Institution: University College London/Birkbeck College

Unit of Assessment: 7 - Earth Systems and Environmental Sciences

a. Context

UCL's submission to UoA 7 comes from the Institute of Earth and Planetary Sciences (IEPS), which integrates staff both from the Department of Earth Sciences at UCL and the Department of Earth and Planetary Sciences at Birkbeck. The IEPS is committed to maximising the impact, reach and value of its expert knowledge and key research findings by reaching a wide range of user organisations and stakeholders from local, national and international governmental, industry, educational and community forums.

The insurance industry, governmental bodies and international humanitarian and development agencies are all key users of our research in areas such as hazard, pollution, environmental and climate change, much of which is transmitted through the Aon Benfield UCL Hazard Centre and the cross-disciplinary Institute for Risk and Disaster Reduction. Engagement with a wider user community encompassing industrial planning, waste protection, risk evaluation and natural resource exploration and extraction is achieved through collaborative and commissioned research and training workshops. Our research impacts range from multi-million pound cost savings for engineering and petroleum companies to global impacts on human health, achieved through the influence of our research on international governmental policies and international donor programmes. Impacts have also arisen from the development of new tools such as extreme weather alert feeds, and from the real-time monitoring of global tropical storms and drought for humanitarian organisations. Our provision of sedimentological studies for and microfossil stratigraphy databases to the oil and oil-service industry have likewise had considerable impacts on the exploration and management of hydrocarbon reservoirs. Our engagement with UK schools and public audiences have impacted positively upon the public understanding of science, whilst our leadership of international corporate social responsibility programmes has contributed to community teaching and training.

b. Approach to impact

UCL and Birkbeck share a research culture that embeds engagement with end-user communities to **promote, communicate, share and transfer specialist knowledge and expertise resulting from our research**. The range of approaches we take to achieving this includes the use of institutional support that helps us meet the specific needs and objectives of our research users. In particular, UCL's Enterprise Strategy has provided the framework for our institution of enterprise, impact and knowledge exchange (EIKT) as a mandatory element within IEPS staff appraisal. This includes setting EIKT objectives and plans to communicate and promote our research and science to a wide non-academic audience of both children and adults as a means of enhancing public engagement with and understanding of science. Our workload model allows appropriate time credit for staff to develop and maintain industry links, engage in CPD activities, work with policy-makers and practitioners, and pursue public engagement activities. Staff work with UCL Public Policy on events and briefings on climate science, change and financial risk to inform and influence public policy and promote awareness of these issues among a public audience.

Fostering **sustainable relationships with industry partners** is a vital strand of our approach to knowledge exchange within that sector, and we make every effort both to ensure that existing research findings are shared with relevant partners and that our research agenda remains agile and responsive to changing industry needs. Within the Unit, the Aon Benfield UCL Hazard Centre (ABUHC), sponsored by Aon Benfield, provides a direct conduit for the transmission of hazard research findings to the insurance industry and has benefitted from £908k sponsorship since 2010. In 2010 the Unit established the cross-disciplinary Institute for Risk and Disaster Reduction (IRDR) to enhance interdisciplinary collaboration and cooperation in response to a growing awareness of the effects of natural disasters and anthropogenic risks on global economics and the need to transfer cutting-edge natural hazard and risk research, practice and innovation from the academic environment to the business world, governments and international agencies. We have also worked hard to establish innovative methods of facilitating the transfer of research expertise to partners in industry. Recognising the power of the internet as a tool to link communities of academics, associations and industry, IEPS led on the establishment in 2011 of Nannotax.org, launched via international workshops hosted by industry and academia. This initiative, supported by NERC, International Nannoplankton Association, SEPM, and The Micropalaeontological Society, provides

467 international academic and industry users with an authoritative guide to nannofossil taxonomy and biostratigraphy. To date, the website has received more than 1.5 million visits.

