision makers around the world.

In our RAE2008 submission, a number of **strategic aims** were identified for the assessment period, namely to: 1) **continue to grow and to build on its existing strengths** in diffuse pollution and ecosystem management, so that the Unit is well-placed to meet the research needs of the UK and the wider international community in the areas of sustainable environmental management, as identified in the relevant research council emerging strategies and the LWEC initiative of the UK funders and agencies; 2) **continue our successful strategy of forging collaborative links** within and outside the University (at home and abroad), to provide complementary expertise and to bring this expertise in-house; to underpin the growth in research by the appointment of additional support staff, including FT research technicians to support the growing analytical facilities; and 3) **relocate the Environment Department to dedicated space** providing additional laboratory accommodation and additional office space. It was anticipated that at least 5 additional academic staff and 3 additional support staff would be taken on during the assessment period.

Since 2008, the number of academic staff has increased from 18 to 26 with the additional staff providing expertise in a range of disciplines that complement our research including behavioural ecology, ecotoxicology, environmental economics, environmental politics, (bio)geochemistry, glaciology and sea level change. The number of support staff in the Unit has also been expanded with the recruitment of five additional technicians and three additional administrators. The SEI York Office, comprising 36 research scientists and support staff, has been brought into the Unit, strengthening the research of each of the clusters. This has also provided improved links for the Unit with international policy makers as well as the other globally distributed SEI centres (in Stockholm, Tallin, Bangkok, Nairobi, Boston and Davis).

To accommodate the significant increase in staff numbers, the Unit has expanded into a second building co-located with the original Environment Department facility. Laboratory space has been expanded by 30% and significant investment has been put into laboratory infrastructure (see later Section). The 'Health of the Environment' research cluster has continued to make extensive use of the state-of-the-art research facilities at the Food and Environment Research Agency at Sand Hutton. A new purpose built 'Environment Centre' is now scheduled to be constructed by summer 2015 and the University have committed £10M to this project.

To better align our research with national and international priorities (e.g. LWEC, IPBES), we restructured our research in 2009 into the three new themes: the 'Health of the Environment' cluster was developed out of the 'Environmental Pollution' theme (mentioned in RAE2008); 'Ecosystems and Societies' builds on our previous 'Environmental Management' theme; and a new theme 'Earth Systems and Environmental Change' has been developed to better place the Unit to respond to national and international research priorities around environmental change. The formation of the clusters has facilitated the development of a number of multi-million pound proposals, a number of which have been funded, including a BBSRC/Gates project on rice, an EU Marie Curie project on pollution monitoring and the NERC BESS Directorate.

The future strategy of the Unit will be targeted at delivering YESI's aim of establishing York as a world centre for sustainable strategies for adaptation to global environmental change. Our research in the coming years will therefore focus on interdisciplinary research that addresses critical societal challenges with significant potential for research impact. This will be aided by the links with SEI-Y which has had a focus on interdisciplinary research to support decision makers and behavioural change towards more sustainable pathways for the past 20 years. The research will be centred on the three YESI key themes: ***Global Change*** (greenhouse gases, atmospheric processes and interactions with the terrestrial biosphere to support developments in earth system modelling; past environments and future scenario projections and human adaption; climate change and biodiversity conservation); ***Sustainable Environments*** (development of sustainable cities; monitoring and managing anthropogenic impacts, encouraging behavioural change towards sustainable living); and ***Future Food and Fuel*** (food production resilient to environmental change; fuels and services from plants and ecosystems, management and governance of resources at the landscape scale to optimise ecosystem services).

To achieve this aim, we will continue to invest in staff and infrastructure, work further to improve the research culture within the Unit and will put mechanisms in place to maximise the impact of our research, as outlined below.

