SYNOPSIS: INCREASING RESILIENCE TO NATURAL HAZARDS IN EARTHQUAKE-PRONE REGIONS IN CHINA

Peter Sammonds 10th December 2014

SUMMARY

A partnership is proposed between China and the UK and between the National Natural Science Foundation of China (NSFC) and the UK's Natural Environment Research Council (NERC) and Economic and Social Research Council (ESRC) to establish a joint science-led research programme, of an internationally excellent standard, into ***Increasing Resilience to Natural Hazards in Earthquake-prone Regions in China (IRNHiC)***.

The high level goals of the programme are to, 1) promote economic development and welfare in China by increasing social and economic resilience through reducing risks from multiple natural hazards in earthquake-prone regions in China; 2) integrate natural and social science approaches across the programme to enhance the potential for impact on those affected by geohazards; 3) building on existing strengths in the UK and China, foster stronger China-UK collaboration involving transferable research, protocols and approaches that can apply to both countries.

The programme would aim to improve the understanding of the fundamental mechanisms and processes (both physical and social) through the hazard chain that can lead to disaster, of hazard forecasting and warning, risk mitigation and preparedness and recovery, in the light of vulnerabilities of individuals and communities at risk, the deleterious impacts and the uncertainties involved.

The programme would address five themes:

1. ***Resilience, Recovery and Reconstruction***
2. ***Understanding Vulnerabilities***
3. ***Hazard Cycles and Impacts: Monitoring and Measurements***
4. ***Hazard Cycles and Impacts: Mechanisms and Processes***
5. ***Risk Management and Uncertainty***

To integrate natural and social sciences, the programme will adopt a co-productive approach to research 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. To foster UK-China collaboration, the programme will be co-produced by UK and China scientists, based on shared values, of equality between participants, transparency, respecting differences in views, opinions, expertise and cultures, on contingent confidentiality, and on shared principles, of sharing data and knowledge, acknowledging strengths and gaps, and reciprocated learning, leading to joint publication.

The programme will be funded up to £5 million in total, with matched funds from the NSFC and from the NERC and ESRC, to support 5 separate but interlinked research projects, spanning the five themes, and programme costs to facilitate linking of the projects and research themes, the communication and application of the science delivered from this programme, capacity building, education, scientific exchange and informing policy, in order to increase the skills and knowledge base at the partners institutions in China.

RATIONALE

Natural hazards cause enormous human and economic losses and disruption, which continue to grow worldwide. The sudden onset of an extreme natural event can have catastrophic, regional-scale, social and economic effects. An example is the 2008 Wenchuan earthquake in Sichuan Province in China, which led to over 69,000 deaths, 18,000 missing and 374,000 injured. Here, as is the case in many disasters, the primary agent was the earthquake, but a major cause of casualties (one third), infrastructural damage and economic loss, was the secondary hazard of landslides (Highland and Sun, 2013), while the potential for outburst flooding also poses a risk to the recovery and reconstruction process. In order to understand the hazard risks, it is necessary to understand the hazard chain leading to disaster.

The Earth is a dynamic planet. Slow forcing from the underlying mantle drives earthquakes. Resulting crack growth in the crust is highly non-linear, making individual earthquake events difficult to predict, while long inter-event times and uncertainty in magnitude estimation can result in standard hazard assessments that can be grossly misleading. Therefore hazard risk assessment needs to be undertaken in the understanding of the uncertainties involved. Decision support approaches need to be developed and evaluated to take better account of the full range of these uncertainties involved; understand the hazard chain; provide a basis for incorporating social and local knowledge; and, to make them more relevant to users.

The physical and social aspects in the hazard chain are co-dependent. Building codes and assessment of critical infrastructure can address to some extent the primary agent of earthquake hazard risk, but the secondary hazard risk, building resilience and enhancing recovery are highly dependent upon developing and understanding vulnerability. Understanding vulnerability is at the heart of increasing economic and social resilience, and increasing the impact of physical science advances. Research needs to assess how scientific knowledge and risk reduction strategies can be most effectively developed and communicated as there is commonly a disjunction between the evolution and provision of expert knowledge and its effective utilisation in resilience building and post-disaster reconstruction.

