Institution: Lancaster University

Unit of Assessment:UoA7 – Earth Systems and Environmental Sciences

a. Context

Impact based on international-quality disciplinary research is core to the research strategy of the Lancaster Environment Centre (LEC). We address the world's pressing environmental issues with an explicit commitment to research excellence, inter-disciplinarity and genuine international partnerships. Our disciplinary strengths in Atmospheric Sciences, Biodiversity & Conservation, Environmental Chemistry, Earth Sciences, Plant & Crop Sciences, Society & Environment, and Soil & Water Sciences connect through our interdisciplinary "research actions" in i) Understanding a Changing Planet (ii) Improving Global Stewardship and (iii) Innovation for a Better Environment. We share our facilities with the Environment Agency (EA), the Centre for Ecology and Hydrology (CEH) and environmentally focussed businesses, all physically co-located within LEC. Our dedicated Enterprise and Business Partnership (EBP) team works with LEC researchers to develop research through innovation in to impact, exemplified in the recent external evaluation by the economic impact assessment company EKOS. "*An embedded professional team, dedicated to maximising user-driven research impact makes LEC an international exemplar for best practice, which many other Universities are now looking to emulate*" (EKOS, 2013).

LEC research has well established links with a diverse range of user communities, who benefit from, but also contribute to our research and its application. Key beneficiaries include policy makers (both nationally and internationally), UK and international business (both high growth SMEs and corporates) and the wider public. By working with these groups and organisations we achieve the following types of impact as exemplified in our Impact Case Studies:

- **Improved economic performance** via sustained regional SME business support (>2500 since 2009), improved business performance, spin-out business growth, and the provision of consultancy and training (Impact case studies (=ICS) B and C: see Section d);
- **Leadership across national and international policy, protocols and regulation** for land, water and air quality policy changes, implementation of policy change; policy debate stimulated/informed, contributions to global environmental treaties and protocols (ICS D & E);
- **Improved environmental management practices** via the introduction of new/improved methods, models, and monitoring techniques that have led to changes or benefits (ICS C & D);
- **Improved practitioner/ professional practice** via knowledge exchange networks of best practice, the development of decision support tools, and business-led professional work-based training programmes (ICS A, C & E: see Section d);
- **Enhanced stakeholder engagement through public engagement**, for example, in flood risk, and catchment management approaches (ICS C & E: see Section d).

b. Approach to impact

Our overall approach makes impact a key element in our departmental research strategy.

Collaborative working and sharing of facilities has been stimulated via LEC's physical co-location not only with CEH and the EA but with environmental businesses embedded in the Department in a dedicated business co-location facility (LEC3). The aim of LEC3 is specifically to nurture partnerships between our research base and commercial end-users. LEC3 houses 26 resident companies and our dedicated Enterprise and Business Partnership (EBP) team of seven FTE. The EBP team works directly with LEC researchers to grow stakeholder relationships, and leads the KE activities that underpin and support effective pathways to impact from our research.

Our UK-based impact partnerships are being complemented by our growing network of strategic international partnerships, especially in China, Brazil and West Africa. Impact via research-to-business links with China is stimulated via a dedicated platform, the International Research and Innovation Centre for the Environment (IRICE), developed as a formal co-funded partnership with the Chinese Academy of Sciences (CAS).

We have a strategic Business Advisory Board chaired by Dr Peter Dirken (TSB) to ensure high-level research-user input to our strategic planning, while the LEC-led Centre for Global Eco-innovation has constituted an advisory board chaired by Sir David King, former UK Chief Scientist. Other members of these groups provide links to Technology Strategy Board, Local Enterprise partnerships, the RCUK Knowledge Exchange lead and the Environment Agency.

The approaches that LEC staff use to deliver impact from our research via interactions with key user groups include:-

