Institution: University of Derby
Unit of Assessment: Earth Systems and Environmental Sciences (07)
a. Context

Earth Systems Science research at Derby University takes place in the Human and Physical Environments Research Group (HPERG), located in the Department of Geographical, Earth and Environmental Sciences. The group formed in the autumn of 2008, and undertakes nationally and internationally recognised research focusing upon the physical and human dimensions of climate change and the associated environmental impacts and crust and mantle dynamics. Prior to 2008 several members of the group conducted consultancy work within the University of Derby's Centre for Land Evaluation and Management (CLEM). Given that this is a young and diverse research group the impact, both planned and unanticipated, has been on a diverse group of beneficiaries (e.g. local and national communities, and international organisations) the principal effect of which has been to enhance the public understanding of and policy decisions in the area of climate change. This is evident in **Abbott's** 'Lived Experiences of Climate Change' (LECH-e) project (**Case study 1**) and the new (sclerochronological) sources of palaeoclimate data emerging from **Johnson's** research (**Case study 2**). The data have been fully acknowledged by the Pliocene Research, Interpretation and Synoptic Mapping (PRISM) group of the USGS and informed the findings of the group as reported in the Inter-governmental Panel's Assessment Report 5 (draft, 2013).

Non-academic users e.g. practitioners directly engaged in development management have been both informed and influenced by **Abbott's** research engagement in sustainable development and gendered poverty. For example, in Uganda, groups involved in decision-making in terms of developing sustainability policies have been directly informed by specific networked academic/practitioner partnership books edited by Abbott and colleagues e.g. *Environment Development and Sustainability in the 21st Century.* A further benefit of **Johnson's** research has been involvement in consultancy reports (Sept 2008 and Mar 2011) for UK Coal. The outputs emerging from **Pope's** geo-anthropological work have enabled a specific group of (unplanned) end-users comprising the general public (Derby Evening Telegraph, June 2009), an MEP and Geoscientists at BP (e-mail correspondence 01 Dec 2010) to better understand the dynamics of Holocene climate change. Specialists working in the fields of karst hydrology and radioactive waste disposal have been informed by **Jones and Banks**' research into dating secondary terrestrial carbonate deposits and landscape evolution. The impact is evidenced by a book chapter being downloaded in excess of 2000 times (since Feb 2012), an international readership (top 5 countries being the USA, Australia, UK, Iran and India, over 100 downloads from the NERC open research archive, and use of data by Derbyshire County Council to better understand the conservation value for tufa as a building stone (source: personal communications).

b. Approach to impact

Engagement/development of relationships with beneficiaries: The HPERG has targeted funding around specific projects that draw upon existing staff expertise and have the potential to stretch research dimensions beyond the academic to engage public discourse and community-related activities. As part of her lived experience of climate change research, **Abbott** engaged with diverse groups of stakeholders e.g. European Regional Centres of Excellence for Sustainable Development (RCEs) and Local Government Taskforces (UK) through an extended LECHe forum (2010) and a series of focused UK and Europe-based group meetings, presentations and interactive workshops (2010 to 2012). Engagement with differing cultural groups took place through the medium of open educational resources/student repositories (which now form a highly quality and readily accessible legacy resource); focused consultancy activities involving diverse social and cultural groups in specific countries e.g. Uganda and university establishments e.g. Makerere. At a regional level, Abbott has developed ties with various NGO organizations e.g.

Village Aid, acting as an academic consultant; and playing a leading role in initiating African refugee community activities throughout Derbyshire.

An indirect pathway to impact is evident in **Johnson's** engagement with academic and non-academic users. Johnson was invited to present aspects of his ongoing research to others in the field of climatology at the USGS (August 2011) after his submitted manuscript was refereed by the leader of the PRISM group (Prof. H. Dowsett). A key outcome following this engagements has been a reorientation of the approach taken by PRISM to climate reconstruction research with the new approach published in a high impact journal (*Phil. Trans. Roy. Soc. A.* [2013]). A planned pathway for generating impact for known beneficiaries is provided by **Pope's** Hellenic cave project Pope was invited by the Municipal Company of Hellenic Caves to generate data for a scheme to develop the geo-tourism potential of cave-sites. Initial engagement via Skype (Sept. 2009) and stakeholder discussions (July 2010) culminated in an agreement to generate critical environmental data (August to December 2010), undertake multi-lingual surveys to better understand visitor requirements and experience (July-August 2011), and disseminate geo-anthropological data using a multi-media approach (Sept. 2012 onwards).The project has been on hold in September 2011 due to the economic downturn In Greece

The University of Derby has a very particular role in raising educational levels in the East Midlands region a part of which is raise the levels of the public understanding of scientific issues. Thus **Rollinson** has sought to reach out to new audiences of professional and lay scientific groups to ignite public debate on the subjects of the 'nature of the very early Earth' and the 'interface between science and religion' via his involvement with the Multi-faith centre (Derby University [May 2009]), Manchester Geological Society, East Midlands Geological Society, Nottingham University (Jan 2010), Christians in Science, Nottingham University (Feb 2010), Leicester Lit and Phil, (March 2010), Café Scientifique, Nottingham (Feb 2012), and South Peak Geology Group (Nov 2012). Similarly, **Cook** has attempted to engage with non-academic audiences through public lectures and presentations at UK institutions such as the Royal Geographic Society, and the Universities of Sheffield and Bristol. In additional, Cook has engaged with lay audiences and the general public at national and international levels through via a blog-site that disseminates climate research, news and other informal resources.