The inter-connectedness of world trade means that the UK economy is dependent upon supply lines that stretch back to China. So the UK has a direct interest in the level of resilience in China to natural hazards. On the other hand, the experience of understanding communities, vulnerabilities and building resilience transcends both the specific hazard and the local cultural context, and lessons and knowledge can be shared in the UK and China. While promoting economic and welfare development is central to building resilience and supporting recovery and local income generation to reconstruction following a disaster, so too is opening up potential for further UK-China collaboration in this sphere. The programme is timely, as it should provide a major contribution to actions arising out of the United Nations Integrated Research for Disaster Reduction (UNISDR), World Conference on Disaster Risk Reduction in 2015.

OBJECTIVES

The Increasing Resilience to Natural Hazards in China call will have five science themes, with embedded objectives, which were identified during the RCUK-NSFC Workshop. Research projects under the programme will directly address the research themes, aiming to link across themes in order to build a coherent programme.

Theme 1. Resilience, Recovery and Reconstruction

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 organizing itself both prior to and during times of need (adapted from the UNISDR definition of resilience). Sustained long-term recovery to disasters lies at the heart of resilience and gives rise to a broad research agenda ranging from effective sustainable waste management to developing long term economic recovery.

Objectives:

Resilience: To assess if the definition and use of term resilience should be developed in light of recent China and UK experiences to include the concept of “build back better”? To understand communities as differentiated entities in relation to income, generational, migrant/ settled, urban/rural and educational status. To interrogate the role of the voluntary sector (e.g. NGOs) and the private sector (e.g. insurance industry) versus that of national/ regional/local government in building resilience and how does culture impact upon perceptions of hazard, risk management and responses. To understand how to inform and educate for hazard warning (DRR); to build community resilience to cascading hazards; to engineer resilience sympathetic with the environment. Further input from the natural sciences is required to develop these components.

Recovery: To understand who are the key players, with China-UK comparisons, including the role of the military, social & health professionals, local officials and NGOs, the international context and disaster diplomacy. To interrogate the role that women play in the recovery process.

Reconstruction: To understand what constitutes ‘good’ reconstruction from the user viewpoint, with China-UK comparison, including schooling, housing, leisure, health and infrastructure; how is ‘good’ reconstruction evaluated and by whom; what factors are taken into account in performance evaluation? To assess reconstruction and the environment; income generation/waged employment for local people; and what role do women play in the reconstruction/rebuilding of communities, processes and decision-making. How do decisions made in the short-term, in terms of governance and humanitarian responses and aid, affect the building of resilient and robust societies over time?

Theme 2. Understanding Vulnerabilities

Institutional 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. While understanding vulnerabilities, in the understanding of the nature of the physical hazards is necessary in order to address increasing resilience (overlapping with the Resilience, Recovery and Reconstruction theme).

Objectives:
To understand how we characterise vulnerabilities to geohazards (physical, socio-economic and institutional); how vulnerability changes with time (i.e. changing hazard, changing perception and experience and changing socio-economic context). To assess what is the relationship between vulnerability at different spatial / temporal scales (individual, household, community, city, region). To determine the role in assessing vulnerabilities of simulation, quantitative versus qualitative assessment, and of indices. To understand what can be learnt from other hazards, particularly for China-UK comparison. To understand how best to involve stakeholders in the co-production of knowledge.

Theme 3. Hazard Cycles and Impacts: Monitoring and Measurements

To understand hazard cycles and their impacts, research is needed in terms of identifying potential hazard sites, joining local and expert knowledge, understanding processes, ascertaining data requirements, developing monitoring and measurement techniques, both through ground monitoring and remote sensing (e.g., geophysics, NIR, remote sensing, LIDAR, laboratory, geodesy, sedimentology, seismology, etc.). While the development of novel sensors and instruments appropriate for the social context in relation to early warning systems, and communication of warning, may be involved.

Assessing the techniques and different data sets that are available will clarify potential synergies derived from collaboration between UK-China at key geographical areas/field laboratories. The identification of long time series and case studies will bring added benefits.

Key questions:
Spatial and temporal distributions: Where are the faults? Where are the potential sites of mass movement? There may be a need to include a combination of techniques such as geological mapping, satellite imagery (SPOT, Pleiades, GaoFen-1, GaoFen-2, hi-res DEMs). What are the rates of strain accumulation across faults? What are the rates of deformation over landslides/debris flow monitoring? There may be a need to include a combination of techniques such as geology (mapping offset features and dating), terrestrial LIDAR and geodesy (UAV, GNSS, INSAR -Sentinel-1, GaoFen-3) and measurements of meteorological parameters. Can local knowledge contribute? How can warnings be effectively communicated in the particular social context.