Staff: We will continue to grow the Unit by recruiting staff to complement our existing research strengths so that we can address the three YESI core research areas. This will include academic, research and support staff and independent research fellows necessary to achieve credible large-

scale grant applications.
Research students: We will increase the number of high quality postgraduate research students to attain a level of three students per full time member of academic staff. To achieve this aim, we will become more pro-active in attracting overseas PGR students (using connections within SEI and affiliated universities across the globe to identify strong post graduate students that, once trained, will take knowledge back to institutions and help extend the global reach of capacity building of the Unit. We will introduce mechanisms (e.g. industry research days) to attract additional PGR funding from the private sector. We will actively exploit opportunities for participating in Research Council Doctoral Training Programmes (e.g. NERC ACCE DTP) and pursue other opportunities for supporting DTP programmes (e.g. EU Marie Curie funding).
Income: We will increase our research income per staff member so we move into the upper quartile for the Environmental Sciences sector. This will be achieved by expanding our current customer-base, developing mechanisms for increasing the success rates of submitted proposals, and through the submission of large multi-disciplinary proposals aimed at important environmental issues. By increasing research income we will be able to further invest in state-of-the-art research facilities and improve the visibility and impact of our research.
Research Culture: We will further improve the research culture of the Unit in order to increase: staff research activity; research income; the number of multidisciplinary research projects; and the quality and impact of research outputs. Activities will include the organisation of at least two research away-days a year and further developing our successful weekly research seminar series delivered by leading experts in the environmental area. These activities will be complemented by research meetings organised e.g. in response to calls from research funders. By improving the research culture, we aim to enhance collaboration across the Unit and the University and to stimulate the development of new research ideas and proposals. We will also make use of improved remote access technology to enable dialogue with key collaborators located across the globe, for example our key research and institutional partners and current and potential end users of our research to ensure dissemination of findings to gain highest possible impact and positive outcomes.
Facilities: We will develop world-class research facilities for performing environmental research. To achieve this, we are working to ensure the new Environment Centre building is designed appropriately, and that research facilities are adequately equipped and staffed, and that methods are in place for the servicing of laboratory instruments as well as the replacement of key pieces of instrumentation in the future. The availability of high quality facilities will increase the appeal of the Department to funding bodies, visiting scientists and prospective postgraduate and undergraduate students.
Impact: We will work to improve the impact of our research by: better exploiting existing links to policy makers and other stakeholders (particularly *via* SEI-Y); encouraging and supporting staff to participate in national and international expert committees and conferences; disseminating the results of our work through press releases and via electronic media; and encouraging staff to publish in the highest impact journals. These activities will enhance the external visibility of the Unit as well as our influence on global policy.

c. People, including:

i. Staffing strategy and staff development

The Unit has seen **significant growth in staff numbers** during the REF period in order to develop a critical mass of expertise relevant to our three core research themes. A number of our academic appointments have come from overseas institutes, including EAWAG, Switzerland (Dr Roman Ashauer), Teagasc, Ireland (Dr Peter Howley), University of Vigo (Dr Julia Touza Montero), and Memorial University, Canada (Dr Murray Rudd). Through these strategic recruitments we have worked to complement our existing strengths by bringing in expertise in new disciplines including ecotoxicological modelling, (bio)geochemistry, sea level change, human well-being and environmental and resource economics. Two academic staff have moved overseas during the REF period (Dr Pierre Delmelle - Belgium; Dr Jim Smart – Denmark then Australia). We have been successful in attracting a Royal Society University Research Fellow (Arnold), which has subsequently been converted into a permanent academic position, three Incoming Marie Curie Postdoctoral Fellows (Perez-Carrera, Jump and Pfeiffer) and a Polish Government Postdoctoral Fellow to the Unit.
Staff development: The University of York has taken the strategic decision to use the **Concordat**