1) **Collaborative Research.** We work with a diverse range of partner organisations including SMEs, international corporates, charities, NGOs and national/international governance and policy leaders. In particular, we are supporting large, consortial research projects with European SMEs (funded by EU and European Regional Development Fund (ERDF)), international food supply chains (e.g. DEFRA HortLINK project - £1.4M over 5 years - incorporating 21 partners covering the whole supply chain from growers to retail), and co-designing research with CEH, BGS, EA and a wide range of business partners. In 2012/13, £4.8M of LEC's total research income resulted from collaborative activity with business. In partnership with a range of businesses and other organisations, we have secured 17 major European Framework Programme projects valued at £3.6M over the REF period.
2) **Embedding staff in national and international policy.** We connect our research to decision-making by supporting staff involvement in global and UK environmental policy (see iii below).
3) **PhD projects with business.** Since 2008, LEC has been awarded 24 RCUK CASE studentships, 12 studentships funded directly by industry, and 17 in collaboration with SMEs, through the ERDF-funded Centre for Global Eco-Innovation (CGE).
4) **Knowledge Transfer Partnerships (KTPs)** have been initiated (total value £486,984 with £214,618 from industry) with Inteb (2009-10), United Utilities (2012-14) and Plant Impact (2013-15), recognizing the need for both knowledge transfer and for people who embody the research skills to bring about innovative step-change in businesses.
5) **Professional Training** acts as a gateway for our external partners to access collaborative research activities. Resource from BBSRC (£50k) and NWDA (£85k) supported the development of business-led up-skilling via new professional training modules in 'Plant Science for Industry' and 'Energy and Fuels from Waste'. A total of 48 training days for more than 150 individual companies have been delivered over the REF period.
6) **Knowledge Exchange Networks** have been developed to inform policy, improve professional practice and decision-making. For example, the NERC-funded Catchment Change Network (£380k) recruited >950 end users and the follow-on Catchment Change Management Hub and Eden DTC Project (£2.2M via Defra) have increased this to >1500.
7) **International Partnerships** are central to our overall research strategy. Our EPSRC China Bridge, one of only 5 'Bridge' projects to harness the international links of HEIs for UK benefit, stimulated a close partnership between LEC and CAS. Recognition of our expertise in "delivering impact" led in 2012 to the creation of IRICE, now resourced with three academic and research-to-business staff. The recent HEFCE Catalyst award (£10M 2014-17) builds directly on this link, extending our relationships in China to encourage the translation of Lancaster's research to support UK business growth.
8) **Direct commercialisation of LEC research.** Working with the university IP development manager, we ensure that research which has significant commercial value and application is appropriately identified and protected. We actively pursue collaborative partnerships to develop novel products and processes for the global marketplace, for example through patents such as WO 2008/007100 (see Case Study B in Section d) and WO/2009/034389A1 (Air sampler: Jones and Timmis).
9) **Co-location and facilities for business.** LEC3 embeds 26 (58 in total since 2007) knowledge-intensive environmental businesses within LEC (a facility specifically noted by the Witty review (p16), 2013). The companies and our researchers work together to develop new products, processes and services with a positive environmental impact. We have also encouraged cross fertilisation of ideas using visiting and honorary appointments. During the REF period, LEC has hosted 221 international visiting staff and 19 honorary staff from business and industry**.**

We can **identify, and in many cases quantify, the impacts resulting from these mechanisms** using the following three different beneficiary groups.

(i) The SME business community. Supporting research-led innovation via SME-engagement represents a distinctive facet of LEC's impact portfolio. Building on the foundation of our research, we have used ERDF mechanisms valued in excess of £18.5M to benefit SMEs. The reach of these programmes of research-led collaboration extends to more than1000 SMEs since 2008. The significance of our impact is evident from an external evaluation (EKOS 2012) of the LEC-led North

West Eco-Innovation Programme (£3.5M) which confirms that since 2009, this single project created 145 new jobs and safeguarded another 290, and is estimated to have generated additional business activity worth c. £10M at the regional level, predicted to rise to £18M. More recently (2009), via the EU-funded KARIM Interreg IVB project (£4.8M), LEC has led the first international network of innovation partners supporting SME growth across NW Europe with a specific focus on bridging the "research-innovation gap" in the low carbon sector, including LEC research into environmental technologies for water, energy and food security. In 2012, LEC led the ERDF (£9.8M) Centre for Global Eco-innovation (CGE) - a unique collaborative project with colleagues at the University of Liverpool that is supporting 285, including 50 collaborative "eco-innovative" PhD research projects with SMEs from the North West (25 at each institution).

(ii) International corporates. LEC has used collaborative and contract research and professional training to develop and grow strategic relationships with several large corporates, most notably Waitrose and Unilever. Unilever explicitly recognise LEC as one of only 6 global partners in their 'Safety Science in the 21st century' http://tt21c.org/partnerships/ in recognition of LECs contribution to the tools and novel thinking they need to implement pathways-based risk assessments, specifically supporting their business ambitions in China. Our collaboration with Waitrose has been continuous since 2005 and focussed on Innovation training for the Waitrose supply chain (>150 companies) and co-designing/delivering their new Sustainable Agriculture platform http://sustainableagriculturewaitrose.org/. Our specific expertise at the interface of agriculture and environment resulted in a Queens Anniversary Prize for Higher and Further Education (Feb 2010) to the University for research led by Distinguished Professor Bill Davies (see case study A).

(iii) Government, policy makers and the public. A growing database of over 3000 individuals is used regularly to grow external engagement activities, nurturing pathways to impact activities via events and training both across the UK, Europe and internationally. Regular staff exchanges with UK policy makers at DEFRA and the EA encourage a two-way embedding of knowledge. Heathwaite is Chief Scientific Adviser for Rural Affairs and Environment (Scottish Government) and a member of Defra's Science Advisory Council. We also support staff in contributing to global environmental policy though expert inputs into, for example, the Montreal Protocol (Paul is co-chair of the Environment Effects Assessment Panel), Stockholm Protocol (Sweetman, Jones) and the IPCC process (Vermeylen contributed to the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation), Wild and Young both contributed to IPCC AR5 chapters). Our research-led public engagement is focussed through our RCUK award (£140K) tasked with training early-career researchers to engage with the public in communicating their research.