Theme 4. Hazard Cycles and Impacts: Mechanisms and Processes

Understanding the mechanisms and processes involved in the hazard chain, from hazard warning through to impacts, is necessary for increasing resilience to natural hazards. To address mechanisms and processes, it is important to consider upscaling requirements to go from site to regional models and where possible, field laboratories should be linked to existing case histories where vulnerable communities have been affected. The identification of long time series and case studies will bring added benefits. A better understanding of these system components will lead to characterisation of the hazard evaluation of particular vulnerabilities and societal resilience. Further input from social sciences is required to fully develop these latter two components. A combination of hazard and vulnerability then leads to a better understanding of risk.

Key questions:

For the hazard chain, to understand what are the cascades of processes that describe the evolution of landscapes in a dynamic setting? What are the feedbacks (e.g. between natural and human systems, or within natural system)? What are the fundamental models? What are the underlying mechanics? What happened in the past? There may be a need to revisit historical earthquakes and landslides and undertake morphology studies, dating,

thermo-chronology and analysis of borehole samples. The use of palaeoseismology techniques such as trenching and dating may also be necessary, together with the structure from 3d records of stratigraphy. For warning systems, a key question is threshold determination to trigger the warning, which needs to be made in the understanding of the mechanisms and physical processes involved and in the knowledge of the potential vulnerabilities.

Theme 5. Risk Management and Uncertainty

Decision support approaches need to be developed and evaluated to: take better account of the full range of uncertainties involved; understand the interrelationship of multiple natural hazards and the hazard chain; provide a basis for incorporating social and local knowledge; and, to make them more relevant to users. Better tools will also maximise the impact of improvements in warning technology and forecasting that this programme will support. In particular, these should address the implications of unquantifiable uncertainty and of the social and institutional dynamics of expert communities concerned with the appraisal of natural hazards – for instance through a focus on sensitivity, scenario and interval analysis, rather than aggregated forms of risk assessment. The aim is to deliver prioritised options for risk management (e.g. early warning systems, land-use regulations, enforcement of building codes, communication strategies) in target regions.

Key questions:

How to develop a risk modelling framework which will deliver standardised risk scenarios? This may include the definition of standardised inputs (e.g. spatial, temporal scale); definition of standardised outputs (e.g. spatial, temporal scale) of realistic disaster scenarios; management of standards including interoperability and the representation of uncertainty. How to develop costed scenarios? This may include generation and delivery of multiple risk scenarios based on combined hazards (under a range of intensities, distributions) and combined vulnerabilities and exposures. How to calculate primary, secondary and tertiary costs of scenarios (impacts)? This may include consideration about comprehensive impacts (in a prioritised fashion, or using simple estimates based on little new data). How to embody community based decision making? This may include the generation of prioritised options for risk mitigation based on analysis of multiple scenarios; community analysis of options (using Bayesian belief, or other approaches, as appropriate).

Hazard Assessment: For earthquakes, landslides/ and debris flows to assess what happens with an event and its aftermath, linking physical models to statistical models (e.g. statistical emulation).

Other drivers: It is important to identify that there are further drivers that need to be considered, including environmental and land-use changes etc. This may require a consideration of non-steady states and the development of scenarios for the appropriate modelling and forecasting of system behaviour (linking to the Hazard Cycle).

PRIORITY HAZARDS

It is expected that the programme will address these scientific themes and objectives within the context of three priority hazards and the hazard chain. These hazards have been identified as priority hazards for consideration under this programme through the RCUK-NSFC Workshop.

Earthquake hazards

Earthquake hazards represent one of the most devastating hazard types in terms of human suffering and economic damage, accounting for the loss of millions of lives, and at a cost of huge economic losses.

Landslide hazard

Understanding landscape evolution and slope instability processes are crucial. This will include the role of earthquakes in building topography and in triggering landslides as secondary hazards, but also other mechanisms and triggering events (e.g. hydro-meteorological).

Debris flows and outburst floods

These may be treated either as primary hazards (triggered hydro-meteorologically) or as secondary/tertiary hazards. These may be done particularly in the context of UK-China comparison studies.

Geographical Area

Hazard regions of China may all be selected for research. However, it is expected that projects will seek complementary field laboratories with other projects in order to maximise effectiveness of the investment.