as a vehicle for change and enhancement for all researchers including, where appropriate, PG research students (PGRs). Training support is provided primarily by the University of York's dedicated Professional and Organisational Development team (POD). POD organizes a range of training courses throughout the year covering four broad themes: Engagement, influence and impact; Personal effectiveness; Knowledge and intellectual abilities; and Research governance and organization. Over the REF period, staff in the Unit attended POD courses on 71 occasions.
The Unit has a number of mechanisms in place to support of ***equalities and diversity***. For example, researchers in the Unit take advantage of part time working and flexible working arrangements. The Unit is currently preparing to apply for Athena Swan Bronze Award.
The Unit has continued to work to support **Early Career Staff** in developing their research careers. Pump priming funds have been provided to a number of new staff (Beukers Stewart, Delmelle, Rippin, Hughes, Selby, Toet, Topi) to fund equipment (Unmanned Automatic Vehicle, Analytical Instrumentation) and costs of exploratory studies and international collaborations (Total = £120,565 in REF period). These have led onto larger successes e.g. Hughes secured an NERC project as a direct result of these pump priming activities. We have continued to allocate Research Council quota studentships (eight in the REF Period) to more junior staff (Arnold, Beukers Stuart, Rudd, Marshall, Delmelle, Thankappan) in preference to senior members of the Unit and have an active mentoring system where every new member of the Unit is assigned a senior academic member of staff to support them in developing a research programme at York. All lecturers and senior lecturers are given an annual research support budget of £500 to cover e.g. conference participation and attendance at project planning meetings.
During the REF period, we have worked to develop an **effective sabbatical system**. Our aim is that every member of academic staff will be eligible for a sabbatical every six years. The sabbatical system is now overseen by the Environment Department Research Committee which is responsible for developing a 5-year rolling schedule of sabbatical leave. Within the REF period, two members of staff (Thankappan, McClean) have already benefited from a sabbatical. Two additional academics (Delmelle, Selby) received University Anniversary Lectureships during the REF period, allowing them to focus on research activities for a period of 12 months. The new system has already resulted in the accelerated submission of manuscripts and research proposals (to Wellcome and ESRC DFID) and has resulted in research projects funded by Natural England and BBSRC.
The Unit has hosted numerous **visiting scholars** from Europe, N. America, Asia and Oceania, including: Bryan Brooks (Baylor University, Texas), Richard Fenske (University of Washington, USA), Seungryl Hwang (NIER, S. Korea), Steve Palumbi (Stanford University, USA), Larry Crowther (Duke University, USA), Mick Clout (University of Auckland, N. Zealand), Thomas Elmqvist (University of Stockholm, Sweden), Henrik Moller, (University of Otago, NZ), Marina Dolbeth (University of Coimbra, Portugal), Mohamed Mahmoud Ould Sidi (INRA, France). These scholars have worked with academic staff on a plethora of topics including: pharmaceuticals in the environment, marine conservation, forest fires in Galicia, climate change and human health, and socio-economic implications of new forms of rice. Three staff in the Unit have participated in **University delegation visits** to N. America, Asia and Europe.

ii. Research students

During the assessment period, our PhD programme has received funding from research councils (NERC, ESRC, BBSRC), the Technology Strategy Board, industry (Syngenta (x 2), Yorkshire Water, Yorkshire Wildlife Trust, GSK, Unilever, Fera, Reckitt Benkiser, Flamingo Land Ltd.), the European Commission and overseas Government scholarship programmes (Thailand, Malaysia, Iraq, Pakistan). We have actively participated in the ESRC White Rose Doctoral Training Centre. All competitive studentships are openly advertised and there is a rigorous selection process involving an independent recruitment panel.
To ensure that PhD supervision is of the highest quality, all new staff receive **extensive training in student supervision** through the Postgraduate Certificate in Academic Practice programme (PGCAP). All PhD students within the Unit have a **Thesis Advisory Committee** (TAC), which has responsibility for assessing progress of individual PhD projects and which meets with the student at least twice a year, under the umbrella of the Board for Graduate Studies. At TAC meetings, students are required to present an overview of their progress and are asked to provide in confidence an assessment of the level of supervision they are given and, if necessary, action is taken to address any issues.

All students are required to undertake a **Research Training and Skills Development** Programme, and can take modules from MRes or MSc programmes running across the University. The University provides significant resources to underpin and enhance PhD training and students are required to actively engage in University activities with the expectation that they attend at least 8 days of training each year. PhD students must also attend weekly research seminars, primarily given by external speakers, and also participate in the Unit's annual two-day Postgraduate Conference where they are required to give a poster (1st year students) or oral (2nd and 3rd year students) presentation. Students are required to keep a record of their training on the University's Skills Forge database and training activities are discussed with and closely monitored by Supervisors and the TAC. The University run an annual 'best supervisor' competition for which staff in the Unit are regularly nominated with one staff member winning the award in the REF period.