Support for researchers and institutional facilities to achieve impact: Researchers have been supported by University funding initiatives with GEES researchers having secured £60k from internal funding streams. The HERPG's creative use of these funds has created impacts that stretch well beyond academic e.g. Abbott's current LECH-e related activities with international groups and Johnson's work with the PRISM group of the USGS. The HERPG has also supported staff to achieve impact through the provision of modest financial support for short periods of release from teaching commitments to facilitate attendance at national and international stakeholder meetings and forums designed to develop follow-on activities.

The HPERG group are also supported in their engagement with non-academic organizations through access to Faculty laboratory facilities. The scanning electron microscope (SEM) has been used extensively by Rollinson and Adetunji in their mineral-chemical studies of chromite and in their £6k study of chemical composition of atmospheric dust funded by the Midlands Asthma Allergy Research Association. This instrument was recent refurbished with a £25 solid state silicon drift detector. Extensive use is also made of a SEM for petroleum industry consultancy into pore flow analysis of core materials for Weatherford Laboratories in Norway and Kirk Petrophysics in the UK). The Mossbauer spectroscopy is used in mineralogical research to characterize the different oxidations states of iron and has been applied to the study of iron oxides, chromite glauconite and rare Ni-bearing spinels. Research and consultancy activities linked with the Centre for Land Evaluation and Management (CLEM) utilize Atomic absorption (AAS) facilities and these were supported by a grant from the East Midlands Development Agency in 2008 for new laboratory equipment including microwave digestion and TEM.

c. Strategy and plans

The critical mass within the research group is in the area of the physical and human dimensions of climate change. Due to the national and growing national and international links of the group, climate change research is the primary focus for the future and indicates the direction of travel. A secondary focus for the group is in the area of the early history of the Earth where Rollinson's reputation provides excellent international links. Thus the HPERG aims to ensure that: (1) impact generated by existing research activity is not only sustained, but also progressively developed; and (2) new collaborative research undertaken by existing and new staff is underpinned by identifiable pathways that generate impact in the medium- to longer-term. The first aim will be achieved through:

(a) the efficient use of funding sourced from University, external, and consultancy activities to support staff engagement in planned follow-up activities related specifically to collaborations involving PRISM/USGS, Municipal Company of Hellenic Caves and the Greek Ministry of Culture & Tourism, and LECH-e.

(b) targeting journals that appeal to a diverse (non-academic) readership (for example, the International Journal of Climate Change and Mercian Geologist), and engagement in regional community-focused events e.g. East Midlands Climate Change Week and community-focused Science day events held at HEIs throughout the Midlands region

(c) the judicious appointment of new research active staff in the Geosciences area.

The second aim will be achieved through a series of events that will be developed in conjunction with Faculty Knowledge Transfer Partnership Managers. Specifically focused workshops will be organized in an annual cycle at both research group level and School of Science level to provide a forum for ideas on best practice in developing pathways to impact (commencing January 2014 and running on a 6 month cycle). Further focused networking events will be arranged to connect researchers, practitioners and policy makers in the relevant fields.

d. Relationship to case studies

The case studies illustrate how research with demonstrable impact is possible even in a young and small research group. The strategy the group is developing capitalizes on the research interests and expertise of its members, supports them financially and releases them into full-time research through 'mini sabbaticals' with the aim of maximizing staff opportunities to interact with external audiences. Funding from the HPERG facilitated fieldwork that generated critical data for **Johnson's** research and engagement with climate scientists in the United States. The Department also supported his release from contractual duties in order to resume an Alexander von Humboldt Foundation fellowship with resultant research activity culminating in data that has led directly to a 'paradigm shift' in the PRISM approach to climate reconstruction. The new strategy is described in a recent publication (Dowsett et al., 2013), has informed PRISM findings as reported in the Inter-governmental Panel's Assessment Report 5 (draft 2013) and is integral to planned PRISM work for AR6 (supporting letter supplied with case study). Aspects of the research have also been presented to local communities, and were showcased at the University of Derby Fun Day (05/05/2013).

Whilst **Abbott's** climate change research is underpinned by scholarly activity that predates the assessment period, the range of impacts generated by her current work is a reflection of the UoA's impact strategy. Support from the HPERG included funding for: (i) periods of fieldwork that have facilitated the generation of new critical data; and (ii) short periods of leave that that provided the opportunity to engage with national and international communities and organisations via stakeholder meetings, focus group meetings, and consultations. Moreover, in disseminating new knowledge in the form of open education resources via Lecher e-forms and portals Abbott has benefitted from the group's philosophy of actively supporting creative approaches to generating impact.