



A Science Plan for Integrated Research on Disaster Risk

Addressing the challenge of natural and human-induced environmental hazards



ICSU

International Council for Science

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ICSU's mission is to strengthen international science for the benefit of society. To do this, ICSU mobilizes the knowledge and resources of the international science community to:

- **Identify** and address major issues of importance to science and society
- **Facilitate** interaction amongst scientists across all disciplines and from all countries
- **Promote** the participation of all scientists—regardless of race, citizenship, language, political stance, or gender—in the international scientific endeavour
- **Provide** independent, authoritative advice to stimulate constructive dialogue between the scientific community and governments, civil society and the private sector.



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human-induced environmental hazards

*Report of ICSU Planning Group on Natural and
Human-induced Environmental Hazards and Disasters*



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Executive Summary

The impacts of natural hazards continue to increase around the world; the frequency of recorded disasters affecting communities significantly rose from about 100 per decade in the period 1900-1940, to 650 per decade in the 1960s and 2000 per decade in the 1980s, and reached almost 2800 per decade in the 1990s. Hundreds of thousands of people are killed and millions injured, affected or displaced each year because of disasters, and the amount of property damage has been doubling about every seven years over the past 40 years. Although earthquakes and tsunamis can have horrific impacts, most disaster losses stem from climate-related hazards such as hurricanes, cyclones, other major storms, floods, landslides, wildfires, heat waves and droughts. Current evidence demonstrates that changes in the global climate will continue to increase the frequency and severity of climate-related hazards.

Globalization, population growth, widespread poverty, particularly in hazardous areas, and a changing climate will cause the risk associated with natural hazards to be even greater in the future, with more people and communities at risk. In urban regions, the complex infrastructure systems that make life and economic activity possible, the concentration and centralization of economic and political functions, social segregation and complex spatial and functional interrelationships, all contribute to the vulnerability of populations to disruptions caused by hazards.

The ICSU Priority Area Assessment on Environment and its Relation to Sustainable Development (2003) and the ICSU Foresight Analysis (2004) both proposed 'Natural and human-induced hazards' as an important emerging issue. The executive summary of the ICSU Priority Area Assessment on Capacity Building in Science (2005a) stated that a great challenge is 'a development problem...the widening gap between advancing science and technology and society's ability to capture and use them.'

It is the assessment of the ICSU Planning Group that, despite all the existing or already planned activities on natural hazards, an integrated research programme on disaster risk reduction, sustained for a decade or more and integrated across the hazards, disciplines and geographical regions, is an imperative. The value-added nature of such a programme would rest with the close coupling of the natural, socio-economic, health and engineering sciences.

The Planning Group recommends that the Research Programme be named **Integrated Research on Disaster Risk – addressing the challenge of natural and human-induced environmental hazards** (acronym: IRDR).

The Science Plan of the proposed IRDR Programme would focus on hazards related to geophysical, oceanographic and hydrometeorological trigger events; earthquakes; volcanoes; flooding; storms (hurricanes, typhoons, etc.); heat waves; droughts and fires; tsunamis; coastal erosion; landslides; aspects of climate change; space weather and impact by near-Earth objects. The effects of human activities on creating or enhancing hazards, including land-use practices, would be included. The IRDR Programme would deal with epidemics and other health-related situations only where they were consequences of one or more of the aforementioned events. Technical and industrial hazards and warfare and associated activities would not be included *per se*. The focus on risk reduction and the understanding of risk patterns and risk-management decisions and their promotion would require consideration of scales from the local through to the international level.

The increases in costs of disasters are taking place in both developed and developing countries, which suggest that reducing the risks from hazards is not simply a matter of economic growth and development. There is a great shortfall in current research on how science is used to shape social and political decision-making in the context of hazards and disasters. These issues also highlight the need for more systematic and reliable information on such events. An aim of the Programme would be to both generate new information and data and to leave a legacy of coordinated and integrated

global data and information sets across hazards and disciplines, with unprecedented degrees of access.

IRDR would leave the legacy of an enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their impacts, such that in ten years, when comparable events occur, there would be a reduction in loss of life, fewer people adversely impacted, and wiser investments and choices made by governments, the private sector and civil society.

The IRDR Programme would have three research objectives, the first of which deals with the characterization of hazards, vulnerability and risk. The identification and assessment of risks from natural hazards on global, regional and local scales, and the development of the capability to forecast hazardous events and their consequences would be, of necessity, interdisciplinary. Understanding of the natural processes and human activities that contribute to vulnerability and community resilience will be integrated to reduce risk. This objective would address the gaps in knowledge, methodologies and types of information that are preventing the effective application of science to averting disasters and reducing risk.

The second research objective involves understanding decision-making in complex and changing risk contexts. Understanding effective decision-making in the context of risk management – what is it and how it can be improved – calls for an emphasis on how human decisions and the pragmatic factors that constrain or facilitate such decisions can contribute to hazards becoming disasters and/or may mitigate their effects.

The third research objective, on reducing risk and curbing losses through knowledge-based actions, would require integration of outputs from the first two and could only be achieved through implementing and monitoring informed risk reduction decisions and through reductions in vulnerability or exposure. Processes of human adjustment or adaptation can be used to reduce vulnerability and increase resilience.

Three cross-cutting themes would support these objectives: capacity building, including mapping capacity for disaster reduction and building self-sustaining capacity at various levels for different hazards; the development of case studies and demonstration projects; and assessment, data management and monitoring of hazards, risks and disasters.

The Planning Group has identified the major programmes and projects that already exist in the field of natural hazards and disasters and, through an extensive consultation process, the Programme would further explore these and other activities and enter into agreements as to how they might become components of the whole as partners in research.

During the first three years, the Programme would establish a team of co-sponsors and make arrangements with existing programmes so as to undertake research with shared outcomes and responsibilities. A Scientific Committee, mandated by the co-sponsors and with support from an International Project Office, would have the responsibility for building the formal linkages with partners in research. The collaborating organizations, working through a Consultative Forum, would become significant actors in the Programme.

In addition, new projects would be initiated to put in place, in a priority sense, the elements needed to fully meet the objectives over a ten-year timescale. It is recommended that the Scientific Committee, when established, create two working groups to help scope out the programme and lay the firm basis for further programme development. These would be working groups for forensic investigations of recent disaster events, and for a long-term hazards research network.

1 Background

As part of the development of the first ICSU Strategic Plan, the ICSU Priority Area Assessment on Environment and its Relation to Sustainable Development (ICSU, 2003) reviewed strategic options for future ICSU activities related to environmental research, and proposed 'Natural and human-induced hazards' as one of four possible new fields of work. The ICSU Foresight Analysis of 2004 equally highlighted this field as an important emerging issue. Accordingly, the ICSU Executive Board decided to appoint an ICSU Scoping Group to consider the establishment of a research programme on Natural and Human-induced Environmental Hazards. The Scoping Group immediately found itself grappling with a question that can be stated in many forms, but might perhaps be succinctly expressed as follows: *Why, despite advances in the natural and social science of hazards and disasters, do losses continue to increase?* In the past, the trends in losses have often been excused on the argument that they follow inevitably from population growth and economic development, which put more people and property at risk. However, this need not be the case: witness instances in which societal activities have greatly increased without a corresponding increase in the impacts of related hazards. One such is commercial air travel, which has generally become safer despite the marked growth in traffic. Examples like this provide opportunities for study and the drawing of valuable parallels.

The Scoping Group reported to the ICSU 28th General Assembly (ICSU, 2005b), noting that research was needed on how to translate research findings about natural hazards and human behaviour into policies that are effective in minimizing the human and economic costs of hazards. Such research required a multidisciplinary approach focused on the needs of identified customers.

The Scoping Group further recommended:

a programme of research aimed at strengthening international science to provide a firmer basis for policies to prevent natural hazards from becoming disasters. Such an objective will need:

- an international collaborative research programme lasting a decade or more;
- the combined insights of the natural, health, social and engineering sciences;
- engagement with populations living in hazardous areas, to understand better the social and cultural determinants of choice in the hazards context;
- engagement with policy-makers at regional, national and international level, to understand better the constraints on policy-making in the hazards context;
- the ability to accommodate both individual hazards and the interplay between hazards;
- a long-term perspective;
- a focus on delivering new scientific insights for the primary customers development agencies, humanitarian assistance agencies and governmental-policy-makers.

It added:

This is an ambitious undertaking, in keeping with the importance and complexity of the subject. ICSU will need to work with appropriate partners to achieve its goals.



The ICSU General Assembly endorsed the recommendation that a new programme be developed, it being understood that any such initiative should build on ongoing efforts in the geosciences and biological sciences and must expand well beyond those fields. A Planning Group was accordingly created, while at the regional level the newly established Regional Committees of ICSU also identified natural hazards and disaster risk reduction as an important component of their respective regional programmes. The Planning Group met four times (20-21 June 2006; 23-25 January, 23-24 May, 30-31 October 2007), and an Open Consultative Forum with potential partners was held on 29 October 2007. The Terms of Reference of the Planning Group are set out in Appendix I to this document, and membership of the Group is given in Appendix II.

The Planning Group concluded that the complexity of the Programme was such that it would require the full integration of natural, socio-economic, health and engineering sciences (the word 'sciences' will be used in this broad context throughout this document), each playing its role, both through excellence in the disciplines and through the interface activities that are essential to make the Programme a success. The Programme would, of necessity, involve scientists well beyond the traditional boundaries of ICSU and its Unions. The Programme would build upon the International Decade for Natural Disaster Reduction (IDNDR), benefit from advances in sciences and observing systems made since then and would avoid duplication by building partnerships with the projects of other organizations, in particular United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Meteorological Organization (WMO).

Although the approaches in the sciences vary, this Programme would need not only to be multi-disciplinary but also to approach the issues of natural and human-induced hazards and disasters from several perspectives – from the hazards to the disasters and also from the human exposures and vulnerabilities back to hazards. This coordinated multi-dimensional approach built on multi-disciplinary participation would take the proposed Programme beyond approaches that have traditionally been undertaken.

The Planning Group recognizes that to accomplish the Programme's objectives, ICSU must reach out to other groups, specifically other scientific organizations, and to policy- and decision-makers, who will need to be included, not just consulted. Further, the Programme requires a global undertaking and, in this respect, the Planning Group notes a conclusion stated in the executive summary of the ICSU Priority Area Assessment on Capacity Building in Science (ICSU, 2005a) to the effect that such efforts face a great challenge, 'a development problem...the widening gap between advancing science and technology and society's ability to capture and use them.'

Accordingly, the Programme Plan breaks new ground in that it calls for multiple starting points: natural sciences; socio-economic sciences; engineering sciences; health sciences; and the policy-making/decision-making arena. There is need for full interaction and involvement of these groups, with each being clear what it needs from the other groups. It is also necessary to work across the interfaces, with continual re-examination as the Programme proceeds. The overall goal of contributing to a reduction in the impacts of hazards on humanity would require some relatively non-traditional research approaches.

2 Rationale

2.1 Impacts of disasters – the global scene

The devastating effects of the 1995 Kobe and 2005 Muzaffarabad earthquakes, the 2004 Indian Ocean tsunami and Hurricane Katrina in the United States in 2005 are vivid reminders that natural disasters are a global issue, and can result in great loss of human lives, livelihoods and economic assets in both developed and developing countries. But while very large events are, fortunately, fairly rare, the frequency of recorded disasters has been rising rapidly. From about 100 per decade in the period 1900-1940, to 650 per decade in the 1960s and 2000 per decade in the 1980s, it reached almost 2800 per decade in the 1990s. Hundreds of thousands of people are killed and millions injured, affected or displaced each year because of disasters, and the amount of property damage has been doubling about every seven years over the past 40 years. Part of the increase in numbers of disasters reported in disaster statistics may be explained by the increasing numbers of smaller and medium-level events that are registered as being related to natural and human-induced or socio-natural phenomena (UN/ISDR, 2007), and by better reporting mechanisms.