All students are given the opportunity to attend one **international conference** during their PhD programme and during the Assessment period our students have presented at conferences in Europe (SETAC Seville, Milan, Berlin, Glasgow) and N. America (SETAC Boston; American Geophysical Union San Francisco; US Air Pollution Workshop, Raleigh; Marine Biodiversity, Vancouver). Students are also encouraged to participate in Summer Schools and to visit overseas institutes. During the REF period our students have attended summer schools on topics including ecological modelling and nanotoxicology and have visited research institutes in Australia (CSIRO, Invasive Animals Cooperative Research), Canada (Memorial University) and Sweden (Swedish Meteorological Institute). Our students have also presented at global policy events run by e.g. the United Nations and the World Conservation Union and have organised expert workshops on Local Managed Marine Areas (IUCN conference, S. Korea) and on the status of endangered marine invertebrates (Field Museum, Chicago).

The quality of our PhD programme is reflected in the fact that the **majority of our students secure employment in the environmental sector**. Greater than 77% (85% in the last 2 years) of the students who graduated in the REF period are now working either in academia (Lectureships in UK (Canterbury), Thailand, Malaysia, Pakistan, South Africa, Tanzania and Cameroon; PDRA positions at Kings College London, University of Cambridge, Universities of Glasgow, Lancaster, Liverpool, Queensland, York), business (Positions in Syngenta, Unilever, Research Institute for Fragrance Materials, Dr Knoell Consulting), Research Institutes (Fera, TERI (the Energy Resource Institute in India), Government (South Korean Environment Agency, KEMI) and for NGOs (Somerset Wildlife Trust, Lancaster Wildlife Trust, Botanic Gardens of Edinburgh, National Museum of Kenya).

PhD students in the Department regularly receive local, national and international awards e.g. four students received the 'Best Oral Presentation' award at SETAC UK and Germany Annual Meetings, one student won the North East award in a science outreach competition and one student received the SETAC Proctor and Gamble Fellowship 2013 Award of $15,000. Publications produced by our students have also had major impact. For example a student paper on engineered nanoparticles was identified as one of the top 10 downloaded articles in the Journal of Chromatography. Student research on marine conservation has featured in newspapers (e.g. the Guardian, National Geographic Magazine) and on television (BBC, ITV, Channel 4, National Geographic Channel, Channel Arte).

d. Income, infrastructure and facilities

Research in the Unit has been funded by a range of organisations, including research councils (NERC, ESRC, BBSRC, AHRC), UK Government (Defra, DECC), European Commission, industry (Cefic, Scottish Builders), international organisations (World Bank, UNEP) and charities (Gates Foundation, Esmee Fairburn Foundation). We have been particularly successful in securing large projects, including funding for managing the NERC BESS programme (£1.4M), a BBSRC/Gates Foundation project on the development of improved strains of rice to help address future threats to food security (£1.7M) and a Marie Curie single centre Innovative Doctoral Programme on pollution monitoring in cities (£2.65M).

The assessment period has seen significant internal investment (>£429K) in infrastructure to perform our research including investment in: analytical instrumentation for contaminants in soil and water (ICP, GF-AAS, GC-MS, HPLC-DAD) and air (Isotopic N_2O analyser, greenhouse gas analyser, IRGA); high-powered computing infrastructure for modelling work; constant environment facilities; and state-of-the-art equipment for field monitoring (ice drill, field water monitoring