Non-scientific objectives and requirements

The main research outcomes of the IRNHiC programme must promote the economic development and welfare of China, rather than only aiming to create the conditions where development might occur. The programme should address poverty and development issues, address the central issue of increasing resilience to natural hazards, use the strengths of the UK to address the issue, and demonstrate that the research component is of an internationally excellent standard. Projects within the programme need to address these requirements. In addition, all projects must directly address the following two non scientific objectives of the programme: a) to build and maintain effective research UK-China partnership, i.e. project teams will need to demonstrate that project partners are appropriate to the research question and fully engaged for the duration of the project; and b) the research questions, implementation and outputs are co-produced from natural and social sciences. All projects must demonstrate how their project links across to other projects in the programme. This may be through shared research personnel, project partners, resources and field locations.

In addition the question of better practice, in conjunction with the overall programme (e.g., through Programme KE fellows), should be addressed, in relation to how does scientific knowledge and evidence get used to shape policy and practice; how does scientific knowledge and evidence interact with local/indigenous knowledges and learn from that interaction; how can the natural environment be respected when human beings rely on it for their existence?

There are already many specialists looking at these issues and NSFC, NERC and ESRC have invested substantial resources. The projects, where appropriate, should make use of the findings of these researches, and in particular the Earthquakes without Frontiers consortium of the NERC-ESRC Increasing Resilience to Natural Hazards programme, the NERC PURE programme on uncertainty, the Global Earthquake Model and other national resources in the UK and China as appropriate.

PROGRAMME STRUCTURE

The key question in deciding how to structure the IRNHiC programme is how to ensure proposals for projects are of internationally excellent standard, whilst at the same time ensuring main research outputs will promote the economic development and welfare of China through increasing resilience to natural hazards. This necessitates that projects within the Programme build and maintain effective research UK-China partnership

and that the research questions, implementation and outputs are co-produced from natural and social sciences. Five themes were identified in the Workshop:

1. Resilience, Recovery and Reconstruction
2. Vulnerability
3. Mechanism and Processes of the Hazard Chain
4. Monitoring and Measurements of the Hazard Chain
5. Risk Management and Uncertainty

Each theme has its own focus, the first two require a co-produced natural and social science approach to increasing resilience, the second two, take a predominantly natural science approach, while the last would take a risk modelling and probabilistic approach.

One approach to structuring the programme, would be to have a single consortium project integrated across the physical and social mechanisms in the hazard chain. The approach proposed here is to have 5 separate, but interlinked projects, drawing on all themes. Increasing resilience is at the heart of the programme, and provides the unifying framework in which all projects would operate. Integration across the programme may be assisted by a three stage process, with a call for expressions of interest, submission of research proposals, and the post-award development of an implementation plan, which identifies integrative and coordination activities.

A strong Programme Management would be needed to ensure the integration of all parts of the Programme, that is co-produced between natural and social scientists, and is an effective China-UK research partnership.

PROGRAMME MANAGEMENT

At a Programme level, the programme will have agreed coordination and management structures between the UK and China; support capacity building such as PhD studentships and research/knowledge exchange fellowships; support training (including community based DRR); support research staff and student exchange programmes; organise regular meetings such as summer schools for students, open forum discussions, joint sessions at international conference; and support translations into both English and Chinese (which may have different solutions, e.g., volunteers, students projects, bilingual PDRAs, researchers and investigators).

The programme will facilitate education, the communication and application of the science delivered (taking account of cultural context, income, sex, generational, migrant/ settled, urban/rural and educational status) in disciplines such as health and engineering, and to a variety of users and stakeholders, including policy makers, government agencies, humanitarian agencies, and industry and commerce, both nationally and internationally. KE Fellows could link the common areas of the programme's research themes, working to focus the research in the areas where the science will have the
greatest impact and foster interdisciplinary working in the priority areas.

ABRREVIATIONS

DRR	Disaster risk reduction
ESRC	Economic and Social Research Council
EwF	Earthquakes without Frontiers
GEM	Global Earthquake Model (based in Pavia, Italy, supported by NERC)
IRNH	Increasing Resilience to Natural Hazards
IRNH	Increasing Resilience to Natural Hazards in China

KE	Knowledge Exchange
NERC	Natural Environment Research Council
NGO	Non-governmental organization
NSFC	National Natural Science Foundation of China
PURE	Probability, Uncertainty and Risk in the Environment (NERC £4m programme with 2 funded consortia)

REFERENCES

Highland, Lynn; Sun, Ping (2013) Environmental impact of the landslides caused by the 12 May 2008, Wenchuan, China earthquake, in Landslide Science and Practice (Eds. Margottini, Claudio; Canuti, Paolo; Sassa, Kyoji), Springer, China.