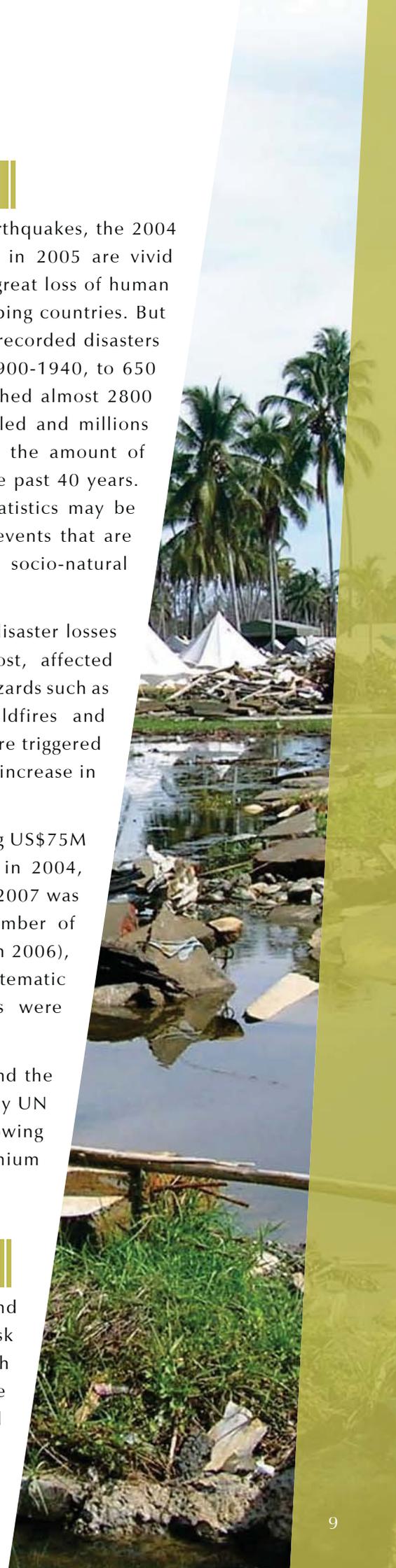
Although earthquakes and tsunamis can have horrific impacts, most disaster losses – be they measured in terms of the number of events, lives lost, affected persons or material destruction – stem from weather-related natural hazards such as hurricanes, cyclones, other major storms, floods, landslides, wildfires and drought. In the 1990s, about three-quarters of all natural disasters were triggered by weather-related events. Since 1997, there has been a several-fold increase in weather-related economic losses.

Disasters are estimated to have caused global economic losses totalling US\$75M in 2007, US\$50M in 2006, US\$220M in 2005 and US\$150 billion in 2004, with 1995, at US\$172M, being the previous high. The high value for 2007 was despite not having particularly extreme events. However, the number of natural catastrophes recorded in 2007 was 950 (compared with 850 in 2006), the highest figure since 1974 when Munich Re began keeping systematic records. It should be noted that the majority of these losses were uninsured.

Natural disasters are capable of cancelling out development gains, and the risk to development stemming from disasters was clearly recognized by UN Member States in the Millennium Declaration (2000), with the growing trend in losses seen as a major constraint towards meeting the Millennium Development Goals.

2.2 Societal and human-induced changes

In many parts of the world, especially hazard-prone areas, poverty and population growth mean that more people and communities are at risk from natural hazards. Even in areas without major population growth or poverty, there have been increases in losses, demonstrating the complex nature of societal-hazards interactions. In urban regions (and particularly in very large cities), the complex infrastructure systems that make life and economic activity possible, the concentration and



centralization of economic and political functions, social segregation and complex spatial and functional interrelationships established in urban areas, all contribute to the vulnerability of populations to disruptions caused by natural hazards. The context in which natural hazard events occur is changing rapidly. In examining effective approaches to risk reduction it is necessary to understand the extent to which the increase in hazard losses can be attributed simply to the rapid growth in human numbers and the wider spread of human settlements and how much influence the manner in which the growth and/or development takes place also contributes. To what extent is the world-wide growth in disaster losses a symptom and indicator of unsustainable development?

Human interventions in the environment can also increase the numbers and types of hazards and vulnerability to natural hazards. Examples include changes in land use that increase the hazards of landslides or flooding, destruction of mangroves that increases the susceptibility of coastal areas to storm damage and removes part of the natural protection afforded coastal communities, and emissions of pollutants and greenhouse gases into the atmosphere that can increase the frequency of extreme weather events, as well as exacerbating the risk from hazards such as heat waves and wild fires.

Globalization results in a world more closely interconnected, with changing senses of responsibility towards countries and localities. The movement of people, trade, communications and financial flows are all increasing rapidly. Hazard events, even in remote places, can have repercussions at a great distance. When they occur in the centres of world trade, finance and communications the impacts can be global. Environmental disasters, wherever they occur, have become a common concern of humankind: some (though not all) would say a common responsibility.

2.3 Climate change

Globalization also extends in new ways to the geophysical environment. The most salient, but not the only, example is climate change. Although the impacts of climate change are highly varied from place to place, there are connections between some of the related events, such as droughts in Africa and Indonesia and the El Niño phenomenon in the eastern Pacific Ocean. The acceleration in the pace of scientific and technical advances has occurred in a time-frame that is short compared with the return frequency of the most extreme events, so that society has only a limited experience base with the new emerging vulnerabilities.

Changes in the global climate will continue to alter the risk associated with natural hazards. According to the Intergovernmental Panel on Climate Change (IPCC, 2007), climate change is accelerating. While the linear warming trend over the last 50 years (0.13°C per decade) is nearly twice that for the last 100 years, a warming of about 0.2°C per decade is projected for the next two decades. With that will come, over the 21st Century, more frequent hot extremes, heat waves and heavy precipitation events (very likely), and more areas affected by drought (likely). Widespread changes in extreme temperatures and more intense and longer droughts have been observed over the past few decades. Extra-tropical storm tracks are projected to move poleward, with consequent changes in wind, precipitation and temperature patterns. As the tropical sea-surface temperatures increase, it is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more instances of heavy precipitation. Glacier- and permafrost-related hazards such as glacier lake outburst, ice and rock avalanches and impacts on installation foundations are strongly connected to climate change and increasingly threaten human settlements and infrastructure. There is also the possibility of abrupt climate change occurring over relatively short periods of time, leading to increased risks of some hazards. These risks need to be accounted for in the risk analysis.

3 The international context and the Hyogo Framework for Action

The World Commission on Environment and Development (1987) defined sustainable development in the statement: 'Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs'. This means that societies need to look to the future and make investments now that will allow future generations to meet their needs consistent with those of present generations. To look to the future and meet the needs for sustaining development, integrated, multi-disciplinary, science-based predictions of the future are essential. It is recognized that there is a literature on the problematic nature of prediction and attention will be given to scenarios and interactive discussions about futures in appropriate balance with reliance on achieving and communicating predictions.

In 1992, the UN Framework Convention on Climate Change (UN FCCC) was signed by most countries, with its objective, as stated in Article 2, of 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure food production is not threatened and to enable economic development to proceed in a sustainable manner.' The objective is stated in terms of avoiding 'dangerous' anthropogenic interference. In the minds of most people, dangerous corresponds to, in this context, hazardous and extreme climate-related events – such as floods, droughts, severe storms and heat-waves. The dangerous nature of these events depends in good part on the exposure and vulnerability of communities and these can be controlled and reduced by human actions. Under other Articles of the UN FCCC, there are commitments, such as Article 4(g) on '...scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives...uncertainties regarding the causes, effects, magnitude and timing of climate change and the economic and social consequences of various response strategies.' The social consequences of response strategies include the impacts of climate-related hazards on communities.

The 2002 World Summit on Sustainable Development and the related Millennium Development Goals led to a Johannesburg Plan of Implementation (UN DESA, 2002) which includes commitments by governments to:

IV. Protecting and managing the natural resource base of economic and social development

37. An integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery, is an essential element of a safer world in the twenty-first century. Actions are required at all levels to:

(h) Develop and strengthen early warning systems and information networks in disaster management, consistent with the International Strategy for Disaster Reduction;

38. Change in the Earth's climate and its adverse affects are a common concern of humankind.

(a) Meet all the commitments and obligations under the United Nations Framework Convention on Climate Change...

...build upon relevant international commitments...including the Millennium Declaration, to strengthen global disaster reduction activities for the twenty-first century. Disasters have a tremendous detrimental impact on efforts at all levels to eradicate global poverty; the impact of disasters remains a significant challenge to sustainable development.

...intrinsic relationship between disaster reduction, sustainable development and poverty eradication,...importance of involving all stakeholders...

In 2005, governments attending the World Conference on Disaster Reduction (Kobe, Hyogo, Japan) agreed that:

We can and must further build the resilience of nations and communities to disasters through people-centred early warning systems, risks assessments, education and other proactive, integrated, multi-hazard, and multi-sectoral approaches and activities in the context of the disaster reduction cycle, which consists of prevention, preparedness, and emergency response, as well as recovery and rehabilitation. Disaster risks, hazards, and their impacts pose a threat, but appropriate response to these can and should lead to actions to reduce risks and vulnerabilities in the future. (UN/ISDR, 2005a)

From the World Conference on Disaster Reduction and especially the agreed expected outcome and strategic goals, five priorities for action are stated as part of the Hyogo Framework for Action (UN/ISDR 2005b), together with some illustrative and research-specific sub-items:

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation

...

2. Identify, assess and monitor disaster risks and enhance early warning

17. The starting point...lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face, and of the ways in which hazards and vulnerabilities are changing in the short and long term

...

3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels

...

(iii) Research

(n) Develop improved methods for predictive multi-risk assessments and socioeconomic cost-benefit analysis of risk reduction actions at all levels; incorporate these methods into decision-making processes at regional, national and local levels.

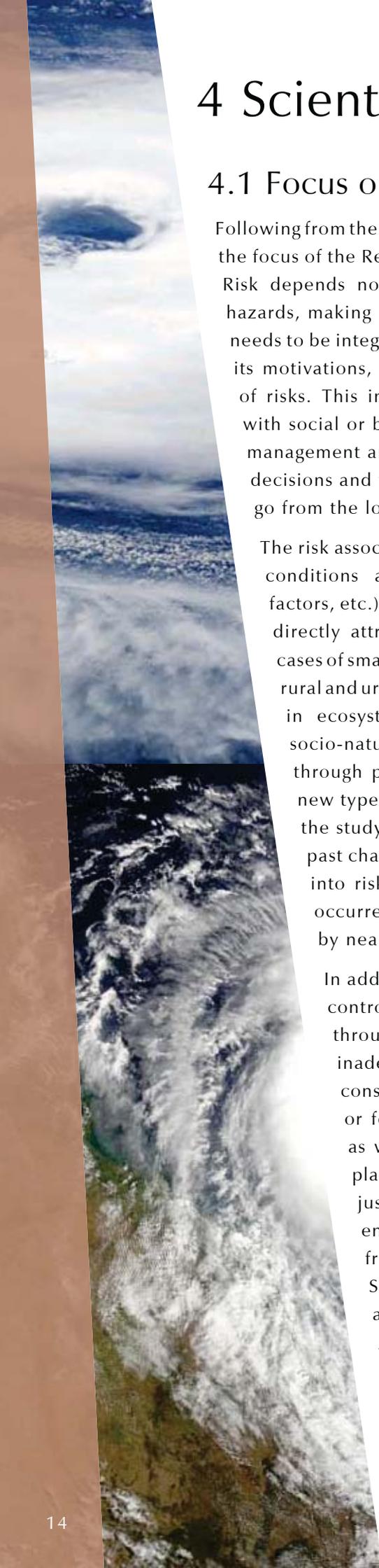
(o) Strengthen the technical and scientific capacity to develop and apply methodologies, studies and models to assess vulnerabilities to and the impact of geological, weather, water and climate-related hazards, including the improvement of regional monitoring capacities and assessments.