equipment comprising flow gauges and automatic water samplers plus associated telemetry and an unmanned autonomous vehicle); and "Skygas" which is an automated facility for measuring greenhouse gas emissions from complex landscapes. This investment helped to ensure success in grant submissions e.g. the greenhouse gas analysis equipment has led to funding of a large NERC grant. We have also made extensive use of other University facilities including the JEOL nanoanalysis centre (imaging on nanoparticles in food and environmental matrices), the Centre of Excellence in Mass Spectrometry (analysis of chemical contaminants in environmental media), Biology Department Technology Facility (DNA sequencing to support environmental change work). During the REF period, we have also benefited from access to **state-of-the-art facilities** elsewhere, including: the Food and Environment Research Agency (analytical facilities for pesticides and pharmaceuticals, aviaries for behavioural studies with birds), ANKA (x-ray fluorescence beamtime for nanoparticle research), Diamond Light Source (beam time), University of Leeds (NCAS), University of Aberdeen (mesocosm facilities). NERC Radiocarbon Facility (Dating mangrove sediments) and SRUC (animal facilities). We have also made extensive use of field monitoring sites at Danum Valley in Sabah, UNECE LRTAP pan-European monitoring stations, 7 Male Declaration sites across South Asia (air monitoring), Abisko Scientific Research Station, Abisko (glacier monitoring), Game and Wildlife Conservancy Trust site at Loddington (pollution monitoring), Dalby Forest, Woodchester Park, IRE in Spain, New South Wales National Parks and the Close House field station.

We have also benefited from **pump-priming from SEI's Institutional Programme** Support Fund which has been used to develop new areas of research to address future challenges in sustainable development. e.g. pump-priming of the international Global Atmospheric Forum helped initiate UNEPs work on short-lived climate pollutants, now a major international effort co-ordinated by the Climate Clean Air Coalition (established by Hilary Clinton) to develop national action plans to implement mitigation measures to reduce black carbon and ozone precursors in Bangladesh, Mexico, Columbia and Ghana. Pump priming funds have also been used to develop equipment to monitor below-ground GHG fluxes from terrestrial ecosystems leading to the patent of a new analytical measuring device 'Gas Snake'. Pump priming was also used to review rainwater harvesting approaches used by smallholder farmers across the globe; this review led to the development of a UNEP commissioned report which was translated into 4 different languages promoting and raising awareness of the variety and benefit of innovative rain water technologies to enhance food security, agricultural livelihoods and human well-being around the globe.

In 2015, the Unit will be relocating to a new state-of-the-art environmental research building that will bring together sustainability researchers, practitioners and educators. It will house internationally-excellent academic researchers and educators from the Environment, Archaeology, Biology and Chemistry Departments alongside influential practitioners involved in global impacts and development of sustainability policies from the SEI York. The building and programmes of work will be designed to facilitate interactions between researchers from different fields, and between researchers and practitioners, nurturing a positive, problem-solving ethos. The building will be a statement of York's intent to develop an understanding of the past, present and future relationships between humans and the natural environment, in a forum that seeks solutions as well as understanding. These facilities will be the first dedicated facility designed to understand the interactions between the natural environment and human health from deep time to the present day and into the future. ***The Past*** – Through a suite of integrated laboratories dedicated to the recovery of ancient biomolecules from environmental and archaeological samples that will be unique in Europe. This will include a palaeomics centre for the extraction and sequencing of proteins and DNA from ancient biological materials using the latest instrumentation for soft-ionisation mass spectrometry and next-generation technologies; the York light stable isotope facility for multi-element analysis of organic and inorganic materials and single compounds; an archaeological chemistry laboratory for ancient lipid characterisation; and the NERC-recognised amino acid racemisation facility for geochronology. ***The Present*** – A dedicated sensor-development laboratory and miniaturisation facilities will allow us to develop novel approaches to monitoring the health of the natural and anthropogenic environment. A data capture and analysis laboratory will enable the collection and analysis of environmental monitoring data from around the world in real time. Trace pollutant laboratories will incorporate mass spectrometry, radiochemistry, nanoparticle laboratories including single particle ICP-MS, disk centrifugation, and imaging equipment. They will be complemented by category 2 microbiological facilities for biogeochemical

process investigations and study of microbial contaminants. ***The Future*** - Aquatic and terrestrial mesocosm facilities and controlled environment rooms will allow us to generate experimental data on the effects of future drivers such as climate change on key environmental processes. These facilities will be complemented by a high-performance computer suite allowing us to simulate different environments in the future.

