Institution: University of Birmingham

Unit of Assessment: UoA 7 – Earth Systems and Environmental Sciences

a. Context

The School of Geography, Earth & Environmental Sciences (GEES) at the University of Birmingham (UoB) is wide, leading to a concomitantly wide range of end-users beyond those mentioned in the case studies. UoA7 comprises themes in Environmental Health Sciences (EHS), Water Sciences (WS), and Geosystems (GS), with input from the Society, Economy and Environment theme and the Centre for Urban and Regional Studies (see REF 5a). Themes draw expertise from across UoA7 and UoA17 to address challenges in environmental health and well-being; natural resource management; natural hazards; and living with environmental change. The audiences for our research – described further below – include national and local governments, international agencies, companies of all sizes in the private sector, and the general public.

a. Approach to impact

The table below illustrates the variety of impact activities in which we engage, often in collaboration with colleagues from UoA17.

Impact Activity	Examples (beyond those in the case studies)
Multi-disciplinary collaborations	EU SWITCH sustainable urban water project; NERC FENAC nanomaterials characterisation facility
Advice to regulatory bodies	Defra, the Environment Agency, UNESCO
Consultancy	Shell, BP International, PetroBras, ExxonMobil, BHP Billiton and OMV (UK) Ltd
Public understanding of science	The Lapworth Museum; UoB's Ideas Lab

Our aim is to develop **long-term, two-way, relationships** with an evolving core community of end-users, supplemented with ad hoc networks of stakeholders which coalesce around specific research projects. We convert the most fruitful of the ad hoc associations into long-term relationships of mutual benefit. For example, the decade-long partnership with Birmingham City Council on socio-environmental risk mapping won a Lord Stafford Award in 2012 for support of growth and economic prosperity in the UK (see the Cai et al. Urban Climate case study).

Our stakeholders repeatedly emphasise the need for **multi- and interdisciplinary approaches**, so we work across disciplinary boundaries within and outside of the university. Significant partnerships in this area include work on the characteristics and toxicity of manufactured nanomaterials with staff in Materials & Metallurgy and BioSciences, and work on atmospheric aerosol with Mechanical Engineering and the Institute of Public Health (most recently as part of a €2.4M ERC project). In 2012, Harrison was awarded the Fitzroy prize of the Royal Meteorological Society for work at the interdisciplinary interface of environment and health.

The unit works with **regulatory and policy** stakeholders in national and local governments throughout their evidence cycles. Ongoing engagement with stakeholders – not always directed at specific short-term end-user needs – provides a "virtuous circle" or "flywheel" that builds trust and awareness of capabilities, and from which emerging needs can be met. Lead, for instance, has, since 2008, sat on panels of the European Chemicals Agency, Defra, the Environment Agency, the Health and Safety Executive, the British Standards Institute, and the OECD. Similarly, Harrison has sat on 6 advisory committees for Defra, predecessor UK government departments, and the Department of Health. Awareness of government policy requirements has enabled Lead and Harrison to focus research on addressing those needs, as exemplified in the Harrison case study (particles and health) and through a total of £0.6M of direct government-department funding. Long-term involvement with policy-makers is also detailed in the Harrad (flame retardants) and Tellam et al. (water resources) case studies. Since joining in 2011, MacKenzie has advised local authorities

on sustainable urban regeneration and air pollution mitigation, providing context-specific translation of research to authorities in Milan, Birmingham, Sandwell, Dudley, Lancaster, and Telford.

The unit is active globally, leading to international engagement and impact. Examples include advice provided to inform policy on indoor air pollution for the World Health Organisation (Harrad, Delgado-Saborit (benzene and polycyclic aromatic hydrocarbons sub-committees) and Harrison), and advice to the same organisation on the 2010 Icelandic volcano emergency (Harrison). Renshaw has been providing advice on remediation of nuclear waste contamination to the Japan Atomic Energy Agency since 2009; this work took on a new urgency as a result of the 2011 Fukushima nuclear accident, after which she was invited back to Japan to deliver a Knowledge Transfer workshop. Colleagues from UoA17 have provided social science perspectives to the same end users, illustrating our commitment to joined-up multi-disciplinarity in our approach to impact.

Users access our expertise primarily through (paid or voluntary) **consultancy** on natural resources (e.g., AkzoNobel, Severn Trent Water, Shell, BP International, PetroBras, Exxon-Mobil, BHP Billiton and OMV (UK) Ltd). Tellam, Rivett and Herbert undertake consultancy in water resources and ground-source heat; during his time in post (2010-2013), Schofield delivered over 40 talks to oil companies. Similarly, Harrington's research expertise in micropalaeontology was bought-out by BP International for summer 2012 for a provenance study of deltaic sand reservoir rocks. Although commercial practices (i.e., several simultaneous consultancies feeding into any single commercial decision) often prevent impact attribution in the natural resources sector, it is clear that value-multipliers are often orders-of-magnitude in the industry business cases that fund consultancy (e.g., £300k to inform drilling of a well which will cost £300M and bring return on investment within a decade).