4. Reduce the underlying risk factors

5. Strengthen disaster preparedness for effective response at all levels

The Chair's Summary of the First Session of the ISDR Global Platform on Disaster Risk Reduction (UN/ISDR, 2007b), identified implicitly research questions such as: 'Some cities and local authorities have successfully implemented risk reduction programmes, and these need to be documented and widely publicised by the ISDR system. All cities and local authorities should create and implement a disaster risk reduction plan, including multi-sectoral disaster preparedness plans with strong civil society participation.' Research to identify and analyse successful risk reduction programmes is very important. Further, it was noted that: 'a core challenge in disaster risk reduction is to scale up proven practices'.

In reference to climate change, the Summary noted that 'ISDR system partners should actively disseminate and apply disaster reduction tools to support adaptation to climate change'. The UNFCCC has now had the benefit of four scientific assessments of climate change by the IPCC which has been able to draw upon the internationally-planned and coordinated scientific research programmes of the World Climate Research Programme (sponsored by WMO, ICSU and the IOC of UNESCO), the International Geosphere-Biosphere Programme (sponsored by ICSU) and other international and national programmes. For the field of disaster risk reduction, there is neither an established and ongoing scientific assessment process, like the IPCC, nor an internationally planned and coordinated scientific research programme. The Research Programme described in this document would fill that latter gap.



4 Scientific perspective

4.1 Focus on risk and disaster risk reduction

Following from the ISDR and other international agreements and statements of organizations, the focus of the Research Programme would be on disaster risk and disaster risk reduction. Risk depends not only on hazards but also on exposure and vulnerability to these hazards, making risk an inherently interdisciplinary issue. In order to reduce risk, there needs to be integrated risk analysis, including consideration of relevant human behaviour, its motivations, constraints and consequences, and decision-making processes in face of risks. This inevitably requires that natural scientists and engineers work together with social or behavioural scientists in promoting relevant decision-making in the risk management area. Moreover, the understanding of risk patterns and risk-management decisions and their promotion require the integration and consideration of scales that go from the local through to the international level.

The risk associated with environmental hazards typically depends not only on physical conditions and events but also on human actions, conditions (vulnerability factors, etc.), decisions and culture. In some cases, the physical events themselves are directly attributable to human agency (i.e. are 'human-induced'), as with many cases of small- and medium-scale flooding, landslides, land subsidence and drought in rural and urban settings related to environmental degradation and human intervention in ecosystems, as well as global climate change. These human-induced or socio-natural hazards are created at the interface of natural and human processes through processes that degrade the environment. Climate change represents a new type of human-induced modification of hazards and risks. There is need for the study of these human-induced events and how they have contributed to the past changes in occurrences of disasters and how this knowledge can be factored into risk reduction approaches. There are also hazards of low probability of occurrence but with serious consequences when they do occur, such as impact by near-Earth objects, which need to be factored into the risk analysis.

In addition, human actions determine whether or not an event beyond human control (e.g. heavy rain or an earthquake) will lead to disastrous flooding (e.g. through construction on a flood plain) or building collapse (the result of using inadequate building specifications and techniques). The seriousness of the consequences of any disaster will depend also on how many people choose, or feel they have no choice but, to live and work in areas at higher risk, as well as on organizational factors relating to protection and emergency planning, and on fundamental aspects of social equity. Furthermore, just as vulnerability to hazards is influenced by changes in the physical environment, so too will the capacity of communities to protect themselves from such hazards be influenced by societal changes and constraints. Special attention would need to be given to early-warning technologies and community advice.

The task of characterizing risk involves identification of the hazards and the exposure and vulnerabilities of places and people, and hence, assessing the level of risk and understanding how the risk can change with time. Knowledge here is still far from complete and also unevenly distributed across the world. Risks are changing as a consequence of factors such as increasing vulnerability due principally to human

activities and, for some hazards, due to climate change. Thus risk identification has not only to do with natural environmental phenomena, but requires identification of human-induced hazards and vulnerabilities and community resilience. There is an urgent need to map hazards, exposures and vulnerabilities and associated risks comprehensively on global, regional and local scales, requiring adequate long-term monitoring and baseline studies. Risk identification requires a multi-hazards approach, since communities are commonly threatened by several different hazards that may be linked to one another.

Once the hazards, vulnerabilities and risks have been identified, a key role for science is to establish measures required to reduce the vulnerability and risk, and these include anticipating future events and, as far as possible, predicting the places affected, the timing and the scale of the phenomena. The consequences of environmental hazards also need to be assessed. A major goal of the programme would be to improve the characterization and understanding of uncertainties, and improve decision-making and coping strategies in the face of such uncertainties. Models form the basis of forecasts, prediction and assessment. The programme would aim not only at investigating natural processes, but also the complex coupling of human and natural systems to model risk. New human and institutional capacities, tools and approaches would need to be developed to combine quantitative and qualitative data, and to integrate the input from many different disciplines. Model development needs to be accompanied by monitoring and measurement, together with pertinent experiments in the laboratory and field. The data and information generated as part of this Programme would be essential not only for its success but also as a legacy for future generations.

4.2 The need for an integrated approach – across hazards, disciplines and scales

Over the past several decades, human knowledge and understanding of natural hazards have grown dramatically. Today, far more is known about the spatial and temporal distribution of natural hazards and the location of high-exposure areas. Scientists can more accurately characterize the possible magnitude of hazard events and better estimate the probability of their occurrence at specific magnitudes. Moreover, forecasting capacity has also improved dramatically, especially for weather-related events. Far more is now known about the social dimensions of disaster, e.g. human exposure and vulnerability (and lack of resistance and resilience) to natural hazards and places where poverty and multiple stresses shape the character and distribution of losses.

Yet, despite this growth in knowledge, losses associated with environmental hazards, as indicated by measure of both insured and non-insured losses, have also risen during past decades at what looks – from some data sets – to be an exponential rate, as noted in Chapter 1. This is particularly dramatic as regards hydrometeorological events, where death rates and numbers have dropped due to more extended and effective early-warning systems and preparedness plans, yet material and livelihood losses as well as numbers of affected persons have grown considerably. The risks associated with earthquakes increase commensurately due to the ever-increasing numbers of people, production and infrastructures located in cities at seismic risk where early warnings are still impossible in any systematic and secure manner.

The data available really only allow an approximation to losses associated with large- and medium-scale events. A growing body of evidence suggests that the accumulated losses associated with small-scale, repetitive and widely distributed events may be of equal or greater magnitude. The increase is taking place in both developed and developing countries, which suggests that reducing the risks from hazards is not simply a matter of economic growth and development. What are the reasons for this? Why, despite advances in our understanding of both the natural and social sciences of risk and disasters, do losses continue to increase? As noted by the predecessor ICSU Scoping Group (2005b), there is a great shortfall in current research activities on how science is used to shape social and political decision-making in the context of hazards and disasters. These issues also highlight the

need for more systematic and reliable information on such events.

In thinking about decision-making quality, it is useful to distinguish accuracy (e.g. the proportion of correct predictions of whether or not a hazard will occur) from bias (e.g. the tendency to over- or under-predict hazard occurrences). With regard to hazards where a failure to predict an actual occurrence (a 'miss') can lead to disaster, it may be appropriate to adopt a precautionary or risk-averse bias. However, this will lead to more situations being treated as dangerous than were strictly necessary in hindsight. An abundance of such 'false-alarms' raises problems for risk communication and decision-making practice. One danger is that different publics may become habituated to warnings and no longer take them sufficiently seriously.

Another challenge is the broad range of time- and space-scales for hazards and disasters. The impacts of most disasters are on the local or national scale but there are then ramifications through to the global scale. It is important that research be able to analyse these spatial scale interactions. For development, there is a need to understand how such interactions take place, leading to more focused and successful investments in disaster risk reduction at the local scale through global initiatives. Hazards and disasters also occur across a wide range of temporal scales. An earthquake causes immediate and devastating local or regional-level damage. It can also trigger a tsunami that can cause damage in distant places hours later. A drought is a slow-onset hazard that can affect large numbers of people over a vast spatial area with complex short- and long-term socio-economic ramifications but whose starting point may be unobserved and perhaps not known even later. The response to these varying types of hazards leads to many challenges, and an objective of this Programme is to understand these connections in ways that will lead to responses contributing towards a reduction in losses.

4.3 The importance of data and information and the legacy of the Programme

An aim of the Programme is to both generate new information and data and to leave a legacy of coordinated and integrated global data and information sets across hazards and disciplines, with an unprecedented degree of access. One of the main contributions of the Programme could be to serve as a framework for the development of a range of modern information systems devoted to disaster risk reduction.

Data management is an important component of any science project, and in particular, for a global and complex environmental hazards research programme of the scope and complexity of the one proposed. To ensure that the diversity of data from the Programme is collected in a consistent fashion, is preserved, properly archived and made accessible to the science community requires special efforts from the onset. Excellent data management, carefully staged and professionally executed, is essential. The resulting data and information may be seen as the most important single outcome of the Programme.

5 The proposed research Programme

The Planning Group recommends that the Programme carry the title **Integrated Research on Disaster Risk – addressing the challenge of natural and human-induced environmental hazards** (acronym: IRDR), chosen on basis of the rationale of the preceding sections – integration, risk and disasters. This document describes the proposed IRDR Science Plan, one guided by three broad research objectives that are elaborated in what follows:

- Characterization of hazards, vulnerability and risk
- Understanding decision-making in complex and changing risk contexts
- Reducing risk and curbing losses through knowledge-based actions

The three research objectives will, when projects make successful contributions to them, lead to understanding of hazards and vulnerability and risk and enhanced capacity to model and project risk into the future; to the understanding of the decision-making choices that lead to risk and how they may be influenced; and how this knowledge can better lead to disaster risk reduction. Over the coming years, in planning and developing the partnerships with other organizations, it may be necessary to revisit these objectives. Some of the existing programmes (see Appendix III) that may become components or affiliates of IRDR, have narrower and some broader sets of objectives; they have varying degrees of inclusion across disciplines and regions of the globe.

It is proposed that IRDR be a research Programme of ten years' duration or more, in line with the recommendations of the Scoping Group to the 28th ICSU General Assembly (ICSU, 2005b). ICSU is the initial sponsor of the Programme and the International Social Sciences Council has expressed firm interest in considering becoming a co-sponsor. The United Nations International Strategy for Disaster Reduction (ISDR) has showed firm support for the new programme and is considering a more formal relationship. Discussions are also ongoing with UNESCO regarding possible co-sponsorship.

Collaboration with other organizations, as appropriate, will lead to integration across sets of objectives to avoid unnecessary duplication and to maximize research outcomes. After the presentation of the objectives below, some existing activities will be mentioned as illustrations of the type of initiative with which IRDR would make scientific alliances. Given the need to limit the size of the report, these illustrative examples will, of necessity, be brief and not all-encompassing. During the consultation process, more examples will be considered through the input of other organizations.

5.1 Scope

The Science Plan of IRDR focuses on natural and human-induced environmental hazards, including hazards related to hydrometeorological and geophysical trigger events: earthquakes; volcanoes; flooding; storms (hurricanes, typhoons, etc.); heat waves; droughts and fires; tsunamis; coastal erosion; landslides; aspects of climate change (for example, increases of extreme events); and space weather and impact by near-Earth objects. The effects of human activities on creating or enhancing hazards, including land-use practices, would be included. IRDR would deal with epidemics and other health-related events only where they were consequences of the aforementioned events. To make for a more focussed programme, technical and industrial hazards and warfare and associated activities would not be included *per se*; however, it is recognized that there is much to be learned from research in such areas and IRDR would seek to take advantage of that knowledge and insight. Moreover, the occurrence of natural and human-induced or socio-natural events is many times associated with the triggering of technical or anthropogenic hazards, as is the case where an earthquake leads to the rupture of oil pipelines, gas ducts, dams or sewerage systems, or to urban fires, for example. This separation of the study of natural hazards from technology and its effects will be the subject of further consideration as the Programme evolves.

