Transdisciplinary collaboration between physical and social scientists

Drawing on the experiences of an advisor to Earthquakes without Frontiers (EwF)

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Introduction

The UK government’s £1.5 billion Global Challenges Research Fund (GCRF) launched in 2016 supports ‘cutting-edge research that addresses the challenges faced by developing countries’ and represents a major research shift in UK research. It emphasises ‘challenge-led interdisciplinary research and strengthening research capacity within both the UK and developing countries’ (RCUK, 2017). GCRF’s significance, reflected in its share of the total government R and D budget of £4.7 billion annually (BIS, 2017), is evident in Figure 2.1. GCRF, as part of the UK’s Official Development Assistance (ODA) commitment, is monitored by the Organisation for Economic Cooperation and Development (OECD). ODA-funded activities aim to promote long-term sustainable growth in developing countries (RCUK, 2017). UK research councils have previously funded transdisciplinary research that addressed these challenges, such as Earthquakes without Frontiers (EwF). This has never been on the scale now envisaged.

The science budget, flat in real terms, is dropping sharply as a percentage of gross domestic product. The GCRF represents significant new funding for research (BIS, 2017). GCRF is administered through the UK Research Councils (RCUK) and national academies (e.g. Royal Society of London and British Council). RCUK has responded by calling for transdisciplinary projects. The call in summer 2017 aims to establish a cohort of large-scale Global Challenges Interdisciplinary Research Hubs, which are expected to deliver integrated and innovative international research programmes meeting ODA aims and ‘incorporate new collaborations and partnerships and be transformative for development challenges and inter-disciplinary in approach’ (RCUK, 2017). UK universities’ responses to GCRF have been corporate in nature, setting up high-level university committees with members drawn from several faculties, under directors of research, to coordinate action across a university.

GCRF funding was announced in the 2015 UK government spending review. Its substantial value and rapidity of the spending have taxed the capacity of funder organisations (research...
councils and academies) and research organisations (universities and research centres) to respond. Additionally, neither funder nor research organisations have drawn on existing institutional knowledge regarding interdisciplinary working and engaging with ODA countries. This is exemplified by the Natural Environment Research Council (NERC), Economic and Social Research Council (ESRC) and Arts and Humanities Research Council (AHRC) Programme on Building Resilience (NERC, 2017). Most funded projects have investigators who have not previously collaborated and/or undertaken research in ODA countries. Researchers who have led successful transdisciplinary teams on ODA-linked projects did not apply for funding because the call was too complex. High-level committees in funders’ and research organisations do not draw on those with the most experience in transdisciplinary working in the development context (e.g. the prominence given to working with development organisations in the Building Resilience Programme). In some ODA countries, working with international development NGOs is anathema in influencing policymakers. Senior scientists with long experience in transdisciplinary research in ODA countries have raised concerns that these factors will either waste GCRF research funds or produce poor outcomes.

Thus, experiences of transdisciplinary research that address challenges faced by developing countries should be described and analysed. Only a few across research councils had been funded. One of these, the NERC–ESRC Increasing Resilience to Natural Hazards in Earthquake-prone and Volcanic Areas (IRNH) Programme, funded two research consortia: Earthquakes without Frontiers (EwF) and Strengthening Resilience in Volcanic Areas (STREVA). EwF (2012–2017) offers a paradigm for transdisciplinary research in ODA countries in central Asia. EwF has produced high-quality research and achieved significant impact. STREVA (2017)
has also produced new ways of transdisciplinary working in geo-hazards, but is not considered here. A successor programme to IRNH, Increasing Resilience to Natural Hazards in China, was launched in 2016. This chapter draws on published research, publicly available documents from the research councils, online programme reports, formal and informal interviews with international physical scientists and social scientists as well as professionals and practitioners in government, research funders, NGOs, a Community Survey, and the outputs of transdisciplinary working groups. The challenges of how to work across disciplinary boundaries with different cultures, expectations and professional norms; how to communicate science to local communities; and how to innovate and keep everyone on board provide important lessons for others embarking on such enterprises.