Many of our staff have performed consultancy work during the Assessment period for either industry (European Crop Protection Agency, Huvepharma, Invesa, European Detergents Association, Syngenta), national or international government departments or agencies (Defra, Countryside Council for Wales, Yorkshire and Humber RDA, CGIAR, DFID, FAO, Natural England, European Parliament, Foreign and Commonwealth Office, German Federal Agency for Nature Conservation, WHO, OECD), Universities (Kings College London), IFAD (International fund for agricultural development), UNEP and NGOs (Wildlife trusts, Royal Botanical Gardens Edinburgh). Our consultancy work has covered a range of topics including: indoor air quality, emerging environmental contaminants, environmental degradation in sub-Saharan Africa and South Asia, climate change and health, climate change and biodiversity in China, provision of pollen data for the Met Office and the Ecosystem Approach to environmental management. Our consultancy programme allows us to better understand the needs and knowledge gaps of end users and many of our recent research proposals have therefore been developed to address these needs. The close working relationships we have with the industry and policy makers means that we are also able to engage them as partners in research projects or as member of project steering groups thus increasing the likelihood that our research will have real world impact.

e. Collaboration or contribution to the discipline or research base

The Unit works closely with other Departments at York as well as with other leading institutes. This is reflected in the fact that of 408 research paper outputs published by the Unit during the REF period, 65 (15.93 %) were co-authored with other Departments at York, 254 (62.25 %) were co-authored with other UK institutes and 296 (72.55 %) were co-authored with overseas institutes (139 (34.07 %) Europe; 60 (14.71 %) N. America; 26 (6.37 %) Asia; 33 (8.09 %) Australasia; 38 (9.31 %) other). In total, we have co-authored with 114 UK institutes, 155 European institutions, 140 North American institutions, 45 Asian institutions, 22 Australasia institutions, and 80 others from around the world during the REF period. We also work actively to contribute to national and international advisory boards and expert committees and to increase the external visibility of our staff. We employ and range of mechanisms to encourage and support these activities. For example, the Unit employs a work-load model that accounts for external engagement activities (participation in committees, editorial roles etc.); more junior staff are provided with funding to support travel; and the University provides central funds for inviting leading scientists to York as well as to support the internationalisation of the University (e.g. During the REF period, staff in the Unit have participated in four University level delegation visits to N. America and Asia).

The Unit has collaborated closely with **other Departments,** in particular Archaeology, Biology, Chemistry, Physics and Health Sciences. To facilitate the interactions we have run a number of joint away-days with other Departments, including Physics, Electronics and Computing Science which have led on to a number of joint projects, including a €3.5 M Innovative Doctoral Programme on novel approaches to pollution monitoring (developed following an away day with Electronics and Computing Science). We have continued our **strategic alliances** with the Food and Environment Research Agency (FERA) and the Scottish Agricultural College (SAC) and have had staff and PhD students located at these institutes giving them access to the knowledge of FERA and SAC's scientists and to their state-of-the-art research facilities. The Unit continues to work with **leading institutes around the world** through joint research projects and exchange of staff and PhD students. Members of the Health of the Environment Cluster have worked with the Free University of Amsterdam, CSIRO, Seoul National University, TERI, NASA, UNEP, Met Office, FAO and Universities including Gothenburg, Danish Technical University, Exeter, Lancaster, Leeds, Leicester, Queensland, Wageningen and Warwick. The Earth Systems and Environmental Change Cluster has worked with the British Antarctic Survey, Met Office, National Museums of Kenya, African Conservation Centre, Stockholm Resilience Centre and a range of Universities including Cambridge, Leeds, Sheffield, Uppsalla, Sokoine University of Agriculture, Univeristy of KwaZulu Natal and Ghent. The Ecosystems and Society have worked with the Universities of Glasgow and California, the Invasive Animals Cooperative Research in Australia, the Central Rice Research Institute Cuttack in India, Manta Trust, Isle of Man Fisheries Department, Community Of Arran