Disaster risk management consists of a range of policies and practices developed to prevent, manage and reduce the impacts of disasters, and includes four elements: *Mitigation–prevention* – actions taken before or after a hazard event to reduce impacts on people and property; *Preparedness* – policies and procedures designed to facilitate an effective response to a hazard event; *Response* – actions taken immediately before, during and after a hazard event to protect people and property and to enhance recovery; and *Recovery* – actions taken after a hazard event to restore critical systems and livelihoods and return a community to pre-disaster conditions. (The Planning Group notes that this view of recovery should be modified by incorporating aspects of mitigation–prevention so as to help a community move forward to a more stable and secure existence than was the case prior to the event, since it is precisely those prior conditions that contributed to the disaster.) The Plan has, as its first priority, research activities related to mitigation and prevention of disasters and, as a second priority, research on preparedness. Hence, the primary focus of the Plan is on research activities leading to the reduction and control of disaster risk factors and the impacts of natural and human-induced environmental hazards.

The scoping exercise identified the most significant research gaps to be interdisciplinary cohesion, i.e. the intersections of the natural, socio-economic, health and engineering sciences, and the issue of how knowledge about hazards is, or can be, put to use. Public perception–decision making in the context of natural hazards, risks and uncertainty would be an important research area, as would the study of human behaviour and cultural contexts for vulnerability analysis.

5.2 Vision and legacy

The IRDR Science Plan envisages an integrated approach to natural and human-induced environmental hazards through a combination of natural, socio-economic, health and engineering sciences, including socio-economic analysis, understanding the role of communications, and public and political response to reduce the risk.

The legacy of IRDR would be an enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their impacts. This would include a shift in focus from response–recovery towards prevention–mitigation strategies and the building of resilience and reduction of risk and learning from experience and avoidance of past mistakes. Through this enhanced capacity and a shift in strategic approaches, societies, in future, would benefit from a reduction in related loss of life, with fewer people adversely impacted, and wiser investments and choices made by civil society, when comparable events occur.

This legacy clearly implies a strong commitment of IRDR to development – development of science and development of broadly-based capacity. Its partners in this development must include the national and international development aid agencies as well as the national and international science institutions and funding councils. To build capacity truly around the world necessitates the involvement of all countries in a meaningful way.

An important part of the legacy would be the repository of information and data that had been acquired and that would be of continuing availability and value to the global community.

5.3 Research objectives

IRDR would undertake coordinated, international, multi-disciplinary research leading to more effective global societal responses to the risks associated with natural and human-induced environmental hazards.

The research objectives and sub-objectives of the programme follow. Capacity building, case studies and demonstration projects and assessment data management and monitoring are considered cross-cutting issues and are discussed in Chapter 6.

Objective 1: Characterization of hazards, vulnerability and risk

This objective concerns the identification and assessment of risks from natural hazards on global, regional and local scales, and the development of the capability to forecast hazardous events and their consequences. Recognizing that risk depends on hazards, exposure and vulnerability, the research will be of necessity interdisciplinary. Understanding of the natural processes and human activities that contribute to vulnerability and community resilience will be integrated to reduce risk. The objective addresses the gaps in knowledge, methodologies and types of information that are preventing the effective application of science to averting disasters and reducing risk.

There are three sub-objectives:

- 1.1: identifying hazards and vulnerabilities leading to risks;
- 1.2: forecasting hazards and assessing risks; and
- 1.3: dynamic modelling of risk.

The natural sciences have a central role in the forecasting of natural hazards and characterizing their attendant risks, and mitigating the adverse effects. Research into the characteristics and dynamics of the solid earth, surface environments, the oceans and the atmosphere, space weather and impact by near-Earth objects will enable advances in understanding hazardous natural phenomena. Natural sciences are the basis of technological solutions to early warning, provision of advice to authorities in areas at risk and during emergencies, and the design of effective mitigation strategies to increase community resilience and protection. They provide critical information for decision-makers and the public to help save lives and avoid economic losses. However, the natural sciences cannot be effective in isolation, with no consideration given to the critical human and environmental factors that lead to disaster. Thus the social sciences have a major role in the assessment of vulnerabilities and risk, as well as developing more effective methodologies. In cooperation with projects aimed at Objectives 2 and 3, projects towards Objective 1 seek to reduce risk by focusing on an integrated understanding of how natural processes and human activities contribute to vulnerability, risk and community resilience.

Sub-Objective 1.1: Identifying hazards and vulnerabilities leading to risks

Here key questions are:

- What are the places at risk, and what is the source of this risk?
- Who are the people most at risk?
- What is the level of risk?
- How may risk change with time?

The answers to these questions require systematic mapping and assessment of hazard, vulnerability and risk at global, regional and local scales. Long-term monitoring is essential to the understanding of natural phenomena and giving early warning of impending events. Baseline studies are needed to establish the frequency and magnitude of events in the past, as well as to identify the factors that have contributed to disasters. It is important to establish responsibility for maintaining the accurate record of disaster events. In recognition of its importance, a cross-cutting theme on Assessment, data management and monitoring is proposed (see Section 6.3).

Monitoring of natural hazards provides large quantities of different types and qualities of data, resulting in the challenge of handling very large datasets. Earth observation systems provide opportunities for comprehensive and robust monitoring of the Earth on many scales. Many parts of the developing world do not have adequate ground-based monitoring to be able to predict and anticipate hazards, and also lack the capacity to take advantage of advanced technologies, for example, the Global Earth Observation Systems.

In order to determine the consequences of environmental hazards and disasters, the undisturbed human and natural environments need to be characterized. There should also be better mechanisms in place to permit timely production and dissemination of easy-to-use, accurate and credible information to the appropriate authorities; this will require close cooperation between the natural science, engineering and technological communities. Also needed are authoritative well-defined parameters to assess impacts, such as mortality figures, consistent measurements of economic loss, degradation of life expectancy, and changes in agricultural productivity.

Under this sub-objective, the theory underlying risk, hazards and disasters terminologies and their assessment methods needs development. Three key challenges are to be developed:

1. Consistent methodologies to assess natural hazards proceeding from the probability of their occurrence and recurrence and using empirical, statistical, and deterministic approaches.
2. A commonly adopted system of natural hazard parameterization that can be applied across different hazard types to enable the hazard potential, the affected area and the impact duration to be estimated in a single measurement system.
3. A consistent procedure for building maps and databases of separate and combined hazards and risks at different temporal and spatial scales: global, regional, national, community and local levels.

Sub-Objective 1.2: Forecasting hazards

Key questions to provide robust, credible forecasts and assess future risks are:

- How can natural hazards be forecast confidently?
- What factors contribute to future risk and related uncertainties?
- How can uncertainties be reduced?
- How can forecasts, their limitations and uncertainty be communicated effectively?

A key challenge for reliable forecasts and risk assessments is to understand uncertainty. Distinguishing and quantifying uncertainties related to natural variability and uncertainties that

reflect lack of knowledge is a formidable challenge that will be addressed by advances in theory, experimental measurements, better monitoring and improvements in modelling. Uncertainties may be reduced as a consequence of better data and improved understanding. However, the limits of forecasting in non-linear systems also need to be recognized and evaluated. Advances in forecasting are needed to identify where and when a hazardous event will happen, what its magnitude and intensity will be, and the consequences. Extreme events, including impact by near-Earth objects, present great challenges because of their rarity and, as a consequence, the paucity of data. It is vital to collect observations and data when such events happen. Advances in extreme value theory and analysis of non-stationary time series are needed. This is a matter of particular importance in hydrometeorological hazards because of climate change; the past may be an unreliable guide to the future in a more energetic earth system. The definition of extreme events is not just dependent on the natural hazard itself, because increasing vulnerability means that events of a particular magnitude can have greater consequences. The problem that the world may be taken by surprise by a major disaster in an unexpected place is of great concern. Communicating uncertainty in forecasts and risk assessments to decision-makers and the public is challenging, especially since there are limits to predictability that are not always understood by members of the public, who can have false expectations of preciseness in forecasts. Drawing on evaluated local indigenous knowledge systems in predicting hazards should also be considered as part of addressing uncertainty.

Sub-Objective 1.3: Dynamic modelling of risk

Modelling of risk requires integration of knowledge about natural processes and human systems. Many natural hazards processes depend on complex material properties and poorly understood dynamic processes. For example, volcanic eruptions, landslides, snow avalanches and earthquakes involve complex multi-phase mixtures (gas, solid, liquid) whose properties are either poorly measured or understood. Laboratory measurements and experimental studies on natural and analogue materials will provide key information for accurate parameterizations of physical properties and dynamic processes within models, as well as validation of models.

Risk assessment and provision of evidence-based scientific advice require natural and social scientists to collaborate. Effective collaboration involves challenges of understanding and developing common language between disciplines, as well as funding mechanisms for allowing the multidisciplinary research to flourish. Modelling of risk concerns the development of holistic models incorporating natural processes, infrastructure, societal factors and behaviour. These are not separate but are interacting risk factors that need to be monitored and modelled together. Understanding the coupling of human and natural systems is the key to preventing a hazard becoming a disaster. Political, social and economic factors can lead to populations being in harm's way from floods, earthquakes or volcanoes, effects due to space weather or impacts by near-Earth objects for instance, or can limit communities' capacities for protecting themselves. Human activity, such as housing construction on flood plains, can increase risk. Likewise, evacuation or relocation of communities away from one hazard may increase exposure to others. Environment and human behaviour thus impact on each other in a dynamic, cyclical, relationship. Research projects should also work closely with local communities and authorities, so that hazards science is integrated into the societal concerns and policy development. Science can also benefit from community knowledge, when appropriate. Dynamical models of risk requires quantitative and qualitative data to be combined, as well as the identification and measurement of relevant physical, behavioural and social variables

Objective 2: Understanding decision-making in complex and changing risk contexts

This objective is focussed on understanding effective decision-making in the context of risk management – what is it and how it can be improved. In linking with the other objectives, the emphasis is on

how human decisions and the pragmatic factors that constrain or facilitate such decisions can contribute to hazards becoming disasters and/or may mitigate their effects.

The political, institutional cultural and economic aspects of decision-making and behaviour are important and need to be explored. Many of the problems in decision-making are also political and social problems in that they involve divergent interpretations of what the problems and response options really are. There are often conflicting values and interests at work, and strikingly different opportunities to influence developments. The salience of strategic societal choices, and of competing rationalities, which cannot be subsumed within the language of risk and risk management, is recognized, so this broader context will be addressed in the Programme as the research moves beyond the management framework to lay out the complexity of the political and social challenges encountered.

There are three sub-objectives:

- 2.1: identifying relevant decision-making systems and their interactions;
- 2.2: understanding decision-making in the context of environmental hazards; and
- 2.3: improving the quality of decision-making practice.

Risk depends critically on human actions and decisions. Although many forms of human activity may increase, rather than decrease, the damage and danger from natural hazards, from the perspective of the actors themselves such decisions may often appear 'rational', and even the only practicable option under the circumstances. Projecting risk into the future will depend, in part, on the choices people make, individually and collectively (through their governments at all levels), and how they implement these choices. Projects designed to meet Objective 2 would identify the decision-making systems, by whom and where the decisions are made, and how these decision-making processes can be understood to provide the basis for intervention when required. From the background and rationale sections of this science plan, it is clear that there are barriers to good decision-making that would lead to effective risk-reduction approaches. Through this process, it is expected that improvements could be made to the quality of the decision-making process. Decision making also depends on the availability of good information. For example, telecommunications and remote sensing are domains in which gaps between operational and scientific activities are easy to identify and have consequences on the decision making. Engineering sciences have a specific role to play in the adaptation of the tools to the need of the decision-makers.

Sub-Objective 2.1: Identifying relevant decision-making systems and their interactions

Here the key questions are:

- Whose decisions make most impact on level of risk?
- How much, and what kinds of, authority do different decision-makers have?
- How do different decision-makers and agencies interact?
- How do decisions made at local and at national or international levels impact on each other?