Structure of transdisciplinary working

Hoffmann-Riem et al. (2008) in the *Handbook of Transdisciplinary Research*, argue that transdisciplinary research aims to overcome the mismatch between knowledge production in academia, and knowledge requests for solving societal problems. They suggest that developing a state of the art for transdisciplinary forms of research is best done by learning from experience.

In a world characterised by rapid change, uncertainty and increasing interconnectedness there is a growing need for science to contribute to the solution of persistent, complex problems, which include not only some of the now broadly known environmental issues such as climate change and biodiversity loss, but also related issues such as poverty, security and governance.

(Jäger, J., ibid.)

The division between expert scientific knowledges and local, indigenous knowledges is unfortunate from the point of view of ‘doing science differently’ (Lane et al., 2011). Yet, there are disciplines within the academy that make it their business to engage with local residents and bring these two knowledges together to initiate changes in behaviour and institutional structures. Among these are social work and community development. EwF included social workers and community development workers in its consortium, and is unique for this reason. Additionally, the research undertaken in EwF contributed to the further development of green social work (Dominelli, 2012). Although reaching similar conclusions as Hoffmann-Reim et al. (2008), green social work arrived at these from a different perspective, namely coproducing them from the ground up. Using participative action-research methodologies (PAR), the marginalised peoples who form the majority among the service users of these social science disciplines have their knowledge valorised and validated alongside that of the scientific experts (Dominelli, 2012). PAR, used in social work since the 1960s, enables researchers to hold the tensions and disagreements between diverse participants, and seek common objectives for avoiding being trapped in the ‘them–us’ binary, thereby persuading them to coproduce solutions that work for the common good (Dominelli, 2012).

As Hirsch Hadorn et al. (2008) point out, while methodological divisions characterised the emergence of modern scientific disciplines from the 17th century, for society to benefit from scientific progress, a figure as prominent as Francis Bacon (1561–1626) was convinced that collaboration among scientists was crucial. Division within science continued with the 19th-century emergence of the social sciences which were strongly influenced by the severe conditions experienced by the working class (ibid.). Professional social work emerged at that time to solve the then-pressing social problems, especially poverty, unemployment and housing among
disenfranchised populations in London’s East End (Gilchrist and Jeffs, 2001). The drive to solve real-world problems has promoted transdisciplinarity whereby different academic disciplines work jointly with practitioners (Klein et al., 2001).

Transdisciplinary research generally shows four characteristics:

1. Focus on real-world problems;
2. Transcending and integrating of disciplinary paradigms;
3. Participatory research; and
4. Search for unity of knowledge beyond disciplines (Hirsch Hadorn et al., 2008).

These characteristics of the IRNH programme and EwF research consortium are at the heart of green social work theory and practice. So it is worth examining in some detail the mechanisms for how the IRNH research programme was initiated, the working methods employed to keep everyone on board and focus on increasing resilience as a transdisciplinary theme.

**Structuring the Increasing Resilience to Natural Hazards (IRNH) research programme**

The IRNH programme was initiated in 2009 as the Natural Hazards Theme Action Plan by NERC (NERC, 2009). Its grand challenge was: ‘Reducing societal exposure to natural hazards by better forecasting, integrated risk assessment and scientific advice’. The programme was to stimulate areas where science was internationally immature, thus providing the UK with opportunities to lead research in new science areas and be closely aligned with the wider international disaster reduction agenda. It had three thematic research drivers: 1) effectively forecasting natural hazards and their consequences; 2) improving considerably the communication and application of scientific knowledge and understanding of natural hazards; and 3) emphasising mitigation strategies and investing significant financial resources in them.

Among the programme’s actions was Action 1, increasing resilience through improved hazard forecasting and take-up of scientific advice in earthquake-prone and volcanic regions, with a proposed budget of £7 million. Hazards are only a component of risk, and vulnerability is the element that can be managed most effectively. NERC science was to be developed with partners in the social and economic sciences. This produced an integrated research programme between NERC and ESRC (funding ratio 4:1 approximately). Although including other important partners, particularly the Engineering and Physical Sciences Research Council, Medical Research Council and UK Department for International Development (DfID), was strenuously pursued from the outset, it was not possible to persuade these funders to take this broad transdisciplinary approach. Researching vulnerability without engineering and health disciplines, and key relevant government departments, were setbacks, which were addressed in other ways. On the other hand, their absence raised the importance of social science in the programme. Sister NERC programmes in the Action Plan covered uncertainty, risk and scientific advice, and hydro-meteorological hazards.