The IEPS furthers its transfer of knowledge and expertise to industry through the **delivery of strategic training** in partnership with end-users both in the UK and elsewhere. In January 2013, Burgess used an EPSRC/UCL knowledge transfer award to provide training and policy guidance on arsenic-safe, sustainable groundwater supplies to the government of Bangladesh, its agencies, and staff from NGOs including the Department for Public Health Engineering, Bangladesh Agricultural Development Corporation, Bangladesh Water Development Board, the Water Resources Planning Organization and UNICEF (see case study UCL07-BUR**).** A 2012 UK Department for International Development CRISSA award to improve water management in Asia was used to establish training partnerships between the National Institute of Hydrology (India), The Institution for Social and Environmental Transition (Nepal) and the UK Overseas Development Institute. We have supported long-term business sustainability in developing countries via collaborations, for example, between Unit staff (Thurow, Thursu) and the Italian energy company ENI, whose Energy Efficiency Campaign and Global Children's Programme we have led since 2008 (renewed in 2013). Here, our approach extends to **community teaching and training** for a new generation of scientists who will be tasked with finding sustainable ways to meet the world's growing energy demands. Since 2008 we have run the ENI programme seven times for audiences of 100-200 teachers and students/pupils in India, Ghana and Mozambique. In 2010 the programme won the prestigious Getenergy Award for excellence in industry-academic collaboration.

Closer to home, we capitalise on the opportunities presented by **collaborative studentships** to institute and maintain productive relationships with external partners both within and beyond industry. In addition to NERC and EPSRC industrial studentships, we take advantage of UCL Impact Awards, an institutional commitment to maximising impact by providing 50% co-funding for collaborative PhD projects with external organisations including charities, companies, government institutions and social enterprises. The Unit has won 12 Impact Awards since they came into existence in 2010, facilitating engagement with a range of industrial partners (BG Group, DeBeers, ExxonMobil, Nexen, Petrostrat Ltd), NGOs (CAFOD) and external agencies (BGS, UK Sport, Center for Research of Crete). In 2008, Edwards, a UCL Knowledge Transfer and Enterprise Champion, initiated a collaborative partnership with the Catholic aid agency (CAFOD) to work on disaster risk reduction and adaptation to climate. The need for science and technology to reduce risk are now embedded in the CAFOD Humanitarian Strategy for 2010–2015; the collaboration won a NERC CASE studentship (Hudson-Edwards) and has been part of UCL's NERC Impact Acceleration Account activity in 2013. Further support for these sorts of relationship come from cross-disciplinary Institutes, notably the Institute for Sustainable Resources, established in 2011 with $5 million funding from BHP Billiton. The 12 PhD studentships produced by the Institute since 2008 have helped the Unit develop important new relationships with companies such as Johnson Matthey, and to consolidate existing collaborations such as that with Nexen Petroleum.

Support for UCL and Birkbeck staff engagement in enterprise activities, including **consultancy and commercialisation**, is provided to both institutions through UCL Business PLC (UCLB: technology transfer organisation) and UCL Consultants Ltd (UCLC: contracting services, liability insurance and use of institutional resources), and through a policy allowing all academic staff to undertake up to 40 days of paid consultancy per annum. Since 2008 the Unit has undertaken 21 commissioned research projects worth a total of £2.1 million. Examples range from Bristow's 2008 consultancy for the Countryside Council for Wales on the impact of Forest Plantation on Coastal Geomorphology in North Wales (resulting in significant changes to land management practice), to the 2008 commercialisation of Saunders' wind research, sponsored by Aon Benfield, RSA and Crawford & Company. This produced the online public warning service www.tropicalstormrisk.com (9 million web hits since 2008), provided continuous storm alert feeds to Reuters AlertNet, the global humanitarian news portal, and created 6 new spin-off licence products (see UCL07-SAU).