The answers to these questions require identification of, on the one hand, the range of responsibilities assumed within specific contexts by different actors (from individual citizens through to international agencies) for risk management and reduction, and, on the other hand, those practices, including both acts of commission and omission, that exacerbate the level of risk posed by specific hazards by increasing the vulnerability of particular populations. Importantly, many practices have the effect of displacing risk, both spatially onto more distant communities and populations, and also temporarily onto future generations. Hence, there is an inescapable ethical dimension to these questions. Regarding risk management, 'corrective' decision-making in the context of existing risk (communities located in high hazard zones, hospitals built to low seismic security standards, etc.) may be distinguished from

‘prospective’ decision-making that attempts to anticipate future risk and control its development. Regarding the former, how are existing risks identified and assessed by various international and national agencies and how compatible are these assessments with the views held by individual citizens and communities at risk? Where is responsibility for corrective risk management seen to lie, and how is it distributed? Are there some risks for which too many agencies appear responsible, and others for which nobody assumes responsibility? Regarding the latter, how are future risks associated with new development and investment projects identified, as well as the possible impacts of broader socio-political and environmental change? To what extent do developers and political leaders typically seek to assess systematically, or even consider, such future risks? How (if at all) are decision-makers held to account for the longer-term, or spatially distant, consequences of their decisions? The political, institutional and economic aspects of those decision-making processes and their divergent interpretations need to be examined. Strategic societal choices and competing rationalities will take the analysis beyond the contexts of risk management.

All such decisions, whether motivated by a concern for the common good or for personal profit, are made within a social context in which the interests, intentions and capacities of other actors and agencies need implicitly or explicitly to be taken into account. How well aligned are the priorities for development and/or risk reduction held by different actors (e.g. international agencies and local communities)? If such priorities diverge, is this recognized? How effective are procedures for consultation with different stakeholders?

Sub-Objective 2.2: Understanding decision-making in the context of environmental hazards

Here key questions are:

- How do actors/decision-makers perceive the level of risk associated with any given hazard considered singly and/or in comparison to other hazards they are facing?
- What options do they believe are open to them when faced with such hazards?
- What do they perceive to be the likely consequences of these different options?
- How are disaster risks perceived in relation to more chronic risks such as unemployment, lack of income, threats to cultural and personal identity?

With respect to the first of these questions (risk perception), it is likely that anomalies will be found in the seriousness with which particular hazards may be viewed by both policy-makers and various publics. Understanding is needed on the role of cognitive appraisals and emotional reactions as motivators of behaviour. Public perceptions of risk (where these diverge from expert views) need to be understood from the perspective of people’s personal experience of the hazard and their understanding or beliefs about the processes that can increase or decrease the likelihood of the hazard turning into a disaster.

To move from risk perception to risk reduction, behavioural or policy choices need to be made among available options. The range of options available will typically be restricted, both objectively and subjectively. If moving away from any area of high risk from flood or volcanic eruption involves losing the opportunity to earn a living or feed one’s family, it is unlikely to be seen as a viable option, at any rate until a disaster is seen as imminent. For the poor, managing everyday chronic risks will always be a greater imperative than avoiding low-probability, albeit high-impact, risks posed by natural hazards. Even in less extreme circumstances, individuals may simply fail to consider enough alternatives, or reject them as unnecessary and/or unaffordable. The time-scale of any consequences will be important in moderating such choices. In several fields of decision-making, immediate consequences have been found to have more impact than prospects of (even large) costs or benefits over the longer term.

Costs and benefits are clearly relevant to many commercial, agricultural and industrial practices that impact on disaster risk. Problems arise whenever costs need to be incurred up-front to protect against uncertain future loss or damage (e.g. protecting buildings against earthquakes). There is need to examine the extent to which regulations are enforced and complied with, as well as reasons for non-compliance. Convenience, political expediency, corruption and economic gain are as much decision variables as good scientific information about level of risk.

Although decision-making, from this perspective, is to be understood as an essentially rational process, many different kinds of values can impinge on people's choices regarding avoidance or tolerance of risk. Attachment to place is frequently a highly charged aspect of people's personal and cultural identity, and not lightly to be set aside just because somewhere else might be rather safer.

Furthermore, while research may point to the influence of individuals' *perceptions* of the predictability and/or controllability of particular hazards (and hence why some may rationalize their reluctance to take protective action), it is important to recognize that many communities, especially in the developing world, have very little *actual* control over their level of hazard exposure. Issues of relative power and powerlessness both between and within cultures – including gender issues and the disempowerment of women in many parts of the world – must be acknowledged. Nonetheless, many at-risk communities still attempt to regulate their hazard exposure even within the limited range of options available to them, and research should examine what belief systems and practical experience are guiding their decisions, and how effective their actions are, with the aim of establishing where and how can interventions be made if required.

Sub-Objective 2.3: Improving the quality of decision-making practice

Key research questions in terms of how to improve decision-making systems are:

- What is the quality of information available to decision-makers at all levels?
- What factors influence whether or not such information will be used?
- What factors influence whether risk communications are trusted?
- What governance structures may facilitate better decision-making practice?
- How to adapt the decision-making systems to the different levels of decision makers?

Decision-making quality depends in part on the information available and the manner in which this information is processed by individuals, groups and systems. Regarding the first of these, a major goal of the programme as a whole would be to provide better information, including early warning systems, to decision-makers for the assessment of risks and the selection of appropriate actions. This, however, raises the question as to how far lack of knowledge or access to knowledge accounts for the rising losses from disasters. In the developing world such information may often be of poor quality, unreliable, or almost entirely lacking. Where are the places that knowledge is most urgently needed and how can this best be created or made available? As noted above, the roles remote sensing and other information-generating and telecommunication systems have in distributing this information are very important and there is need for interactions between the engineering and technological communities and policy analysis researchers in order to address these issues.

However, just providing 'better' information does not guarantee that the information will be attended to, understood, trusted or seen as relevant to decisions, either at the level of public policy or individual response. To be effective, communication of risk information and recommendations must be seen as a social process, reflecting the interests of the recipients as well as those of the communicators, and facilitated by the relationships between them. There are issues and need for further study on how to warn the population of an impending event, including literature on the giving of bad news regarding medical conditions – i.e. giving it in a way that does not scare unduly but ensures that the

message is not ignored. The needs of children – since these differ from those of adults – and how children can best be prepared to respond to disasters would need to be considered.

Expertise (even when acknowledged) is no guarantee of trust if communicators are seen as serving their own interests rather than those of the audience to whom they are offering advice. Likewise, scientists should as far as possible help other stakeholders to recognize not only the scope, but also the bounds, of their expertise and hence the limits of the information they can provide. There is evidence to suggest that if communities at risk are actively involved in information collection and analyses then they are far more likely to rely on that information than if it is just provided to them from ‘outside’.

Previous decision research offers guidelines in terms of procedures for defining problems and scoping the costs and benefits of alternative solutions. These may improve decision-making quality by making decision-makers less vulnerable to motivational and cognitive biases arising, for example, through wishful thinking, selective search for information, difficulties in attending to multiple aspects of a problem, and too short a time-perspective. Both to avoid such biases and to facilitate trust and acceptance of decisions reached, governance structures should ideally seek to involve the participation of a wide range of stakeholders. This ideal, however, may often be difficult to achieve in complex environments characterized by inter-group rivalries and with poorly developed institutional frameworks for (e.g. cross-border) negotiation.

In providing an understanding of the political, institutional, cultural and economic aspects of decision making and behaviour, the social sciences will make important contributions to the management perspective and extend into the complexity of the political and social challenges encountered.

It is important to consider the range of economic, financial and political incentives for making better and sometimes worse decisions. Many of these incentives may skew decisions towards a concern with short-term profits. Prospective decision-making priorities may also be skewed geographically towards the prevention of insured rather than uninsured losses, leading to an economic devaluation of disasters in the developing as opposed to developed world (see UN/ISDR, 2005*b*: Hyogo Framework for Action Priority for Action 4, bullet point ‘Financial risk-sharing mechanisms’). Once again, non-compliance with regulations, e.g. building codes, may be motivated by short-term profit.

Objective 3: Reducing risk and curbing losses through knowledge-based actions

‘Reduction of risk’ refers to all the factors that are contributing to the growing hazard and disaster losses and would be an overall objective of the new Research Programme. Objective 3 integrates outputs from Objectives 1 and 2. Since risk results from the interaction of hazards with vulnerable communities, property and facilities and ecosystems which are exposed, all these variables fall within the span of the programme. Reductions in risk can be achieved through implementing and monitoring informed risk reduction decisions (this includes modification of the hazards themselves) and through reductions in vulnerability or exposure. The latter can be achieved by the prevention or discouragement of the occupation of high-hazard-risk zones and sometimes by the relocation or protection of those at risk. Also, the processes of human adjustment or adaptation can be used to reduce vulnerability and increase resilience. Since risk is a constructed concept, the conception of reduction of loss is in the end the central objective, including attention to risk and risk management, and also to the reduction of impacts and the management of uncertainties.

The combination of factors can vary considerably from place to place, and the wide range of disasters experienced in the recent past demonstrates that there is no simple causal explanation. The central thrust of research towards Objective 3 would therefore be to use the combined understanding from many different fields of expertise into an integrated approach to the understanding of the causes of disaster in order to provide practical guidance on the reduction of risk and the curbing of losses. The approaches suggested may be described as diagnostic or forensic. At a superficial or anecdotal level

many of the reasons for past failures to reduce risks and curb losses are known. What is not well understood is how these factors work together in different ways and in different places to produce the adverse consequences with which we are more and more familiar. Research towards achieving Objective 3 would develop a new approach to understanding rising risks by bringing to bear and integrating to the extent practicable all existing knowledge of risk factor in order to provide better diagnoses and to lay the scientific basis for more effective policies and actions.

In interacting with projects contributing towards Objectives 1 and 2, these components of the Programme would need to be advised by, and draw upon, existing knowledge, and would also be helpful in the identification of knowledge gaps relating to Objectives 1 and 2. Towards Objective 1, identification and forecast of the hazards would be a major research initiative so that information on the changing characteristics of the hazards would be an input towards Objective 3. Reductions in vulnerability can be made through a variety of approaches that are usually grouped into structural and non-structural approaches, although the categorization can at times seem arbitrary. The decision-making processes leading to the choices as to which to implement, or to take no action, would be addressed under Objective 2. In order to plan in greater detail the research to be developed in relation to Objective 3, it is proposed that some initial pilot investigations be carried out by a series of case studies of recent disasters (this is further developed in Section 12.2). These would be diagnostic or forensic in that they would be carried out by multidisciplinary teams drawing upon the expertise gathered around Objectives 1 and 2. A restricted number of (perhaps 10) salient examples of recent disasters would be subject to detailed examination following a common research framework and a common template of research questions. Each case study would have merit in throwing light upon the mix of risk factors operative in that case. But the greater added value of the studies would derive from their commonalities and the possibility to carry out a meta-analysis of the studies. A pilot exercise of this kind would be an important first step in gaining the necessary experience in combining and integrating the diverse areas of knowledge that are necessary for any practical programme of risk reduction.

Such case studies would necessarily involve vulnerability assessments and the analysis of effective (and ineffective) approaches to risk reduction.

Sub-Objective 3.1: Vulnerability assessments

In order to address the overriding question of how to develop and use knowledge for the purposes of reducing risk, assessment of the current state of knowledge and its use is required. This part of the programme could, at local and regional levels, bring public and private sector experts and leaders together with hazards researchers to develop vulnerability assessments and coping strategies (both pre-event mitigation plans and emergency response plans) and to provide input to establish government initiatives to evaluate and strengthen community resiliency nationwide. The programme would serve to mobilize within countries government agencies and external donors and international programmes to provide the resources needed for such community-based efforts (hazard maps, forecasts and outlooks, inventories of vulnerable structures, best engineering practices, templates for developing hazard plans, and other forms of information, and in some cases, some level of cost-sharing to cover the costs of implementation, etc.).

The effectiveness, at the national level, of standing National Disaster Review Boards – independent agencies to analyse the cause of major disasters and report findings and recommendations – could be examined, noting the experience of the United States with the National Transportation Safety Board, which suggests that even though reports of such agencies do not carry the formal force of law, they can carry considerable weight and drive far-reaching action on the part of government agencies and private enterprise. For groups of smaller countries it is conceivable that similar arrangements could be made on a regional or multi-national basis. Internationally, perhaps working through the UN International Strategy for Disaster Reduction (ISDR) or other bodies, one might develop a web-based database, conduct conferences, and take other measures as appropriate to disseminate the

results of national efforts with respect to these actions and foster the adoption of best practices.

