Institution: The University of Edinburgh

Unit of Assessment: B7 – Earth Systems and Environmental Sciences

a. Context

The Unit's impact activities: Geoscientists at Edinburgh engage with an international range of non-academic audiences and users and deliver impact and benefit of global significance and reach. Our impact activities are in three main areas (the types, audiences and users are not mutually exclusive):

- ***Economic***. Our global impact in the energy sector, with specific reference to the discovery and exploitation of hydrocarbons, is evident in terms of economic benefit, commercial spin-out, and technical development (3 indicative case studies);
- ***Governmental and public policy and services***. Impact is evident in policy formulation at national, international, and inter-governmental levels, and in the development of standards within the environmental and finance industries (5 case studies);
- ***Public engagement***. We have enhanced public understanding of scientific, environmental, and historical issues (e.g. the low carbon economy, climate change mitigation, cartographic history) through public outreach, award-winning publications, and social media (3 case studies).

End users: The Unit's end users include (but are not limited to) national governments and their constituent agencies (e.g. UK Government and Meteorological Office; Scottish Government), supra-national organisations (e.g. UNESCO and the UN), global, multi-national, and national energy and resource companies (e.g. Total, Shell, Scottish Power), national and international environmental agencies (e.g. in Belize, several sub-Saharan African nations, and in the UK), British and European research libraries and national archives (e.g. British Library, National Library of Scotland), commercial companies and not-for-profit organisations, local government, professional bodies and subject associations, and the public.

Impact planning: Planning for and delivering impact is embedded in the School's research and staffing strategies and is managed via its three Research Institutes. We develop and implement impact through a three-fold strategic approach: creating the right environment; working in partnership; support, advice and training. The School, through its Business Development Executive (BDE), works closely with Edinburgh Research and Innovation (ERI), the University's research and commercialisation and technology transfer office. Planning for impact and ensuring knowledge exchange (KE) as a pathway to impact, is a formal part of the Staff Workload Model. Impact activities are recorded in the Annual Progress Review, for all academic and research staff.

Impact results: In the REF period and for the 11 case studies selected, the £20.64M research grant income underpinning the studies (including £10.5M for Edinburgh Centre for Carbon Innovation – see below) generated an estimated £13.4B – a ratio in excess of £640 of impact/benefit for every £1 of competitive research grant income secured. The significance and reach of our impact is evident for at least 15 different national governments, global organisations, the work of numerous environmental agencies, and in the enhanced understanding of multiple public audiences.

b. Approach to impact

Our overall strategic approach is to produce impact of significance and reach to appropriate end users. We do this by ensuring that impact is underpinned by high-quality research, promoting knowledge exchange as a route to impact, working with stakeholders (commercial, industrial, governmental, educational), by effective public outreach, and by monitoring and managing impact as part of staff responsibilities. Our approach is distinguished by three interconnected elements: **creating the right environment**; **working in partnership**; **support, advice and training**. This approach is coordinated and led by our Business Development Executive, appointed in September 2005 in order 'to develop, coordinate and manage knowledge exchange in and beyond the School

in support of its overall research objectives', working with impact partners, the Head of School, the Heads of Research Institutes (HoRI), the Research Organisation, and ERI. Impact is monitored and evaluated through Annual Review for all academic and research staff, by liaison between the BDE and ERI over University and national initiatives, and in School and University committees.

Creating the right environment

SAGES and ECCI: In 2007, the School extended the remit of its SAGES initiative (Scottish Alliance for GeoSciences, Environment and Society), the multi-HEI research programme led by Edinburgh and funded from the Scottish Funding Council and the University of Edinburgh, in order to widen and direct impact. SAGES is primarily aimed at research to understand climate change and environmental change. From 2007 to 2008, the increased significance of social environmental research justified appointment of a new member of staff (Andrew Kerr, former SAGES Director). Kerr was charged with developing a new 'Society and Environment' theme central to SAGES and the School's impact agenda in order to meet the demands of the business, policy, and politics communities in tackling the 'grand challenges' of climate, environmental, and social change.