APPENDIX 1: INCREASING RESILIENCE TO NATURAL HAZARDS
NOTES FROM THE RCUK-NSFC WORKSHOP, CHENGDU 18-21 NOVEMBER 2014

Peter Sammonds 23rd November 2014

From the breakout groups the following research, knowledge exchange and cross-cuttings themes were identified. (The number of votes casts for each theme is given in brackets.) The delegates who signed up to discuss each theme are listed, with the rapporteur underlined. Listed under Other Themes are themes which were proposed and voted upon, but had one or zero delegates signed up. Cross-cutting themes were discussed in the general discussion. *Mechanisms and Processes* and *Monitoring and Measurement* were combined into a single theme, *Hazard Cycles and Impacts*. The *Early Warning* theme was presented.

Discussed Themes

Resilience, Recovery, Reconstruction (14 votes)
Peter Sammonds, Lena Dominelli, Sheng Chen, Nibedeta Ray-Bennett

Understanding Vulnerabilities (30 votes)
Nigel Wright, Alex Densmore, Guiwu Su, Song Wu, Wenguo Weng

Hazard Cycles and Impacts

Mechanisms & Processes (including the hazard chain) (67 votes)
Tom Dijkstra, Andy Gibson, Honglin He, Xijie Feng, Jianbing Peng, Runquin Huang, Yu Hwang, James Hammond, Yong Li, Gordon Zhou, Yuntao Tian, Yongkang Ran

Monitoring & Measurements (including spatial and temporal distributions) (42 votes)
Barry Parsons, Peizhen Zhang, Zhenhong Li, Andy Gibson, Xingmin Meng.

Risk Management and Uncertainty (26 votes)
John Rees, Mark Naylor, Lili Yang

Other Themes

Early Warning Systems (practical and social) (votes 34 votes)
Xingmin Meng

Education (14 votes)

Geographical Regions (11 votes)

Cost Impacts (7 votes)

Community (6 votes)

Informing Policy (covering prevention) (3 votes)

Cross-cutting Themes

Capacity Building (including visiting scholarships, studentships and fellowships)

Data

Technological Drivers

Common Models

UK-CHINA COLLABORATIVE ARRANGEMENTS

It was discussed that UK-China collaboration might proceed on the basis of shared values, shared principles and joint mechanisms.

VALUES

- Equality between participants
- Transparency
- Respecting differences in views, opinions, expertise and cultures
- Contingent confidentiality

PRINCIPLES

- Sharing data and knowledge
- Acknowledging strengths and gaps
- Reciprocated learning
- Joint publication

MECHANISMS

- Frequent interactions, including discussions over Skype, video conferencing and emails
- Having agreed coordination and management structures
- Capacity Building such as PhD studentships and research/knowledge exchange fellowships
- Training (including community based DRR)
- Staff and student exchange programme
- Regular meetings such as summer schools for students, open forum discussions, joint sessions at international conference
- Translations into both English and Chinese (may have different solutions, e.g., volunteers, students projects, bilingual PDRAs, researchers and investigators)
- Joint Field investigations

RESILIENCE, RECOVERY AND RECONSTRUCTION THEME

Key questions:

RESILIENCE

- Definition and use of term resilience (bounce back) China-UK comparison
  - Should there be build back better?
  - Role of private sector (e.g. insurance) versus central government
- How to define and measure social capital?
- How does culture impact upon perceptions of hazard, risk management and responses, with China-UK comparison?
- How to understand communities as differentiated entities in relation to generations, migrant/ settled, urban/rural, income and educational status?
- How to inform and educate for hazard warning (DRR)?
- How to build community resilience to cascading hazards?
- How to engineer resilience sympathetic with environment
  - or improved environmental standards?

RECOVERY

- Who are the key players, with China-UK comparison?
  - Role of military (decision makings, regards longevity)
  - Role of social & health professionals
  - Role of local officials
  - Role of NGOs
- What is the role that women play in the recovery process?