Seabed Trust, Department of the Environment for the Cayman Islands, Scottish Inshore Fisheries Trust, Bermuda's Department of Environmental Protection, the Marine Conservation Society of the Seychelles and Universities, including Cornell, Leeds and Massey.
The Unit has hosted a number of **international conferences and workshops**. Conferences include the International Conference on Pesticide Behaviour in Soils, Water and Air (Sept 2009 and 2013) and the All at Sea International Coastal/Sea Level Conference (2011 and 2013). International workshops hosted by the Unit have covered topics including: climate change and risks of contaminants from agriculture (Environment and Human Health Programme funded workshop in 2008); effects of pharmaceuticals in the environment (EU funded workshop in 2008, Royal Society funded workshop in 2013); Air pollution as a threat to food security (Sida funded workshop in Delhi, India in 2010) and nanopesticides (IUPAC workshop in 2013) and environmental impacts of resource recovery from waste (NERC funded workshop in 2013).
Staff in the Unit have continued to sit on **National or International Committees** relating to impacts of chemicals on the environment and human health (Advisory Committee on Pesticides, Veterinary Products Committee, Hazardous Substances Advisory Committee, UK Indoor Environment Group, Environmental Panel of the ACP, Bystander Risk Assessment Working Group, the Ecotoxicology working group of the European Food Safety Authority, the EFSA Working Group on Environmental Risk Assessment of Feed Additives, and the European Medicines Agency Working Group on Risks of Veterinary Medicines in Manure), marine conservation (British Indian Ocean Territory Science Advisory Panel) and wildlife disease (Defra TB Expert Panel). One member of the Unit also serves as Vice-Chair of the Field Programmes Committee of the British Association of Zoos and Aquariums.
Many of our academic staff have held **Editorship, Assistant Editorship or Associate Editorship** positions on international journals including , Applied Geochemistry, Atmospheric Environment, Australian Journal of Zoology, Biology Letters, Conservation Biology, Elements, Environmental Politics, Environmental Pollution, Environmental Sciences Europe, Environmental Toxicology and Chemistry, Journal of Animal Ecology, Journal of Environmental Health Sciences, Journal of Glaciology, Journal of Sea Research, Pest Management Science, PLOS Biology, Science of the Total Environment, Sustainable Remediation of Soils, Tropical Conservation Science, Wildlife Research. Our research staff have contributed to a number of high profile **Global Assessments** including UNEP Global Environment Outlook, UNEPs Black Carbon and Ozone Assessment UNECE Hemispheric Transport of Air Pollution, IASSAs Global Energy Assessment, CGIARs comprehensive assessment of water management for agriculture; World Water Development Report (WWRD).
The policy relevance of our research is demonstrated by the fact that a number of staff within the Unit has provided **oral or written evidence to parliamentary committees** in the UK and overseas and to the European Commission. Activities include: **2008**: Evidence to the Welsh Assembly on Ecosystem services; Parliamentary briefing lecture on the Marine Bill at the House of Commons; Parliamentary political party briefings on state of the UK marine environment; Breakfast briefing of European Commission officials from DG Mare and DG Environment on reform of the Common Fisheries Policy. **2009**: Presentation on environmental inequalities to the UK Rural Commissioners; Oral evidence on marine conservation to All Party Parliamentary Enquiry into Global Food Security; Evidence submitted to House of Lords on Co-decision and National Parliamentary Scrutiny. **2010**: Submission to the Canadian Parliamentary Standing Committee on Environment and Sustainable Development on species at risk; Oral evidence on marine conservation to the Parliamentary Forum on Food and Health. **2011**: Evidence to House of Lords Rural Economy Group on the Ecosystem Approach; Contribution to USEPA Science Advisory Panel on Pesticides and climate change. **2012**: Evidence to the Environmental Audit Committee Inquiry into Insects and Insecticides; Report cited in House of Lords debate on the work of zoological gardens.
Our research activities have been recognised through a number of international awards. For example, CIRCLE won the PraxisUnico Impact award for the best collaboration with business and Professor Callum Roberts' received the Mountbatten Award for Conservation Literature for his book 'The Ocean of Life: The Fate of Man and the Sea'.