Through Kerr, we established the Edinburgh Centre for Carbon Innovation (ECCI) in 2009, with £2.2M Scottish Government funding, as a 'proof of concept' expression of our approach to impact. ECCI builds impact into its institutional structures by liaising with users at the outset of the research. Our approach to impact is embedded in ECCI's three strands of activity: policy and partnership work; business innovation; skills and learning. ECCI policy centres around 'ClimateXChange' (funding of *c.*£4M per year), a call-down service for Scottish and UK Government policy teams and public agencies to access academic research expertise on climate change and the transition to a low carbon economy. In business innovation (£0.6M ERDF funding, £0.75M University matched funding; £50k per year from National Biofuels Partnership to support BioChar), ECCI helps researchers develop low carbon products/companies and build innovation clusters, including: carbon finance and accounting (e.g. the case study 'Development of Professional Practice for the Financial Accounting of Carbon', as led by Lovell), UK forestry and carbon sequestration (e.g. the case study 'Financing Global Forests Through Monitoring, Certification Schemes and User Networks', as led by Patenaude), and energy systems such as BioChar (Shackley, in Scottish Power Academic Alliance: see below). In July 2013, ECCI moved into newly-refurbished buildings within the Unit of Assessment at a cost of £10.5M (secured through the Scottish Government, ERDF, and the University). This provides a physical hub for ECCI and ClimateXChange and places its activities at the heart of the UoA's estate.

Working with RCUK: The School partnered NERC on a pilot impact accelerator project to ensure appropriate impact targets and mechanisms within the natural sciences (£70k, May 2013-). This is moving to phase II (£200k, July 2013-). We lead social science impact initiatives for ESRC/NERC/UK Aid via ESPA (Environmental Services for Poverty Alleviation) with a focus on the impact of development in the global south (Van Gardingen, Director): see http://www.espa.ac.uk/files/impact/making-impact. Recent projects with impact upon indigenous user communities include work on subsistence agriculture in Bolivia; carbon credits and mangrove conservation in Kenya; 'Green Revolution' crop introduction in Zambia (D.van der Horst) and sustainable agriculture in eastern China.

The effect of providing the right physical, social, and cross-institutional environment for impact has been: the coordination and leadership of impact agenda across international and national agencies (e.g. UNESCO and RCUK) (van Gardingen); the targeted development of impact in association with sub-Saharan governmental agencies (see case study 'Economic Benefits and Policy Formation Related to Monitoring Sub-Saharan Forest Degradation', led by M. Williams *et. al.*); the use of facilities to promote exchange with non-HEIs (e.g. Pearce and Shortt on 'Environment and Health' with Scottish health institutions (November 2011), Lovell (with Edinburgh City Council) on low carbon economy and domestic energy consumption (September 2012; May 2013)); widespread recognition from user communities (e.g. overseas delegations, Scottish Government, United Nations and European funding agencies, partner HEI, schools) of our capacity for impact; the appointment of new staff in ECCI (5 since 2008).

Working in Partnership

We work for and plan impact collaboratively. One way we do this is through industrial partnerships.

This approach has ensured liaison with industry and commerce and helped secure income and impact in difficult financial environments (Industrial income rose from £544k in 2007 to over £2 million in 2010). One illustration of this is our leadership in forming, in 2010, the Scottish Power Academic Alliance (SPAA) (with Scottish Power) to reflect our research expertise, to coordinate research and impact across different institutions, and as an agile response to the national policy and energy agenda.

SPAA is the UK's first research alliance between industry and academia focusing specifically on Carbon Capture and Storage. SPAA is led by the University of Edinburgh in association with Imperial College London. The partnership has brought together the needs of the CCS industry, in the UK and beyond, with academic researchers. Scottish Power has invested £2 million to fund up to twelve full-time researchers. SPAA contributed over £460k in 10 awards in 2010, and levered further funding (£95k) in support of PhD projects. The SPAA initiative has added value to our impact cases (e.g. 'Public and Private Sector Investment in Carbon Capture and Storage Technologies', as led by Haszeldine) and laid foundations for future impact.

Partnership initiatives are apparent in a range of Joint Industry Projects (JIP). Since 2008, the total award value from JIP has been *c.* £5 million. In the period 2008–2012, we have had over 60 JIP, with over 36 different organisations including Shell UK (3 different JIP projects in REF period), Scottish Enterprise (3), Schlumberger Ltd (5), and the Scottish Government (6) and associated institutions (for example, Scottish Environmental Protection Agency (2)). A proportion of the funding from these JIP is used to support '50:50' PhD studentships (half JIP, half School resources) in order to strengthen liaison between industrial partners, develop entrepreneurial insight in the academic staff, and incorporate impact awareness in the postgraduate community. Twenty such 50:50 studentships have been established since 2008. Industrial partnership underpins other impact case studies, such as 'Economic Benefits Derived From MTEM Limited', as led by Ziolkowski.