The action was to address research areas where the science was ‘internationally immature and so provide the UK with the opportunity to lead research in new science areas’. However, the novelty of a transdisciplinary approach for UK research required a programme of integration activities, which NERC and ESRC introduced. These were:

- Appointment of a Strategic Advisor (the author) responsible for the strategic direction and alignments of the programme, providing overall intellectual leadership and ensuring
progress against the delivery of the programme’s objectives. Tasks included ongoing liaison and advice to the research councils through the Programme Executive Board (PEB), research consortia and knowledge exchange (KE) fellows, writing the programme calls (Announcement of Opportunities or AOs) and scientific leadership for programme meetings.

- Establishing a programmatic Natural Hazards Advisory Group (NHAG), chaired by the strategic advisor, tasked with advising the PEB on the strategic direction of the programme, recommending the award of research funds (but not making specific project-funding decisions) and integration of the programme science. NHAG was composed of four research council staff, six researchers (two international), one member from a government agency and one from an NGO. Areas of expertise covered physical sciences (earthquake and volcanoes), social science, public health, economics and humanitarian response. These formed an effective team with international experience. The involvement of colleagues from the Instituto Nazionale di Geofisica e Vulcanologia, Rome, was particularly valuable.

- The commissioning of six scoping studies in a competitive process. An additional earthquake-focused Scoping Study and report on resilience thinking in health protection were independently produced. Their reports are publicly available through the NERC website. Three of these studies fed directly into the two successful consortia research projects.

- Professional survey of nine in-depth interviews undertaken by the strategic advisor over a one-month period in May 2011 with representatives of the UK government, and professionals employed in finance, engineering, humanitarian agencies and NGOs engaged in disaster risk and reduction work. Participants were contacted beforehand with information about the programme and indicative interview questions. All discussions were noted and written up.

- Community online survey prepared by Oxford Innovation in April 2011 in two phases totalled 104 online visits. Of 59 respondents answering the Phase 1 questionnaire, 19 had been involved in the programme scoping studies. Phase 2 resulted in 44 respondents completing the survey. This survey aimed to: 1) gather a breadth and diversity of perspectives on the challenges that the scientific community foresaw in this transdisciplinary area; and 2) encourage individuals to view the topic from various perspectives (Oxford Innovation, 2011). The survey comprised two phases: Phase 1 asked individuals to contribute their thoughts and ideas to set questions; Phase 2 took responses from Phase 1 questions and asked individuals to evaluate and comment upon these responses.

- Programme meetings included an open one-day Town Hall Meeting in London that brought together physical and social scientists; an open three-day meeting in Chengdu, China; and a two-day integration workshop in Windsor for the IRNH-in-China programme.

I have provided considerable details because my reflections suggest that these are necessary components in successfully launching a transdisciplinary research programme in a research community with limited experience of either transdisciplinary working or engaging with ODA governments and communities around the geo-hazards theme. Other research communities in the natural environment (e.g. climate change) had far more experience.

\section*{Defining resilience}

The IRNH Programme’s high-level goal is to increase economic and social resilience to earthquake, volcanic and related hazards based on reliable knowledge of the fundamental physical and social processes involved, and full understanding of prevention and mitigation of the associated risks. An early issue for NHAG to address was what was meant by increasing resilience. The
definitions and etymology of resilience had previously and subsequently been much studied (Thywissen, 2006; Bahadur et al., 2010; Castleden et al. 2011; Alexander, 2013).

The professional survey showed that their organisations had dealt with this issue, and some like the UK Cabinet Office, in-depth (Cabinet Office, 2017). The Community Survey revealed a spread of opinion about the definition of resilience. But, a common reaction to the question was to request that NERC–ESRC provide their definition (Oxford Innovation, 2011). What the Community Survey also revealed was a minority who did not accept resilience as a suitable topic for a NERC research theme.