RECONSTRUCTION

- What constitutes ‘good’ reconstruction from user viewpoint, with China-UK comparison?
  - Schooling
  - Housing
  - Leisure
  - Health
  - Infrastructure
- How is ‘good’ reconstruction evaluated and by whom?
- What factors are taken into account in performance evaluation?
  - Reconstruction and the environment?
  - Income generation/waged employment for local people
- What role to women play in the reconstruction/rebuilding of communities processes and decision-making?

BETTER PRACTICE

- How does scientific knowledge and evidence get used to shape policy and practice?
- How does scientific knowledge and evidence interact with local/indigenous knowledges and learn from that interaction?
- How can the natural environment be respected when human beings rely on it for their existence?

UNDERSTANDING VULNERABILITIES THEME

Key questions:

How do we characterise vulnerabilities to geohazard?
- Physical
- Socio-economic
- Institutional

Consider infrastructure as a source rather than an engineering system

How does vulnerability change with time, i.e., changing hazard, changing perception and experience and changing socio-economic context?

What is the relationship between vulnerability at different spatial / temporal scales (household, community, city, region)

What is the role in assessing vulnerabilities of simulation quantitative versus qualitative assessment and indices?

What can be learnt from other hazards?

How best to involve stakeholders in the co-production of knowledge?

HAZARD CYCLES AND IMPACTS THEMES

Key questions:

SPATIAL AND TEMPORAL DISTRIBUTIONS

Where are the faults?

Where are the potential sites of mass movement?
- Geological mapping
- Satellite imagery
- Hi-res DEMs
- SPOT
- Pleiades
- GaoFen-1
- GaoFen-2

What are the rates of strain accumulation across faults?

What are the rates of deformation over landslides/debris flow monitoring?
- Geology: mapping offset features and dating
- Terrestrial LIDAR Structure from motion - UAV
- Geodesy:
- Campaign / targeted GNSS
- INSAR Sentinel-1, GaoFen-3.

Approach aimed at understanding the mechanics.

Measurement of meteorological parameters is necessary.

What happened in the past?
- Revisiting historical earthquakes & landslides
- Morphology / dating / boreholes
- Palaeoseismology
  - Trenching and dating
  - Structure from motion - 3d record of stratigraphy

Hazard Assessment
- for earthquakes / landslides/ debris flows

If there is an earthquake, landslide, what happens:

Earthquakes use ambient noise tomography to provide Green's functions to enable calculation of shaking scenarios

Landslides / debris flows - predict mass movements- risk assessment

HAZARD CHAIN

What are the cascades of processes that describe the evolution of landscapes in a dynamic setting?

What are the spatio-temporal components?

What are the feedbacks (e.g. between natural and human systems, or within natural system)

What are the fundamental models?

This key question can be addressed by targeting three systems

Societal system

The shallow (sub)surface process system (including hydro-meteorological geohazards)

The active faulting system

There are interactions between these systems that need to be considered holistically.

Each of these have particular needs in terms of process models, data requirements, and monitoring techniques (geophysics, NIR, remote sensing, LIDAR, laboratory, geodesy, sedimentology, seismology, etc.). The use and further development of techniques should demonstrate added value to the programme.

Determining what techniques are available will clarify potential synergies derived from collaboration between UK-China at key geographical areas/field laboratories. We need to consider of up-scaling requirements to go from site to regional models. Where possible, field laboratories should be linked to existing case histories where vulnerable communities have been affected. Availability of long time series and case studies will bring added benefits.

A better understanding of these system components will lead to characterisation of the hazard and will lead to evaluation of particular vulnerabilities and societal resilience. Further input from social sciences is required to fully develop these latter two components. A combination of hazard and vulnerability then leads to a better understanding of risk.

It is important to identify that there are further drivers that need to be considered, including environmental change, political/market changes, etc. This requires a consideration of non-steady states and the development of scenarios for the appropriate modelling and forecasting of system behaviour.

RISK MANAGEMENT THEME

Aim: To deliver prioritised options for risk management (e.g., early warning systems, land-use regulations, enforcement of building codes, communication strategies) in target region.

Key questions:

How to develop a risk modelling framework which will deliver standardised risk scenarios?