The audience for our **broader cultural activities** is very diverse and includes schools, museums and local interest groups as well as practising professionals. Advice on **professional best-practice** is most commonly pursued directly through knowledge-transfer projects such as Marie Curie Initial Training Networks (2 in the field of persistent organic pollutants coordinated by Harrad since 2008), Knowledge Transfer networks (Tellam sat on the management board of the Hyporheic Network 2006-2009) and professional fora such as the Groundwater Forum (Tellam sits on the steering group). Birmingham staff from UoAs 7, 17 and 14 led researchers from across the UK in producing the *Designing Resilient Cities* (BRE Press 2011) practitioner guide.

The Lapworth Museum of Geology provides a valuable conduit for **public engagement** through activities such as the Lapworth public lecture series and university community days, in addition to daily opening. The museum has been awarded a Heritage Lottery Fund grant of £130k to develop plans for a £2.4M expansion project that will broaden its scope and elevate it from regional to national importance, significantly increasing public access to our research.

Institutional facilitation of impact

Institutional facilitation of impact is provided at University level via a range of initiatives (e.g. Impact Acceleration Fund to support secondments, Medici entrepreneurship training, Enterprising Birmingham Fund, outreach to schools, and formation of the Public Engagement Group under the RCUK Concordat). At College-level, support is provided by a Director of Knowledge Transfer, a business engagement directorate, and a College Business Engagement Partner. Spin-out activities, including consultancies, are facilitated through ALTA Innovations (e.g., US Environment Protection Agency, Gloucestershire County Council, the Nuclear Decommissioning Agency and the Environment Agency); our strategy aims to increase spin-out and commercialisation from UoA7.

University help to enhance public understanding of our research is provided by the Press Office,

which facilitates real-time news feeds and engagement with public discourse through web outlets *The Birmingham Brief* and *The Conversation*. A recent article on "fracking" by Herbert was picked by the All-Party Parliamentary Group on Unconventional Oil & Gas, who consequently invited him to be an associate member of the group. News streams are complemented by less formal streams through the Twitter accounts @BUCL_HiTemp, and @DinosaurusGrace. The university Ideas Lab develops documentaries based on work at Birmingham. Since 2008, the Lab has produced 3 university podcasts and 1 "research in 60 seconds" video for our website, highlighting recent research results, and has initiated discussions with the BBC on future programmes.

b. Strategy and plans

Our strategy and plans for achieving impact are implemented across GEES (i.e. across UoAs 7 and 17) since we believe that the most impactful relationships with end-users make use of all the research power at our disposal. The GEES Research Committee leads our strategic focus on impact. Specifically, we seek, and will continue to seek, to maximise our future impact by producing research of the highest calibre, bringing our research progressively to practice with the highest degree of rigour, in order to yield impacts in the near-, medium-, and long-term. We encourage engagement with end-users by recognising it in our workload model, and reward engagement by assessing it explicitly in our promotion criteria as a key component of "Academic Citizenship". Other best practice is shared through staff mentoring (e.g. guidance from those sitting on Research Council funding committees and a national conference on "Impact, Exchange and Making a Difference" hosted by the School in 2012). We involve end-users in the teaching provision in all our MSc programmes - with the dual purpose of ensuring accreditation compliance and learning about emerging end-user priorities. Training in outreach and public engagement for doctoral students is currently provided by Unravelling Science, a specialist private-sector company; our doctoral training for impact is expanding to facilitate more commercial internships and entrepreneurship training.

We will strengthen ties to our end-user community through User Fora, each comprising a small number of senior people meeting annually to provide immediate feedback on the impact potential of emerging research. We will seek to move our stakeholders from "end-users" to "co-producers" by involving stakeholders earlier. We will learn key lessons from our preparation for REF: (i) the importance of recording stakeholder engagement as it happens and (ii) tracking evidence of impact. The first of these issues is already being addressed by the implementation of the PURE system, in which staff can record stakeholder engagement as living documents. Tracking impact has been made easier by the recent establishment (2012) of the College business engagement team.

At College-level, we have won very recently a European Regional Development Fund project: Accelerating Business-Knowledge Base Innovation Activity (ABIA). We are in the process of recruiting two ABIA business engagement managers that will identify SMEs in the region wanting to access academic expertise, match them with the most appropriate academics, broker the contact and engagement, and identify the best route for collaboration for both parties. The ABIA project will provide further support for engagement-linked travel and subsistence, consumables and events.

d. Relationship to case studies

The *Harrison (particles and health)* and *Harrad (flame retardants)* case studies show impact informing and shaping environmental regulation and policy. The *Cai et al. (urban climate)* and *Tellam et al. (water resources)* case studies show commissioned expertise working hand-in-hand with commercial and public stakeholders.