An outcome of the Scoping Study by a transdisciplinary team led by Densmore (2011) was the recommendation that: ‘Resilience must be defined in the broadest possible context, to allow for the multi-faceted nature of the ways that populations engage with and adapt to earthquake-related hazards. Resilience is fundamentally a dynamic concept, rather than a static or conservative one.’ The Scoping Study consultations also highlighted that meaningful resilience with respect to livelihoods may not necessarily predicate re-establishment of the pre-disaster state. Importantly, changes to pre-disaster arrangements involving livelihood, location and mobility may ‘enhance future resilience’. Members of the EwF consortium involved in this Scoping Study are currently using green social work principles to enhance individual and community resilience in post-Gorkha community-based developments, including sustainable income-generation projects and recording these developments for further research purposes and changes in policy and practice. Dominelli (2017) discusses the implementation of green social work post-disaster in Nepal.

A definition, adapted from the United National International Strategy for Disaster Reduction (UNISDR), was adopted for the IRNH programme as it encompassed the spread of opinion and encouraged a transdisciplinary approach:

Increasing societal resilience requires that the society, community, economies or system exposed to these natural hazards has the ability to resist, absorb, accommodate to and recover from their effects in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions, determined by the degree to which the society has the necessary resources and is capable of organising itself both prior to and during times of need.

Science excellence versus societal co-benefits

Physical hazards are only one component of risk. Significant amplification of the impact of the research programme, including reductions in mortality rates and economic loss, would be achieved through the broader interdisciplinary characterisation of risk and resilience. As the IRNH Programme Announcement of Opportunity stated (NERC, 2017), one of the principal goals:

is the integration of natural and social science research across the programme to enhance the potential for impact on those affected by natural hazards, in the short and long-term. To that end a co-productive approach to research was required [of the project consortia] involving a framework for the sharing in parallel of knowledge and values between natural and social scientists and by consultation with policy makers, civil society and other stakeholders throughout the research programme.

In reaching this point, there had been considerable discussion within NHAG. It took the view that the programme delivering scientific excellence and societal co-benefits were of equal value.
So, the natural science research needed to be undertaken in conjunction with social science (co-designed, produced and delivered) that addressed issues including decision-making under conditions of uncertainty, vulnerability analyses to increase resilience; translating assessment into policy, and policy into action; exploring knowledge relationships and reflective learning across disciplines; and recovery management. The position was strongly endorsed by physical scientists who had direct experience of dealing with similar issues. Co-production of the research was not envisaged in the NERC Theme Action Plan, so approval from members of NERC Council was necessary for the AO to be approved. This required unanimity in NHAG.

The Community Survey revealed that co-produced programmes between natural and social sciences were not popular. When the IRNH programme questioned what should be the balance between commissioning science publishable in the highest quality journals versus science with ‘impact’ in increasing resilience, comments indicated some resistance that suggested transdisciplinary research should be a priority – rather studying the fundamentals of the physical process.

In response to the question, ‘what would be your main suggestions to the IRNH interdisciplinary research programme’, community responses indicated that a sizeable proportion were unwilling to engage in research outside the physical sciences domain. Figure 2.2 summarises the Phase 2 Community Survey output showing the mix of opinions and perceived role of social

**Figure 2.2** Community Survey Phase 2 outputs: challenges to produce the best research excellence and societal co-benefits

Source: Oxford Innovation, 2011
science in the programme. There was low disagreement that education, increasing the use of scientific knowledge by NGOs as responders and increasing knowledge in the developing world were highly relevant. There was high disagreement over working with communities and local governments, mitigating damage and making science relevant for the people affected. This supports the view that many physical scientists regard the role of social sciences as communicating the science, rather than engaging in a co-designed, co-produced and co-delivered programme.

**Natural hazards remit**

As part of the broader NERC Natural Hazards Theme Action Plan and to avoid overlap with other programmes, the IRNH Programme was prescribed a range of natural hazards in geo-hazards. This excluded a multi-hazard approach which would have been the best approach if the increasing resilience had been addressed primarily through vulnerability. However, as highlighted in the Theme Action Plan, earthquakes, volcanoes and related hazards – such as landslides, tsunamis and lahars – cause enormous human and economic losses and disruption which continue to grow worldwide. Lack of preparedness in major urban conurbations (e.g. Tehran) makes the million-death earthquake seem inevitable (Musson, 2012). The sudden onset of an extreme natural event can have catastrophic, regional-scale, long-term social and economic effects. For example, the 2010 Haiti earthquake had high levels of mortality and morbidity, and economic losses that exceeded annual GDP. The societal disruption caused may require a generation to overcome and this can be superimposed on existing poor development and health.