Staff are supported to deliver impact through a range of targeted mechanisms at Department, Faculty and University levels. LEC recognises staff contributions to impact by the specific inclusion of such activities in workload allocation. The University recognises research impact in its promotion criteria, directly allocates researchers a share in any income generated from technologies commercialised from their work, and through annual staff Impact Prizes. LEC staff won the University Impact Prize in 2006, 2007, 2009, 2010 and 2011.

The significant investment in the Department's EBP team, c. £1M of HEIF funding over the REF period, is key to supporting our research staff to maximise the impact of their research, helping them to develop and grow their stakeholder relationships, and leading effective KE and commercialisation activities. The EBP team have a strategic Faculty Framework for Business Partnerships in which they operate and are governed by a series of KPI targets that have been benchmarked against national data. Evidence to date indicates outperformance against the majority of these KPI targets At University level, Research and Enterprise Services provides a central focal point for KTP administration and contracts. Their IP Development Manager has been instrumental in the exploitation of the jasmonate seed treatment (Case Study B). LEC benefits from access to University awards supporting impact from research. These include £0.6M of EPSRC Impact Acceleration Funding (2012-15), an award designed to promote impact and address barriers in university/SME collaboration, and the HEFCE Catalyst award (£10M, 2014-17) that builds directly on LEC's experience in addressing the Government's priorities to focus on high-growth SMEs and to increase exports via research-led innovation in science and technology.

The success of these varied support mechanisms is evident in the significant increase in the number of staff involved in external stakeholder interactions, and currently over 85% of our Category A staff have such links compared with 50% at the RAE census date.

c. Strategy and plans

Our overall department research strategy for 2013-2020 emphasises supporting and enabling international impact from high quality environmental research.

i. We will expand and deepen our international research and innovation partnerships, further developing our world-class research and its global impacts. Our international priority remains China and more specifically to bring to fruition the already well-developed plans for a joint research and innovation campus with the Chinese Academy of Sciences in Guangzhou. Another international focus is Brazil where we are co-designing a new business-led environmental research and innovation facility at the University of Lavras. Joint appointments will be made and our dual PhD with Lavras and international Masters programmes will provide a key mechanism of delivery. We will also be extending the new Lancaster Ghana Campus activities towards collaborative opportunities with business across West Africa. We are growing our partnership with the Federal Institute of Industrial Research (FIIRO) in Nigeria and co-designed a new split-site PhD Programme funded by Niger Delta industrial partners. Up to 20 new PhDs are planned for 2014-16 via this mechanism. In the UK, we will further develop synergies with CEH, BGS, EA, and Rothamsted Research via several new joint staff appointments. Several of these partners are in discussion to join us at the new China Centre.

ii. We will expand and deepen our leadership in eco-innovation via at least 2 new academic/technology-led posts. We will deliver significant impacts from our departmental research, building on past successes by (i) focussed collaborations with Engineering, Computing, Chemistry and Physics and (ii) stronger, interdisciplinary translation of research. We will deliver solutions that will promote cleaner sustainable energy, sustainable, smarter cities and waste as a resource, as well as our established areas of strength in translational research on chemicals, food and water. Staff secondments (3-6 months) from business into LEC during 2014/15 will strengthen a shared development of new research to impact activity.

iii. Integration between LEC's natural and social scientists will be focussed on future pathways to impact. Our investment of 5 new posts in sustainability science supports the growing body of interactions between natural and social sciences and the "human dimension" to delivering impact from environmental research.

iv. LEC has its own "impact orientation programme" for all members of staff, including researchers and PhD students. This draws on the expertise of our EBP team and those LEC academics who have already delivered impact.

v. We will continue to use our Strategic Business Advisory Board and the CGE advisory board to provide high-level research-user input to our strategic planning, and will ensure that the membership of these boards is reviewed and changed to meet the changing impact landscape.

vi. We will help lead University initiatives, including a planned Science Park and a possible new physical space to connect research excellence from LEC, Engineering and the Lancaster Management School to further develop research-led eco-innovation.

d. Relationship to case studies

Our case studies reflect the full range of approaches used to deliver impact and can be related back to (b) as follows;

A. "Sustainable ground water use…" exemplifies impact delivered through iterative long-term research and development, where fundamental research outputs combine with stakeholder input to deliver impact (Approaches 1, 3, 5 and 7 on page 2, section b of this form).

B. "Increased yields in global food production …" is an example of impact where LEC applied "traditional" approaches to protecting and licensing intellectual property arising from our research, leading to a technology that benefits global food production (Approaches 1, 8 and 9 in Section b).

C. "Improved flood mapping…." is an example of impact facilitated by the appointment of LEC-trained individuals to key posts with stakeholders working with the water industry (1, 3 and 6).

D. "Reducing the global impacts of persistent pollutants …." delivers impact in to global pollution control from our environmental chemistry research, based on direct and indirect involvement in pollution policy (Approaches 1, 2, 3, 7 and 9 in section b of this form).

E. "Improving resilience and recovery…." relates to enhancing disaster resilience via policy and practice, with impact delivered through close working links with policy makers, practitioners and networks of best practice (Approaches 1, 5 and 6 in section b of this form).