The benefits of our work on natural disaster risks are also realised through our **provision of expert advice to policy-making bodies, advisory boards and panels**. The links through which we deliver this advice have been fostered particularly through the ABUHC, which has advised the UK Cabinet Office on the National Risk Register and community resilience. In 2008, the Centre also advised the Science and Technology Section of the Chinese Embassy to the UK about Asian earthquakes. Sammonds is a member of the international, multi-disciplinary Earthquake

Engineering Field Investigation Team, set up to investigate the Tohoku earthquake and tsunami, whose reports are used by the Cabinet Office for Civil Contingency Planning and Preparation. Latterly, advice has also been channelled through the IRDR, which has broadened stakeholder engagement in the area of hazard risk reduction by extending our expertise from natural (geophysical and meteorological) hazards to engineering hazards, health risks and pandemics. Despite its recent establishment, the IRDR has developed a strong reputation for expertise, leading to the invited provision of its members' advice to help insurance industries meet the requirements and risk management standards of the new Solvency II EU Directive (Sammonds, Roberts), and membership of the UK BOND Disaster and Risk Reduction Working Group, through which UK NGOs deliver effective risk reduction programmes (Edwards).

Our provision of expert advice to policy- and other decision-making bodies has been central to our capacity to deliver environmental benefits both in the UK and abroad, and many of our academics have served on advisory boards and panels that contribute to policy-making. McGuire sat on the 2010 UK Government Scientific Advisory Group in Emergencies (SAGE), and Burgess was a member of the 2009 DEFRA 'Nitrate Vulnerable Zone Appeals Panel', designated by DEFRA and upheld under EU law to determine and enforce restrictions on agricultural land-use practices. In February 2013, Rapley was appointed Chair of the London Climate Change Partnership, a conglomeration of public, private and community sector organisations which acts as the hub for expertise on climate change adaptation and resilience in London and seeks to prepare London for extreme weather today and climate change in the future. The Unit has also provided numerous briefings on climate change and energy, which have informed governmental policy and industry strategy. These have included briefings to the Foreign and Commonwealth Office (February 2008); MI5 / Security Services (April 2009); John Laing (May 2009); Shell (April 2010); Channel 4 (December 2011); and Total (November 2012). Further afield, the Indian government commissioned a study of Ladakh's geothermal potential in response to our provision to the Indian Vice President of a 2010 briefing document on the region's energy needs.

To expand our engagement with non-academic audiences – and thereby the reach of our impacts on them – Unit staff also engage in a range of **outreach and engagement activities**, including **public lectures**, **community teaching projects**, and development of **reusable learning resources**. We undertake these particularly in recognition of the role of science in underpinning sustainable economic development and social wellbeing essential for UK competitiveness. Since 2008, Unit staff have given over 140 public lectures and delivered keynote presentations at major science festivals including the British Science Festival (2009 and 2011), Edinburgh International Science Festival (2012), Hay Festival (event 215, June 2012) and Rome International Science Festival (2010). We participate in UCL-led science weeks, organise taster courses, and run summer schools for Year 11 and 12 students on subjects such as 'Understanding the Earth' and 'Mars in the Classroom', from which we developed a web-based learning resource for 13-16 year olds. The reach of our educational benefits has been expanded by our role as the London partner in the UK Schools Seismology project, which links to schools worldwide. Blogs, Skype interviews and YouTube are used to share relevant research findings: Bown, for example, has contributed to 7 IODP/Ocean YouTube films attracting over 15,000 hits and highlighting research conducted during IODP Expedition 342 in 2012. Unit staff achieve still wider exposure via media engagement in their roles as commentators, advisors to, or participants in, radio and television news, science, and documentary programmes. They have made a total of 91 such appearances on programmes including *Newsnight* (7/4/08), *The Star at Night* (9/10/12), *Stargazing Live* (8/1/13), *Wonders of the Universe* (6/3/11), and several episodes of *Dinosaur Planet* (2011).

c. Strategy and plans

The Unit recognises that maximising the efficacy of its approach to impact involves the engagement of research groups, not only within the IEPS but also across our institutions as a whole. An important part of our strategic plan for the future is to capitalise on opportunities presented by the UCL Institute for Risk and Disaster Reduction (IRDR) for **productive cross-disciplinary partnerships** as it matures over the next 5 years. These will enhance the impacts of our research both by expanding its remit and facilitating its communication via our new partners to a broader network of individuals and groups within their end-user communities. Within the next year we plan to appoint two new cross-disciplinary, joint academic posts in collaboration with the Department of Statistical Science and the Division of Medicine, and envisage further expansion

through strategic academic appointments and studentships to maximise the impact and value of activities in risk and disaster reduction through increased interdisciplinary collaboration.