Definition of standardised inputs (e.g. spatial, temporal scale) from Hazard Chain and Vulnerability Projects

Definition of standardised outputs (e.g. spatial, temporal scale) of scenario outputs

- Management of standards including interoperability and representation of uncertainty

Assumes Hazard Chain and Vulnerability projects go-ahead and engage appropriately

- How to develop costed modelled scenarios.
  - Generation and delivery of multiple risk scenarios based on combined hazards (under a range of intensities, distributions) and combined vulnerabilities and exposures
- How to calculate primary, secondary and tertiary costs of scenarios (impacts)
  - Consideration about how comprehensively to cost impacts (could be done in a prioritised fashion, or using simple estimates based on little new data)
- How to embody community based decision making?
  - Generation of prioritised options for risk mitigation based on analysis of multiple scenarios
  - Community analysis of options - using Bayesian belief, or other approaches, as appropriate

Assumes appropriate community engagement.

Response

- Rapid response
  - Earthquakes: fault location mechanism
  - Landslide distribution
  - InSAR
  - Hi-res satellite imagery
  - Aerial multi-spectral imagery
  - (Different EMS if they exist)
  - LIDAR

EARLY WARNING THEME

Key Questions:

- Identify potential hazard site
  - Use of remote sensing
  - Link to Risk Assessment
- Ground monitoring
  - Development of sensors (instruments)
  - Development of internet based communications (physical and social)
- Threshold determination
  - Link to Mechanisms and Physical Processes
  - Link to Understanding Vulnerabilities
  - Record of historical information
- Development of Earth Warning System
  - Hardware
  - Software
  - Policy and social network
- Planning for disaster responses

WIDER CONSIDERATIONS

Given the size of the likely programme budget it is likely that some projects need to be excluded and that the programme should just focus on one region (X).

A strong Programme Director will be needed to coordinate separate work packages (a possible project by itself)
Uncertainty is broader than just a risk management activity and needs to be integrated between all themes
Even though not discussed, the theme Early Warning Systems (both physical and social) is an integral part of any DRR strategy.
How should we construct an underlying uncertainty framework to enable information transfer?
Parts work packages could be based on existing frameworks (e.g. GEM) if necessary
Region X could to be common for all projects. How will this be achieved?

REGIONS PROPOSED

1. Ordos Plateau
2. Quilian Shan (Gansu)
3. Bailong River Catchment (Gansu)
4. Eastern Tibetan margin
5. Loess plateau
6. Longmen Shan

APPENDIX 2: NOTES ON THE BIS NEWTON FUND

The Newton Fund is an initiative intended to strengthen research and innovation partnerships between the UK and emerging knowledge economies, developing partner countries long-term sustainable growth and welfare through building research and innovation capacity.

The Fund forms part of the UK's Official Development Assistance (ODA) commitment which is monitored by the Organisation for Economic Cooperation and Development (OECD). ODA funded activity focuses on outcomes that promote the long-term sustainable growth of countries on the OECD Development Assistance Committee list and is administered with the promotion of economic development and welfare of developing countries as its main objective. Newton Fund countries represent a sub-set of this list.

The Newton Fund requires that the funding be awarded in a manner that fits with ODA guidelines. All applications must therefore be compliant with these guidelines. Note that this applies to UK funding only, and not the partner country, however as these are collaborative projects, it's expected that the project as a whole is ODA compliant and makes clear that its primary purpose is to promote the economic development and welfare of the partner country. For further information of Newton Fund see http://www.rcuk.ac.uk/international/newton/.

Any Newton Fund project must make it clear how the main research outcomes will promote the economic development and welfare of the partner country, rather than merely creating the conditions where development might occur. Applicants should consider how their project will:

- Address poverty and development issues
- Address the issue identified effectively and efficiently Use the strengths of the UK to address the issue
- Demonstrate that the research component is of an internationally excellent standard.

It is expected that through collaboration the projects should seek to increase the skills and knowledge base at the partners institutions in this area, improving their ability to undertake and disseminate research in order to maximise the countries impact on issues of poverty and economic growth.

Any benefit to the UK has to be the secondary consideration and should not lead to a project being funded if it doesn't primarily deliver the development objective.

The AO must clearly state that applicants should address ODA compliance (economic development and welfare of developing countries) in both the JeS summary and then more fully, in the case for support.

Capital requests

It should be stated within the AO that requests for capital will only be considered if the proposed equipment is to remain in the partner country for use after the project is completed. If equipment is returned to the UK after the project this cannot be funded through Newton and an alternative source of funding should be sought.