Sub-Objective 3.2: Effective approaches to risk reduction

To reduce risk it will be important to understand the roles in decision-making of those exposed or at risk and those who manage the risks in the public and private sectors at all levels. This would require identifying the relevant key actors and their relative effectiveness. There are strong research linkages with Objectives 1 and 2, and the need to build upon the assessments developed through Sub-Objective 3.1.

Approaches to risk reduction include risk-sharing and risk-spreading, and research is needed into the effective design and availability of risk-sharing and -spreading mechanisms such as insurance in reducing risk. These are instruments for political and business leaders who are quite aware of the risks posed by natural hazards. For the larger population, use of insurance and other financial mechanisms to redistribute risk or reduce their personal exposure may not be available. The roles of insurance companies and financial and policy institutions and instruments at national and international levels in reducing (or increasing or redistributing) risk need clarification.

Governments can also reduce risk through effective implementation and maintenance of warning systems and the setting and enforcing practices of codes and standards for infrastructure at local and national levels and through international cooperation. This will work only if there are resources to enforce this in the first place, and if the population has the economic means to meet the standards required. It is important that the right scientific information be available to serve as a basis for code- and standard-setting and that adequate enforcement is implemented. This focus would cover the scope from engineering/technical approaches, with economic analysis of cost effectiveness, to socio-legal-political analysis of methodologies to design and implement codes and standards, recognizing the wide range of socio-cultural and legal-political regimes that exist. In addition to these important steps, it is necessary to move to having this knowledge used in an operational sphere, where social science research is needed.

Early-warning platforms provide timely and effective information through identified institutions in a way that allows individuals exposed to the hazard to take action to avoid or reduce their risk. This ISDR definition notes the importance of timely and effective information. Research building on Sub-Objectives 1.2 and 2.2 would examine the questions of timeliness and effectiveness – for example, what are the trade-offs between ‘early with larger uncertainty’ and ‘later with less uncertainty’? Research would also examine the cost-benefit ratios of investments in these systems. A second theme of research would be on the information content in terms of its being understood and the resulting effectiveness of actions. Analysis is clearly needed of optimum electronic and other communication systems.

Another aspect would be how to build the ‘culture of prevention’. Following the Hyogo Framework for Action (UN/ISDR, 2005b), prevention involves activities to provide avoidance of the adverse impacts of hazards and a means to minimize related environmental, technical and biological disasters. Through social and technical feasibility and benefit-cost considerations, the case can be made for preventive measures and public awareness and education activities related to disaster risk reduction, that can lead to changed public attitudes and behaviour, contributing to this culture of prevention.

Part of this research focus would be to create a database of lessons learned from experience, best practices and success stories. Case studies and demonstration projects, using a common research design and a common template for data collection and analysis, would be important. This focus on building resilience needs to be considered in the context of countries having the resources to undertake the actions. The studies need to consider cases and countries over a range of development contexts, situations or levels. Special analysis for developing countries will need to be considered.



6 Cross-cutting themes

The overall global benefits of the IRDR Programme would be dependent on global capacity building and recognition of the value of risk reduction activities, which are likely to come through successful case studies and demonstration projects.

The Programme, would have three cross-cutting themes.

6.1 Capacity building

Capacity or capability can be defined as a combination of all the strengths and resources available within a community, nation or region that can reduce the level of risk, or the effects of a disaster. It includes physical, institutional, social or economic means such as financial, political and technological resources, as well as skilled personal or collective attributes such as leadership and management at different levels and sectors of the society. Capacity building aims to develop human skills and societal infrastructures within a community, nation or region in order to reduce the level of risk.

The objectives of the capacity building theme would be to:

- Map capacity for disaster reduction.
- Build self-sustaining capacity at various levels for different hazards.
- Establish continuity in capacity building.

Mapping global capacity for disaster reduction

Similar hazards can have vastly different social consequences in different countries, regions and situations, for example in urban and rural areas. This sub-theme would assess the status of current capacity for risk mitigation at the international, regional and national levels, focusing on: institutions and coordination; effective governing systems; equity; physical infrastructure, human, financial and technology resources; and indigenous knowledge systems. Capacity would be assessed in relation to defined geographical context of hazards. The aim in mapping current global capacity for disaster reduction would be to: establish the strengths and gaps in available capacities for different risks from environmental hazards in different geographic locations and social systems; understand why there are gaps and why other communities or geographical areas experiencing the same hazards have weak capacity, i.e. understand sources of vulnerability in terms of capacity. The sub-theme would also establish past and ongoing capacity-building success stories that could be used in future capacity-building schemes. Addressing this sub-theme would help to indicate appropriate intervention strategies required to enhance capacity in disaster reduction at various levels.

The sub-theme would address the following questions:

- How is adequate capacity measured in relation to known hazards in different geographical regions?
- How does capacity account for variations in resilience to hazards?

- Are existing national and international training institutions, methods and tools adequate?
- What are the needs, gaps and deficiencies in capacity to reduce disasters?
- How do social-economic inequalities influence the capacity to manage hazards?
- Are there any capacity-building success stories? What can we learn from them?

The sub-theme would draw on ongoing or past work conducted on capacity building in risk reduction for environmental hazards. From this experience, the status of capacity building in disaster reduction at the global, regional and national scales would be established to help map the way forward.

Building self-sustaining capacity at various levels for different hazards

Having established vulnerabilities related to capacity in the first sub-theme, the next task would be to investigate how interventions can be instituted to enhance capacity. A hazard may strike an entire region or several countries at once, or it might be limited to one country, or it might strike a city or a rural area within which there are socio-economic variations. Different capacities would be required to address these geographically and socially different exposures to the same hazards. Further, some hazards are more frequent than others. Different institutional frameworks and governance schemes would be needed and these would require different manpower skills, as well as different planning, information gathering, access and dissemination and resources mobilization and allocation strategies. Also critical would be mechanisms for a capacity-enabling environment, i.e. measures for institutional commitment to the development of activities for which human resources have been developed. The guiding questions for this sub-theme would include:

- How can the existing capacity be best enhanced and enabled?
- How can capacity/resilience best be transferred, expanded and disseminated among communities and nations?
- How can self-sustaining capacity for disaster-resilient communities (and nations) be built?
- In what ways can indigenous knowledge and capacities be best used, enhanced and incorporated into natural hazard management?
- How can communities be engaged to identify their own capacities to reduce vulnerability to disasters and build resilience?

Disaster risk management requires capacities at all levels: institutions, decision-makers, professionals and practitioners at national and local levels. It also involves multidisciplinary, inter-institutional and multisectoral perspectives as a subject of the socio-economic development. A capacity-building programme needs to cover the different phases of comprehensive and integrated disaster risk management. The topics for capacity activities, courses and training modules would be developed in consultation with ISDR and other appropriate organizations.

Establishing continuity in capacity building

Continuity in capacity-building is essential. This can be achieved where capacity for disaster risk reduction is not externally driven, but draws on region/country/community initiatives and resources. Multinational capacity-based initiatives would require long-term programmes. Mechanisms for monitoring and evaluating to enhance and nurture capacity building for different hazards at various levels and provide timely interventions constitute an important part of an international disaster reduction strategy. The Programme would build upon existing networks and structures and would address the following:

- Capacity-enabling environment.
- Capacity for risk mapping, monitoring, early warning and information dissemination.

- Capacity for formulating and implementing disaster reduction policies backed by appropriate legal and monitoring frameworks.
- Mechanisms for mainstreaming disaster reduction into development programmes.
- Investigating and implementing innovative capacity-building schemes – e.g. learning from past success stories.

6.2 Case studies and demonstration projects

Over the first three years of IRDR the Scientific Committee would commission and encourage case studies to identify major research needs and gaps at the interface of natural and social sciences. The case studies would aim at analysis of crises or disasters caused by natural phenomena from which lessons can be learnt. The focus of the analysis would be to establish what was done well and what caused failure. The case studies would elucidate how well methods and approaches applied at the time had worked, where there were shortcomings in the science and procedures, learn from examples of good practice, and identify what integrated research were needed within the framework of IRDR. The proposed case studies provide important entry points for social science research and the projects are important as having value in their own right as well as for inputs into integrated models.

The case studies would involve a wide range of hazards, scales, geographical regions, cultural and economic contexts. Some would be major events, like Hurricane Katrina, where there is already a large literature and extensive analysis. The objectives would be to summarize in succinct form the results of this literature to address the implications for the key research questions that require integration of the natural and social sciences towards providing effective solutions. Disasters and crises can rarely be characterized as complete failures or successes; real situations are always complex and simple categorization is not helpful. However, there is a disproportionate emphasis in the media and public debate on failures. Relative successes would therefore be included, such as the 1991 volcanic eruption of Mount Pinatubo in the Philippines, when 300 000 people were evacuated and the loss of life was restricted to 300. Another example is the mitigation of lives lost by cyclones on the east and west coasts of India. In the 1970s tens of thousands of deaths occurred. The number of lives lost has since been reduced to a few tens for similar cyclones as a consequence of an efficient radar system combined with the development of effective communications systems.

Case studies will include social contexts from hazards affecting large mega-cities to rural communities, from the most impoverished countries that have limited resources to highly sophisticated communities in the developed world, which may be nonetheless very vulnerable, particularly economically (e.g. Tokyo). Cultural variations will be important as this is a very important facet of responses to emergencies and disasters. Many natural hazards involve processes and consequences that cross national borders, adding significant complications and making this an area where global science and regional co-operation are essential. Most response mechanisms are based on national facilities, mechanisms and institutions. Thus some case studies will assess situations where regional or global collaborations, institutions (e.g. the UN) and responses are important, such as the Asian tsunami.

IRDR would commission teams of experts and practitioners to carry out the case studies to a template that addresses the key questions to be answered. The teams should include enough expertise to cover the relevant field of natural and social sciences, as well as decision-makers. It is likely that such teams would be partly composed of those actually involved in the particularly emergency as they have the practical understanding and experience. However, it is also recognized that it is not always easy for those involved in such events to come up with objective views or assessments, especially if the events involved loss of life, controversy or debates on who was to blame. There may also be experiences, issues and views that are very important for understanding a case study, but might be sensitive and difficult to include. Thus teams may need some members who were not involved in the crisis, and the studies will need to recognize the sensitivities of what may have been traumatic experiences for the actual actors. Each case study would have a leader who can then propose a team that would need to include both natural and social scientists. Some individuals with particular

expertise in generic issues might participate in more than one team to facilitate comparison and application of consistent analysis. In many cases teams would be encouraged to involve or seek views from decision-makers and other key actors.

These case studies would be integrated with the proposed Forensic investigations against the analysis template (see Section 12.2).

The case studies would be partly selected by the IRDR Scientific Committee, with invitations to individuals or groups to set up case study teams. There would also be invitations to the community to propose case studies. The case studies would be carried out over the first three years of the IRDR programme and would be a key mechanism of identifying research to be carried over the ten-year programme. A possible timetable is: identification of cases studies and study teams (6 months); main research and analysis with interim ICSU-sponsored workshop (18 months); write-up and publication of a journal special issue or book with complementary web access (12 months); final workshop to evaluate the assessments to identify generic issues and research themes (6 months before the end of the case study project). The case study would partly rely on human and funding resources in the community, but would need some additional funds. It is likely that some new analysis would be needed in some cases, especially on social and cultural aspects.

There would be spin-offs to this project. It would engage some social scientists in the hazards field and to promote collaboration between natural and social scientists. The project would help catalyse the science community and policy-makers to help them develop better prevention, preparedness, response and recovery strategies. Funding would be sought so as to allow scientists from the developing world the resources to participate.