Earth is a dynamic planet, as the IRNH AO pointed out (NERC, 2017). Slow forcing from the underlying mantle drives both volcanism and earthquakes. Resulting crack growth in the crust is highly non-linear, making individual earthquake or volcanic events difficult to predict. Long inter-event times result in standard hazard assessments that can be grossly misleading, such as for the 2011 Tohoku Japan earthquake and tsunami, 2010 Haiti earthquake and 2010 Eyjafjallajökull eruption. The direction of recent UK research into the physical processes that control the occurrence and magnitude of natural hazards in earthquake-prone and volcanic regions has the potential markedly to contribute to increased resilience (NERC, 2017). For instance, recent research has made significant contributions to the forensic studies of earthquakes in the determination of spatial patterns of inter-seismic strain rates, on fault interactions and subsequent migration of seismic activity, which together allow quantitative assessments of the zones of greatest earthquake hazard. A very high proportion of losses in earthquake-prone regions are caused by related hazards of landslides, and tsunamis activated during earthquakes. Advances in their spatial characterisation have considerable potential for development within risk management.

Earthquakes without Frontiers (EwF) is a five-year transdisciplinary consortium project funded from the IRNH Programme, involving Cambridge, Durham, Hull, Leeds, Northumbria and Oxford universities, the Overseas Development Institute, British Geological Survey and National Centre of Earth Observation in the UK. The consortium aims to provide transformational increases in knowledge of the primary and secondary earthquake hazards in the continental interiors (EwF, 2017). Frequent, devastating, large magnitude (Mw = 7~8) earthquakes occur in continental interiors. As England and Jackson (2011) argue, the networks of faults within the continents are not well mapped out. The fault zones are commonly hundreds or thousands of kilometres in width and contain many separate faults, each slowly straining. A large earthquake is caused by a fault slipping a few metres so the time required for the necessary strain to accumulate is a few hundred to a few thousand years. This makes assessing the hazard from widely dispersed continental faults with long inter-event times particularly challenging. EwF
employ a range of advanced scientific methodologies to understand continental faulting. These include: 1) measurement of strain in Earth’s crust from satellite, combined with seismology; and 2) forensic analyses of faults (including hidden faults), combining established field mapping techniques, trenching across faults and Quaternary dating with innovative survey techniques to produce high-resolution topographic models. For example, in Kazakhstan, EwF have uncovered and surveyed the ruptures from a great earthquake in 1889 that destroyed the then-town, and now-major, city, of Almaty, and have also discovered the ruptures from another unknown large earthquake that occurred 300–400 years ago. Analysing seismically triggered landslides through field surveys and satellite remote sensing to understand temporal and spatial distributions is a key part of this enquiry (EwF Report, 2015; NERC, 2017).

Vulnerability to geo-hazards

As stated in the IRNH Programme AO:

understanding vulnerability is at the heart of increasing economic and social resilience, and increasing the impact of physical science advances. Vulnerability can be social, economic, technical and infrastructural, and understanding vulnerability historically can help inform approaches to each of these areas. Components of vulnerability that require research include well-being, self and social protection, governance, the strength of livelihoods, resolve to survive, modelling techniques and methods which use social and spatial data to develop indices of vulnerability and community risk maps.

(NERC, 2017)

The developed world is characterised by societies relatively highly resilient to geo-hazards. This is illustrated by the low death tolls from significant recent earthquakes such as 2011 Christchurch where only 0.1 percent among those exposed to shaking of intensity VIII+ were killed (England and Jackson, 2011). By contrast in the developing world, for example, even relatively small events may cause large death tolls that have huge social and economic impacts. ODA countries also provide the best opportunity for UK science to make significant impact. So the IRNH AO contained a clear steer in that direction. EwF research addresses the Alpine–Himalayan belt, which stretches from the Mediterranean to the Pacific, with specific focus on Northeast China, Iran and Central Asia (including the Tian Shan mountains in Kazakhstan, Figure 2.3), and the Himalayan mountain front (including Nepal). The project’s second objective is to identify pathways to building resilience in populations affected by earthquake hazards (EwF, 2017).