One of our key strategic priorities is the development of closer collaborative links with the **London Centre for Nanotechnology**, through which we will expand engagement with industry end-users in the areas of energy and the environment. This will be conducted under the auspices of the UCL Institute for Sustainable Resources and through the development of an expert group to study (in collaboration with ExxonMobil, BG Group, and BP) the efficiency and risks associated with exploitation of shale-gas. To exploit and foster the complementarity of expertise and synergies between Earth Science and Nano-technology, we plan a **Nano-Geo initiative** directed at enhanced oil and gas recovery via hydraulic fracturing. We made the first joint academic appointment to exploit this new academic-industry initiative in 2013 (Papineau), with further growth planned over the next 3-5 years.

We will continue our policy of **encouraging significant commitment of academic staff time to issues of science policy**. In 2013 Professor Chris Rapley, CBE (not returned in our submission due to his focus on communication of climate change to the public, and climate change policy and governance) took over as chair of the London Climate Change Partnership with the goal of making London the most "climate-robust" city in the world. This appointment and the pertinence of our academic expertise will allow us to feed into relevant policy and decision-making processes and to support the Mayor's Climate Change Adaptation Strategy and the UK Government's National Adaptation Plan. Also in 2013, Professor Jacqui McGlade completed her second five-year term as Executive Directory of the European Environment Agency, where she developed a shared European environmental information system to strengthen the link between science and policy and improve the communication of environmental issues to the public. These roles will strengthen IEPS' connections with the newly established UCL Department of Science, Technology, Engineering and Public Policy, with whom we will work closely to maximise the value of future contributions.

The reach of the educational benefits of our research will be expanded through our contribution to ENI's Global Children's Programme in Papua New Guinea, Indonesia, Angola and Congo. Building on established links, IEPS staff are organising an international conference on Sustainable Resource Development in the Himalaya, to be held in India under the auspices of the Governor of Jammu and Kashmir and in collaboration with the Geological Society of London and the University of Jammu.

The Unit will strengthen its strategy of pro-actively **embedding EIKT activities** into its research culture by extending staff training and interactions with UCL support structures and promoting individual collaboration and engagement within relevant UCL multi-disciplinary institutes. EIKT objectives and record keeping of engagement and media activities will become mandatory for all staff, who will also be expected to take full advantage of the 30 business-related training programmes provided by UCL Advances, UCL's centre for entrepreneurship. The Unit has appointed an EIKT Champion (Edwards, from May 2013) to act as the first point of contact for impact-related training, internal mentoring and commercial consultancy and to help identify areas where there is scope for increased engagement.

d. Relationship to case studies

The impacts outlined in the five submitted case studies demonstrate the breadth of our activities within the integrated IEPS and shared use of institutional resources supporting knowledge transfer and enterprise. Both our pathways to and the importance of **fostering sustainable relationships with industry partners** is demonstrated by three case studies: UCL07-SAU 'Extreme weather services benefiting industry and humanitarian relief'; UCL07-PIC 'Improved geological models aiding hydrocarbon reservoir development' and UCL07-BRI 'Methods to determine sand dune migration benefiting engineering and hydrocarbon companies'. These case studies also show how engagement with the hydrocarbon industry through **PhD sponsorship and consultancy managed by UCLC** led to impact, and how **support offered by UCLB** enabled us to increase the end-user benefits of our work, included through its commercialisation. Our **delivery of strategic training in partnership with end-users** is described in the case studies UCL07-BUR 'Groundwater arsenic pollution: informing policies and mitigation programmes, leading to improved public health security in Bangladesh', and UCL07-ROB **'**Improved seismic hazard mapping by institutions in Italy and Greece'.