6.3 Assessment, data management and monitoring

In order to be able to determine the consequences of environmental hazards and disasters in terms of their impacts and effects, one needs baseline monitoring so as to provide the characteristics of the undisturbed environment and its populations, and episodic monitoring to provide the magnitude of the environmental hazard, and the severity of the impacts and effects that led to the hazard becoming a disaster. For the disaster prevention and recovery community to use such data it is important that a mechanism be in place to permit timely production and dissemination of easy-to-use, accurate and credible information to the appropriate authorities. As noted earlier, these assessments, data and monitoring capacities will be an important legacy of the IRDR Programme.

To be able to achieve such a goal requires both long-term ground-based and remotely sensed monitoring, pre-determined methodologies for data presentation, and identification of the gaps in our ability to rapidly provide this information to the disaster managers. This cross-cutting theme would have two objectives:

- Guidelines for consistent data management and assessments of hazards, risk and disasters.
- Applying local assessments globally and global assessments locally.

Guidelines for consistent data management and assessments of hazards, risk and disasters

There are many assessments of environmental hazards and environmental risks to be found in the published literature and on the Web. Re-insurance companies such as Munich Re provide such information, as does the Centre for Research on the Epidemiology of Disasters (CRED) (see Appendix III). Sometimes there are inconsistencies between the various assessments that arise because of the use of different data sources, different frameworks, different metrics, or different scales. Sometimes the assessments differ because of a lack of consistency in the management of the data on which the assessments are based. Guidelines to minimize such inconsistencies are needed in all areas of data

management and in environmental hazard and risk assessment. One example is that cost-benefit studies indicating the costs of damage caused by environmental hazards and the possible benefits of information to assist with early-warning for disaster prevention produce widely varying figures in relation to the costs and benefits. Such studies need international guidelines related to the conduct of cost-benefit analyses in this context. Recognizing the need for multi-disciplinary data and information, it is essential that social, natural and engineering scientists with expertise in this area be engaged in the debate about data consistency and sensitivities, perhaps through workshops.

It is considered important to develop the theory underlying hazards, risk and disasters terminology as noted in Sub-Objective 1.1 and their assessment and data management methods. The ICSU Committee on Data for Science and Technology (CODATA) (Appendix III) has the type of expertise in data systems that the Programme could draw upon. In considering risk in this context, it is important to note that it depends on vulnerability and exposure and these ideas are implicit in the approach. Three key issues need to be addressed prior to implementing a single (global) assessment and data management system (see Objective 1 above):

1. To develop a consistent procedure to assess different natural hazards proceeding from the probability of their occurrence and recurrence and using statistical, deterministic and combined approaches.
2. To develop a commonly adopted system of hazards parameterization that can be applied across different hazards types. This would permit an estimation of the hazard energy (destructive force) as well as the affected area and the impact duration in a single measurement system.
3. To develop a consistent procedure of building maps of separate and combined hazards at different temporal and spatial scales: global, regional, national, community and local levels.

ICSU and others co-sponsor systematic observing programmes for the oceans (Global Ocean Observing System, GOOS), the climate (Global Climate Observing System, GCOS), the land (Global Terrestrial Observing System, GTOS), and for the Earth's shape, gravity field and rotational motion (Global Geodetic Observing System, GGOS), which are partners in the Integrated Global Observing System (IGOS).

Applying local assessments globally and global assessments locally

A well-planned monitoring system is required at all levels from global to local scales. Earth observations and earth observation systems now operate at many different spatial scales that can range from detailed microzonations, to large-scale, space-based remote sensing. The monitoring, prediction, early warning and mitigation of hazards occurring at local, regional and global levels depend on an ability to mesh the observations at different scales, and to integrate the observations with disaster prevention, mitigation and recovery systems.

It is desirable to specify accurately and consistently the types of observations to be preferred at different monitoring scales; the type of information and the way it should be exchanged at different observation levels.

Systematic attempts to undertake such activities may be expected to identify scientific gaps, and remedying such gaps will be an important component of this cross-cutting theme. These gaps could be in theoretical knowledge, observation systems, methodologies, capacity, or in linkages amongst practitioners.

The use of remote-sensing and/or space-based products is a particular focus of a number of initiatives. The International Society for Photogrammetry and Remote Sensing (ISPRS) develops appropriate tools and methodologies for disaster management using remote sensing and GIS technologies. One of the ten IGOS themes is Geohazards, 'to respond to the scientific and operational geospatial information needs for the prediction and monitoring of geophysical hazards, namely earthquakes, volcanoes and land instability'. The Group on Earth Observations (GEO) and their Global Earth

Observation System of Systems (GEOSS) are inter-governmental initiatives to develop comprehensive, coordinated and sustained Earth observation. One of its themes is 'Reducing loss of life and property from natural and human-induced disasters'. The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) is a recent programme to 'Ensure that all countries have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle'.

7 Linkages within the research Programme

It is recognized that research activities may contribute to more than one of the objectives or sub-objectives. For example, mapping of risk would, in addition to the cross-cutting themes, require interplay between projects contributing to Sub-Objective 1.1, on identifying and characterizing hazards, and Sub-Objective 3.1, on vulnerability assessments. Forecasting risk would require interplay across many projects due to the need for projections of hazards, vulnerability and exposure, and the latter two, at least, would require projections of the evolution in decision-making. Future implementation, or not, of risk reduction activities (Sub-Objective 3.2) would depend on outcomes of research focussed on Objectives 2 and 1. The integrated programme, focusing on these scientific objectives, would provide society with the scientific basis for characterizing, identifying and forecasting risk, for making effective decisions and, hence, for reducing risk. The interactions along the objectives and the cross-cutting activities are shown schematically below in Figure 1. As a schematic, the three boxes labelled 'Case Study' are meant to be indicative of various case studies, crossing over the three research objectives.

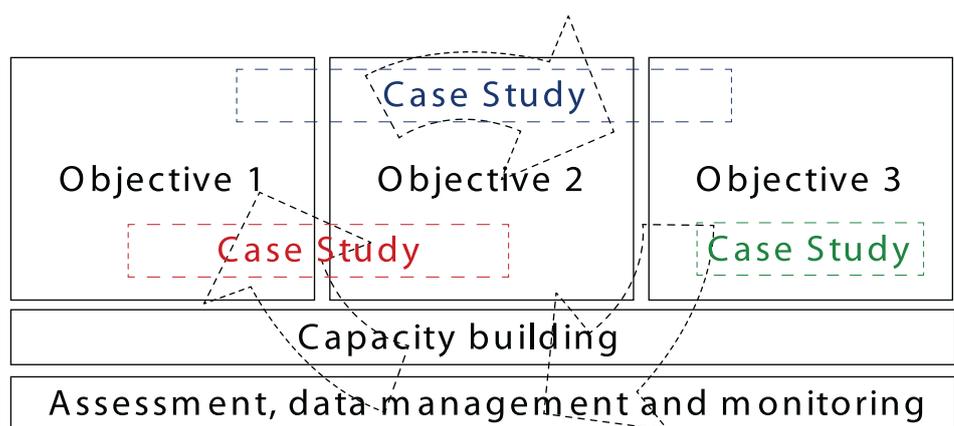


Figure 1. How the IRDR research projects, case studies and other activities would contribute across the research objectives.

8 Schematic structure of the Programme

IRDR would be constructed to meet its research objectives through a set of research activities that would evolve over time. It is recognized that there are, through many organizations, existing research activities with partially similar objectives, and the Programme would be designed to build upon these activities and to initiate new ones so as to make an overall, multi-disciplinary, coherent research programme.

8.1 Interactions with existing international programmes and projects

This draft Science Plan has identified the major programmes and projects that exist in the field of natural hazards and disasters (see Appendix III) and, through an extensive consultation process, the Programme would further explore these and other activities and enter into agreements as to how they might become components of the whole.

Figure 2 gives a schematic example with respect to the designation of the set of research activities. For example, to accomplish Objective W in the realm of Hazard Z, the Programme would build an appropriate relationship with existing Projects Y1 and Y2, both focussed on Hazard Z but in different geographical areas X2 and X5, and with different disciplinary foci. The Programme would seek to develop new projects across the missing disciplines and regions. It would also need to have a project to fill the gaps in the existing projects and to link them with the remainder of the Programme. Further, there may be projects outside the foci of the Programme, such as Project Y3 with the focus on response to environmental hazards, for example, from which the Programme can draw benefits, and vice versa. A 'learning from' mechanism will need to be instituted, perhaps in the form of joint seminars, preparation of reports or other means.

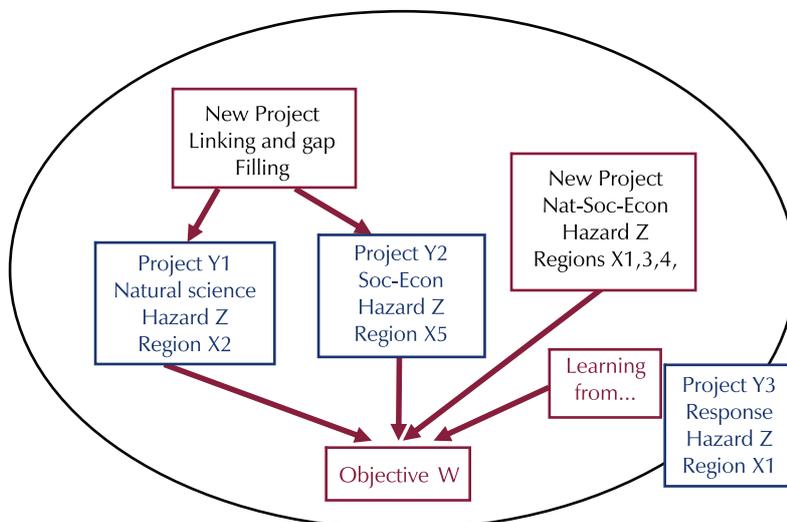


Figure 2. Building a research programme: a schematic example.

In the broader context, the Programme would need to be able to

cover all appropriate disciplines from all relevant hazards in all regions. This is an enormous undertaking and will need to be approached in a progressive way. In effect, this means analysis of a multi-dimensional matrix, indicated schematically in Figure 3. For each element there needs to be a survey, consultation and analysis, leading to conclusions that: E – there are existing programmes that adequately meet the programme’s research needs; P – there are existing programmes, but which only partly meet the needs; all N – there are no programmes and a new one is needed.

E: Existing programmes that adequately meet research needs.

P: Existing programmes that partly meet research needs.

N: No programmes exist. New programme is needed.

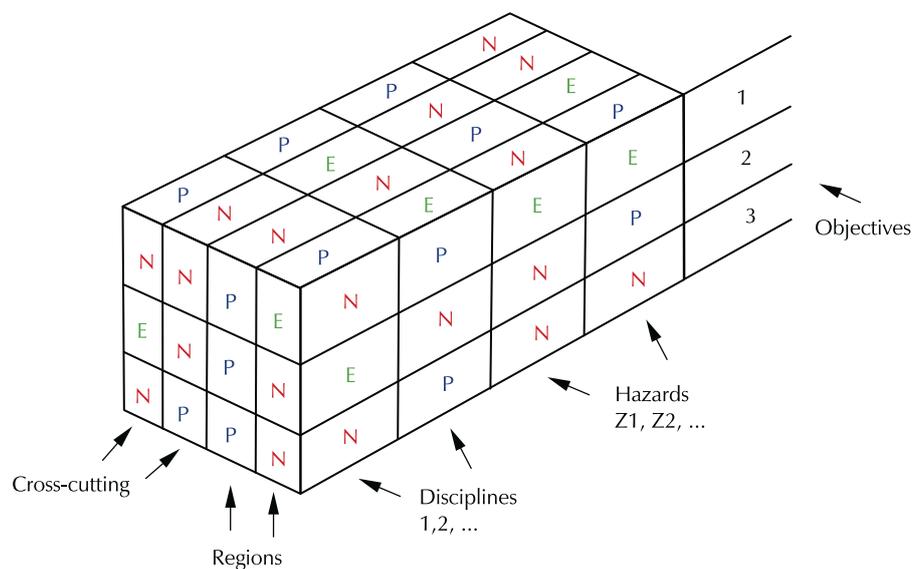


Figure 3. Analysis array of research areas by discipline, region, hazards, objectives and cross-cutting themes.