Community Based Disaster Risk Reduction

To translate science into resilience and impact of the IRNH programme, effective exchanges of knowledge between scientists and communities at risk, local governments and regional organisations, including through the dissemination of scientific ideas, education, training and building of local capacity, was required. The IRNH programme required that this be undertaken in the appropriate context and in collaboration with and understanding of communities at risk, supported by partnership-building with scientific organisations, government agencies, policymakers, and industry and commerce. At the community level, how capacity, resilience and agency can be increased while avoiding the imposition of a ‘top-down’ model of hazard assessment and risk management was an important consideration (NERC, 2017). It was a concern that externally generated scientific expert knowledge (like hazard maps) may not be appropriate
for communities at risk in the developing world, with the result that such knowledge may not contribute to resilience-building. But as Densmore claimed:

> The findings from the Scoping Study challenge the binary view of scientific/indigenous knowledge often reported within the literature. In reality, people’s understanding of earthquake hazards is far more nuanced than this simple distinction suggests. Also, different knowledge types can come together in surprising ways, such that people may hold quite different explanations for geophysical hazards at any one time with little tension between these opposing world-views.

(2011: 2)

Encouragingly, the low death toll in some Tohoku coastal towns demonstrates the importance of successful mitigation measures of communication, preparedness and flexibility, even when the magnitude of the event was significantly under-predicted (EEFIT, 2011).

EwF employed a method for Community Based Disaster Risk Reduction by using sets of scenarios, co-developed by communities, civil society organisations and local government officials working closely in teams with scientists. This is described by Davies et al. (2015). These scenarios were based on the impacts of realistic high-magnitude earthquakes and landslides on a community and provided a basis for further work by community/scientist/local government teams to devise mitigation strategies for reducing the impacts. In China, the government policy required that people would be exposed to scenarios that would not worry them, so EwF had to focus on the 1556 earthquake. They emphasised the need for long-term partnerships between

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*Figure 2.3* Kazakhstan. Cattle are walking up a hidden earthquake fault close to the Tian Shan mountain front

*Source:* photograph by author
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the different stakeholder groups including government, to build trust and develop in-depth understanding of the social and natural systems and their changing vulnerability over time. This approach is a substantial departure from much current practice. Its implementation requires local governments, civil society organisations, scientists and communities to work equitably and constructively with each other (Sim et al., 2017).

Translating assessment into policy and policy into action

There is commonly a disjuncture between the evolution and provision of expert knowledge and its effective utilisation. Research needs to assess how scientific knowledge and risk reduction strategies can be most effectively developed and communicated. Working across Central Asia, EwF have found that there is no universal approach across the diverse countries. These countries range from middle-income former Soviet republics to low-income democracies. Only by understanding the political, cultural and socio-economic context of the country can strategies that make policy impact be devised. An important common strand is the importance of gaining trust among and working with local scientists (ibid.). EwF’s first goals were to: (i) organise meetings with stakeholders in individual countries, and (ii) establish links with the scientific communities in partner countries. Their approach was to organise a three-day meeting in Cambridge in October 2012, bringing together stakeholders from Europe, the Middle East, Asia, and the Indian sub-continent. This led to in-country meetings in Nepal and India, China and Central Asia (EwF Report, 2013; NERC, 2017). These in-country meetings were frequently linked to fieldwork where a range of stakeholders, and early career scientists, were invited (Figure 2.4).

![The Geological Institute, Almaty, Kazakhstan. The somewhat austere Soviet location for a meeting of international physical and social sciences, practitioners and government officials in September 2016](source: photograph by author)
EwF’s use of science in earthquake risk reduction efforts in Nepal exemplifies its work. They established that: 1) there is a high level of knowledge around earthquakes among physical scientists, although earthquake-triggered landslides were a critical unknown; 2) important gaps exist between scientists, practitioners and engineers, such that current scientific knowledge is poorly taken up; and 3) scientific knowledge is useful for practitioners as an advocacy tool but plays little role in disaster risk reduction, given their focus on spatial variations in vulnerability (EwF Report, 2014; NERC, 2017).