We work in partnership with governments and inter-governmental bodies to develop and initiate policy in, for example, climate change mitigation, environmental services and the finance industry. Three case studies are illustrative of this: 'Public Engagement and Policy Formation Related to Climate Change Mitigation by Individuals', as led by Reay; 'Provision of Environmental Services in Belize', as led by Stuart and 'Development of Professional Practice for the Financial Accounting of Carbon', as led by Lovell. We encourage impact which arises from development of longer-term research partnerships or from collaboration initially designed for other purposes. The case study led by Withers, 'Public Engagement with Scotland's Cartographic Heritage', occurred in parallel with the award of competitive AHRC Collaborative Doctoral Awards and research collaboration with the National Library of Scotland.

The result of our impact work in partnership has been: identification of, and collaborative on, specific research themes (see case studies); recognition by users, governments, and commercial bodies of our capacity for impact – in policy take-up, the energy sector, industrial collaboration, governmental liaison – and in the incorporation of an entrepreneurial outlook in future generations (evident in PhD training and in staff development and training).

Support, Advice and Training

We provide support, advice, mentoring and training to help academic staff, research staff and PGR maximise the impact of their research. This is effected, in liaison with ERI and the Institute of Academic Development (IAD), through **staff development**; **targeted support**; **identifying outreach**. We aim in these ways to enhance existing work and to develop 'impact capacity' in future (taking that term to mean the capability for high-quality research to be developed and undertaken by Unit staff in association with, and delivered to, identified end users).

Staff development

- We appointed a BDE in 2005 to target impact and knowledge exchange across the School's activities;
- Following University-wide shifts in staff grading criteria, impact is a requirement for all academic staff (from 2009), and an 'essential' feature in staff appointments. Impact features

in promotion criteria, is incorporated in the School's Staff Workload Model and managed via Annual Progress Review;
- Academic staff are supported in applying for Fellowships and secondments to enhance impact: Woodhouse was awarded a NERC Knowledge Exchange Fellowship (2010-11), and a Royal Society of Edinburgh Enterprise Fellowship (2011-2012). This helped develop the two case studies related to forest monitoring and has laid the basis for future impact.

Targeted support
- Research Institutes ensure staff lead impact workshops and training (Laurier, ESRC residential media training course; Laurier, Morris, MacDonald, workshops in social media; Hegerl, Stevenson, to American Geophysical Union, 2011, 2012). Academic staff participate in impact training workshops via ERI (2011, 2012), and in Research Institute-led one-day workshops on writing for the media;
- Research staff engage with these issues through the Research Staff Organisation (RSO): the RSO workshop, 'Writing for Impact', held on 18 June 2011, was led by postdoctoral staff. Research staff discuss impact in their Annual Progress Review (with their PI);
- School pump-priming funds assist staff in developing impact, including financial under-writing during secondment (e.g. Kerr, Ziolkowski, Woodhouse, Van Gardingen). This is reflected in our case studies (e.g. 'Economic Benefits Derived From MTEM Limited', as led by Ziolkowski), as is our industrial/commercial partnership in research (e.g. 'Economic Benefits Arising From Exploitation of North Sea Oil and Gas Fields', as led by Underhill).

Identifying outreach
- Questions of impact/benefit are integrated into the research process from its inception (in discussing target audiences, the means for reporting impact, and in recording impact). We do this via research grant demand management review, HoRI, and the BDE.
- We have established systems of public outreach and educational liaison to public bodies, industrial and commercial enterprises, schools, and public audiences. Cameron was awarded the MBE (2011) in recognition of his 'enormous contribution to the public understanding of science over many years'.