The EwF programme actively engages and supports scientific and technical communities to inform decision-making and capacity-building. For example, EwF ran a two-week summer school/workshop on Earthquake Tectonics and Hazards on the Continents in Trieste, Italy, in association with the International Center for Theoretical Physics. This involved 50 students from partnership countries (including Iran, Kazakhstan, Kyrgyzstan, China, India, Pakistan and Mongolia) and other developing countries in Africa, Indonesia and Asia. Highly successful, it raised the level of knowledge and skills among participating students and scientists (EwF, 2017). This is an essential component of EwF, but funding for in-country capacity-building has to come from other sources.

EwF response to the Nepal Gorkha Earthquake, 25 April 2015

During the EwF project, a significant major earthquake occurred in Nepal: the Gorkha earthquake of 25 April 2015 (M<sub>W</sub>=7.8). This killed almost 9000 people, destroyed hundreds of thousands of homes and damaged the rich cultural heritage of Nepal. The earthquake and its aftermath are an important test of the IRNH experiment, to observe the outcome of transdisciplinary research and its practical impact. EwF’s engagement with this earthquake is described in EwF Reports (EwF, 2017). The Gorkha earthquake became the major focus of the EwF team (EwF, 2017).

Ten days before the Gorkha earthquake, EwF had held a three-day meeting in Kathmandu with colleagues in the National Society for Earthquake Technology in Nepal. EwF had well-established collaborations in Nepal and strong trust relations (Oven et al., 2016). The response to the earthquake and its aftermath included:

- Media engagement. EwF PIs and others engaged in the IRNH programme gave over 60 interviews on television and radio.
- Advice to UK government. EwF researchers were involved in briefing chief scientists of the UK government and DfID, and provided direct daily inputs to UK government briefing committees, SAGE and COBR, on what happened in the main shock, implications for the humanitarian relief effort, significance of aftershock activity and possibility that future large earthquakes will occur adjacent to the region.
- EwF researchers collaborated with the British Geological Survey to deliver a series of maps of coseismic and postseismic landslides. These were made freely available through the Humanitarian Data Exchange and MapAction, which used the data to prepare outputs for the UN Logistics Cluster and Nepal Red Cross to plan relief activities.
- EwF researchers provided advice to the UN Resident Coordinator’s office.
- EwF monitored landsliding through the 2015 monsoon, providing important scientific insights.
- EwF interacted with colleagues in Nepal (National Seismic Center), India and California to monitor the areas adjacent to the 2015 rupture, which are thought to be particularly vulnerable to future large earthquakes.
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- EwF scientists contributed to several high-profile publications on the Gorkha earthquake, including in *Science* and *Nature Geoscience*.
- EwF social scientists were involved in supporting earthquake victim-survivors throughout the disaster cycle from relief and recovery to income generation as part of reconstruction.
- EwF were invited to carry out two substantial reviews: a review of the ‘9 Minimum Characteristics of a Disaster-Resilient Community’, led by the International Federation of the Red Cross and Red Crescent and the Ministry of Foreign Affairs and Local Development, supported by the DfID South Asia Research Hub, to inform future Community Based Disaster Risk Reduction policy and practice in Nepal.
- EwF was invited by the UN to prepare an earthquake scenario led by social scientists for use in contingency planning by the Humanitarian Country Team (consisting of major UN organisations and major NGOs).

Conclusion

The NERC–ESRC Increasing Resilience to Natural Hazards Programme funded bold experiments in transdisciplinary research. Looking back, the level of distrust revealed by the Community Survey was exaggerated. UK science has worked out new ways of transdisciplinary working to increase resilience to natural hazards in ODA countries. With substantial large-scale funding for challenge-led transdisciplinary research from GCRF, the IRNH programme seems remarkably prescient. The wisdom gained in transdisciplinary working needs be taken up by research councils, universities and government.

The success of the IRNH programme was revealed following the 2015 Gorkha earthquake. The EwF consortium delivered not only high-quality research, but also significant and long-lasting societal benefits locally and nationally in Nepal and other ODA countries, high-level science advice to the UK government, and internationally in the United Nations (UN). This lends to great optimism: GCRF projects can bring significant societal benefits to ODA countries.

References