The effect of our approach to impact via support, advice and training has been: success in securing competitive Enterprise Fellowships; enhancement of media skills; recognition by HoRI that impact must be planned for in workload models; the results of several cases have fed back into School practice and strategies (as approaches to impact, as financial support for PGR activity); understanding that colleagues need mentoring about translating dissemination into impact and we work with ERI and the BDE to effect this. We have effected a wider staff use of social media and readership of our blogs (e.g. the case study 'Operational and Strategic Policy Formation Related to Volcanic Hazards in North-Western Europe'); and incorporated impact as a formal element of research demand management.

c. Strategy and plans

Our vision for impact is underpinned by the breadth, depth, and quality of our research, by a commitment to developing work in partnership, by managing staff to deliver impact and benefit in ways which enhance career development, and by providing work of real consequence to appropriate end users. We will pursue our established strategy and three-fold approach (creating the right environment; partnership; support, advice and training), monitor its success and appropriateness, and build upon it in response to new opportunities. Impact planning for the future is additionally informed by: commitment to achieving high quality in the underpinning research; the importance of flexibility in judging how impact is achieved, measured, and reported; identifying and managing impact within overall staff responsibilities; engaging *with* stakeholders in establishing appropriate outcomes. Over the next 5 to 7 years, these are matters of **staff management and training**; **collaboration and liaison**; **extending the impact agenda**.

Staff management and training
- We will make optimal use of the breadth of research excellence and impact capacity within the Unit, by disseminating examples of good practice and managing impact as part of

normal duties, managing this through Annual Progress Review (see section **b**);
- We will enhance existing programmes of mentoring, support, advice and training to support new generations of researchers and to extend the impact activity of those in mid- or late career. Many staff have an evident 'impact capacity' where the impact is, as yet, either not clear by audience/end-user or not fully measured: e.g. Pearce, Morris and Shortt on environment and health inequalities in association with Scottish health boards; Lovell on urban heat regimes with Edinburgh City Council; Shackley whose work on BioChar in Cambodia has been taken up by the Asian Development Bank; Metzger and Rounsevell, whose 12.5 million Euro research project on ecosystem services includes work, with ECCI and government agencies, to propose mechanisms for climate change adaptation. The world-leading involvement of Hegerl on the IPCC is recognised, for example, but we need to develop ways in which individual impact can be attributed within such globally collaborative science. We anticipate impact cases to develop from this and other work underway;
- We are committed to the appointment of a new full-time member of support staff with specific responsibility for impact (pathways to impact, monitoring impact, and knowledge exchange).

Collaboration and liaison
- We will develop new partnerships, strengthen existing links, and establish an Industrial Advisory Board to work with ERI, ECCI, and with users external to HE;
- We are committed to extending our Joint Industry Projects and Knowledge Transfer Partnerships, to enhancing opportunities for industrial placements, and to ensuring that the benefits of individual impact initiatives feed into UoA strategy;
- We will ensure, by working through our BDE, and ERI, that long-term collaboration and partnerships are effective routes to impact planning. We will do this via Impact Planning Workshops.

Extending the impact agenda
- We will improve and implement appropriate key performance indicators by which to measure impact. This will involve rewarding and disseminating excellent impact work; encouraging academic staff to include an appropriate partner with respect to impact in all RCUK and other research funding applications;
- We will develop use of social media in disseminating impact by extending take-up of media training for staff (including research staff). We will do this by building upon the experience of colleagues with TV impact output (Brusatte, Hegerl, Nienow, Tudhope (BBC); Palmer (Discovery); Stevenson (Sky));
- We will develop the next generation of academic researchers by extending opportunities for impact awareness and training through, for example, NERC and EPSRC Doctoral Training Consortia/Partnerships, AHRC Collaborative Doctoral Programmes, ESRC Case Studentships.

d. Relationship to case studies

Our selected case studies reflect the Unit's strategic focus on economic impact and benefit; upon governmental and public policy and services; and in public engagement. Our strategy of industrial partnerships facilitated three case studies: 'Public and Private Sector Investment in Carbon Capture and Storage Technologies', 'Economic Benefits Derived from Exploitation of North Sea Oil and Gas Fields', and 'Economic Benefits Derived from MTEM Limited'. Our work in earth surface processes underpins two case studies with international significance and reach upon different governments' strategies on hazards and natural disasters ('Development of Operational Earthquake Forecasting Services'; 'Operational and Strategic Policy Formation Related to Volcanic Hazards in North-Western Europe'). Several case studies – on climate change mitigation, environmental services, and the development of professional practice – illustrate our impact upon governmental and business policy, within the UK and internationally. The public has benefitted extensively, internationally, in the UK and in focused local contexts. Development of new facilities for impact (e.g. ECCI: see **c** above), in association with established strategies (see **a**) and planned initiatives (see **c**), will enhance and extend the Unit's research impact in future.