In undertaking the analysis, the sense of what is adequate would need to be weighed in terms of capacity and priority issues. If there were only a single P programme in the area and it fully met the needs, then the strategy would be to incorporate the programme, or come to an agreement with it such that confidence were gained that the research products would be delivered on a realistic and reasonable schedule. There would be need to ensure full and open exchange of research results. It is likely that there would be elements where there are several programmes that collectively correspond to a P rating; the challenge would then be multi-dimensional in bringing such programmes together in way that achieves the objectives.

8.2 Examples of interactions with existing international programmes and projects

The International Strategy for Disaster Reduction (ISDR), established under the aegis of the UN Office for the Coordination of Humanitarian Affairs, provides an overall intergovernmental mechanism for programmes on disaster risk reduction. ICSU has been a member of its Inter-Agency Task Force. The central task of ISDR is to coordinate the global implementation of the Hyogo Framework for Action 2005-2015 (UN/ISDR, 2005b), and the Hyogo Framework for Action provides an overall target for the research within the proposed Programme. The Chair of the Planning Group represented ICSU at the First Session of the UN Global Platform for Disaster Risk Reduction, held on 5-7 June 2007, and serves as a member of the UN ISDR Scientific and Technical Committee (ISDR-STC) advising the UN Global Platform.

As summarized in Appendix III, there are many existing international programmes and projects dealing with some of the aspects of natural hazards and disasters. These projects usually have a focus on or within a single discipline, most often within the natural sciences, and on one or a small range of hazards. Further, they often have a geographical focus. In that sense, IRDR would address all the issues and would need to draw upon the expertise and scientific outputs of many of these existing programmes. In the following sections, examples are provided, put in the context of the scientific objectives and cross-cutting themes of the new Programme. These examples are illustrative and, of

course, cannot be usually prescribed to a single objective.

Objective 1: Characterization of hazards, vulnerability and risk

The five Geo-Unions of ICSU – IUGG, IUGS, IUSS, IGU and ISPRS – collaborate on a number of issues, including natural hazards and have established the International Year of the Planet Earth (IYPE), which has identified four broad, overlapping research questions:

- How have humans altered the geosphere, the biosphere and the landscape, thereby promoting and/or triggering certain hazards and increasing societal vulnerability to geohazards?
- What technologies and methodologies are required to assess the vulnerability of people and places to hazards and how might these be used at a variety of spatial scales?
- How does our current ability to monitor, predict and mitigate vary from one geohazard to another? What methodologies and new technologies can improve such capabilities, and so help civil protection locally and globally?
- What are the barriers, for each geohazard, that prevent governments (and other entities) from using risk and vulnerability information to create policies and plans to reduce both?

Through its Union Associations, IUGG promotes and coordinates studies of geophysical and hydrometeorological hazards, dynamics of the geophysical processes resulting in extreme hazard events, and forecasting and prediction of these hazards. IUGG established a Commission on Geophysical Risk and Sustainability (GeoRisk) to study the interaction between hazards, their likelihood and their wider social consequences as a result of the vulnerability of societies. The International Geographical Union (IGU) has a Commission on Hazards and Risks that takes as its starting point the fact that disasters arise from interactions between natural phenomena and societal conditions.

The International Union of Geological Sciences (IUGS) and UNESCO collaborate as partners in the International Consortium on Landslides, the International Geoscience Programme (IGCP), International Consortium on Landslides (ICL) and the Scientific Committee on the Lithosphere. Some of the initiatives within this realm are the Global Earthquake Potential, Global Seismic Hazard Assessment Programme Earthquakes and Megacities Initiative. The World Organization of Volcano Observatories (WOVO) is the foremost international body dealing with volcanic eruptions, and is run under the auspices of the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI).

IUGS is engaged in research on endogenous (earthquakes, volcanoes) and exogenous (landslides, collapses, rockfalls, earth subsidence, karst, mudflows, erosion, permafrost) geological hazards through the study of development mechanisms, distribution regularities and mapping of these processes.

The World Climate Research Programme (WCRP) aims to develop the fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent of human influence on climate. The WCRP emphasis on ensemble forecasting naturally leads to analysis of risk. The WCRP Extremes cross-cutting approach will be central to the addressing of climate hazards and extremes. The Global Energy and Water Cycle Experiment (GEWEX) is focused on the understanding and modelling of the occurrence, evolution and role of extremes within the climate system and to contribute to their better prediction with an initial focus on droughts and extended wet periods.

UNESCO has research programmes on natural hazards and provides intergovernmental coordination and policy support in the establishment and operation of monitoring networks and early warning and risk mitigation systems for natural hazards, with particular emphasis on earthquakes, tsunamis, floods and landslides. The UN Decade on Education for Sustainable Development (led by UNESCO), contributes to the achievements of the ISDR Joint Work Plan relative to Priority 3 of the Hyogo Framework for Action. The Intergovernmental Oceanographic Commission (IOC) of UNESCO promotes the concept of 'end-to-end' tsunami warning systems, in cooperation with ISDR and WMO.

The WMO Natural Disaster Prevention and Mitigation Programme contributes to different stages of disaster risk reduction, including prevention, preparedness, response and recovery and reconstruction, through research, monitoring, detecting, analysing, forecasting, and the development and issuance of warnings for weather-, water- and climate-related hazards (the source of nearly 90% of disasters caused by natural hazards). The WMO World Weather Research Programme's THORPEX is a ten-year international study aiming to reduce and mitigate natural disasters by transforming timely and accurate weather forecasts into specific and definite information in support of decisions that produce the desired societal and economic outcomes. The Organization's Associated Programme on Flood Management promotes the concept of Integrated Flood Management which takes an integrated, rather than fragmented, approach to flood management, aiming to maximize the net benefit from floodplains while minimizing the loss to life and economic damage caused by flooding.

The OECD Global Science Forum with a public-private partnership, including Munich Re, has a project, called the Global Earthquake Model, to develop a global, open-source earthquake model that would generate information of the highest standard through cooperation between many of the world's top earthquake experts beginning in early 2008. The International Seismological Centre in the UK is an example of an institution that could contribute to the global effort.

Objective 2: Effective decision-making in complex and changing risk contexts

The International Human Dimensions Programme on Global Environmental Change's (IHDP) now completed Institutional Dimensions of Global Environmental Changes has provided important analysis of governance and the IHDP is now initiating the scientific planning for an Integrated Risk Governance Project. The ongoing project on Global Environmental Changes and Human Security is also relevant. The British Psychological Society has recently set up a working party on disasters, crises and traumas, recognizing that the role of psychology is not only to assist in managing the psychological impact of disasters but also to play a key part in understanding how people behave (or do not behave) in the events leading up to a disaster; and engaging in planning at all stages. The European Federation of Psychological Associations (EFPA) is working on planning responses to disasters and terrorism at a European level and has recommended that a group be set up to perform psychological autopsies on recent disasters in order to develop a better understanding of how people behaved during the event.

Objective 3: Reducing risk and curbing losses through knowledge-based actions

The goal of the Global Risk Identification Programme (GRIP) is a reduction in natural hazard-related losses in high-risk areas so as to promote sustainable development. The International Disaster and Risk Conference (IDRC), Davos is a global, technical and operational gathering of leading experts in the natural, social and engineering sciences, governments, private sector, civil society, IGOs, NGOs and risk management professionals, to be a bridge between practice, science, policy-making and decision-making in the search for sustainable solutions to the complex risks facing society today.

Capacity building

The Global Change System for Analysis Research and Training (START), presently co-sponsored by the WCRP, IGBP and IHDP, has ongoing projects to build capacity and regional networks in Africa, Asia and Oceania. The Inter-American Institute for Global Change Research has capacity building and research activities in the western hemisphere.

The World Bank Global Facility for Disaster Reduction and Recovery (GFDRR) is a partnership that recognizes disaster reduction as a critical dimension of the global poverty reduction agenda.

The ProVention Consortium is aimed at reducing disaster risk in developing countries and to make disaster prevention and mitigation an integral part of development efforts,

Assessment, data management and monitoring

The Committee on Data for Science and Technology (CODATA) has the expertise in data systems that the Programme can draw upon, and ICSU's current review of its data centres will contribute positively to the development of this aspect of the Programme. One of the ten themes established so far in the Integrated Global Observing Strategy (IGOS), is Geohazards: 'respond to the scientific and operational geospatial information needs for the prediction and monitoring of geophysical hazards, namely earthquakes, volcanoes and land instability'. The Group on Earth Observations (GEO) is an inter-governmental initiative to develop comprehensive, coordinated and sustained Earth observation. One of its themes is 'Reducing loss of life and property from natural and human-induced disasters'. The International Society for Photogrammetry and Remote Sensing (ISPRS) is developing appropriate tools and methodologies for disaster management using remote sensing and GIS technologies.

The Centre for Research on the Epidemiology of Disasters (CRED) promotes research, training, and information dissemination on disasters, with a special focus on public health, epidemiology, structural and socio-economic aspects.

8.3 Role of ICSU regional programmes and Regional Offices

The Regional Committees of ICSU have all identified natural hazards and disaster risk reduction as an important component of their respective regional programmes.

The Regional Office for Asia and the Pacific (ISCU ROAP) has now established an ICSU Asia-Pacific Strategic Planning Group on Hazards and Disasters (STRAPGHAD).

The ICSU Regional Office for Africa (ISCU ROA) is now moving into implementation of its science plan on Natural and Human-induced Hazards and Disasters in which five flagship projects were proposed. The Science Plan has received endorsement of a broad scientific community from Africa and beyond, and the approval of the ICSU Regional Committee for Africa. The implementation of the ICSU ROA science plan on hazards and disasters was launched at the International Workshop on Natural and Human-Induced Hazards and Disasters in Africa (Kampala, Uganda, 21-22 July 2007). Two major projects, for which proposals will be developed further, were retained at the Kampala workshop, namely: (i) Project HD1, Geohazards in Africa and linkage with the International Year of Planet Earth (IYPE); and (ii) Project HD2, Hydro-meteorological Hazards in Africa: Vulnerability and Resilience.

The ICSU Regional Office for Latin America and the Caribbean (ISCU ROLAC) has also formed a Scoping Group on Natural Hazards.

In the area of natural hazards – as with all other fields – the ICSU Regional Offices will take every opportunity to collaborate with partners – and especially the respective regional components of other international programmes and organizations. These initiatives provide an opportunity for the combined development of regional components for the Research Programme, and in particular its outreach activities. The Programme, ICSU and other partners and collaborating organizations will work together to ensure that duplications and gaps are avoided.

9 Mechanisms for guidance and oversight of the Programme

The International Council for Science (ICSU) has initiated the planning of the IRDR Programme and provided oversight. For an initiative of the interdisciplinarity and complexity of a hazards research programme, there is need for a broad base of scientific involvement and for agency support to make a difference. The International Social Sciences Council (ISSC) has expressed a readiness to consider co-sponsorship of the Programme, and the presence of ISSC would certainly strengthen the involvement of the social science community in the planning and execution of the proposed programme.

The trigger events for the largest fraction of disasters are hydrometeorological. The World Meteorological Organization (WMO), which has had a representative at the meetings of the Planning Group, is the main UN lead body for these issues and its member organizations have large scientific and technological capacity in this area. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is the main UN agency involved with geophysical hazards and has also been represented at the meetings of the Planning Group. The Intergovernmental Oceanographic Commission (IOC) of UNESCO, which is a co-sponsor with ICSU and WMO of the World Climate Research Programme, has major programmes on tsunamis and other ocean hazards. There are significant advantages in having the WMO and UNESCO and its IOC as co-sponsors: for their S&T capacities, for the access to the information, data, services and research of their member organizations and because they have major roles in delivering the benefits of the research from the Programme. They have natural and formal ties to all governments.

The International Strategy for Disaster Reduction (ISDR) is the UN lead agency on natural hazards and a representative has participated in the meeting of the Planning Group; a close relationship has been established through ICSU's participation in the UN Global Platform and ISDR Scientific and Technical Committee (ISDR-STC).

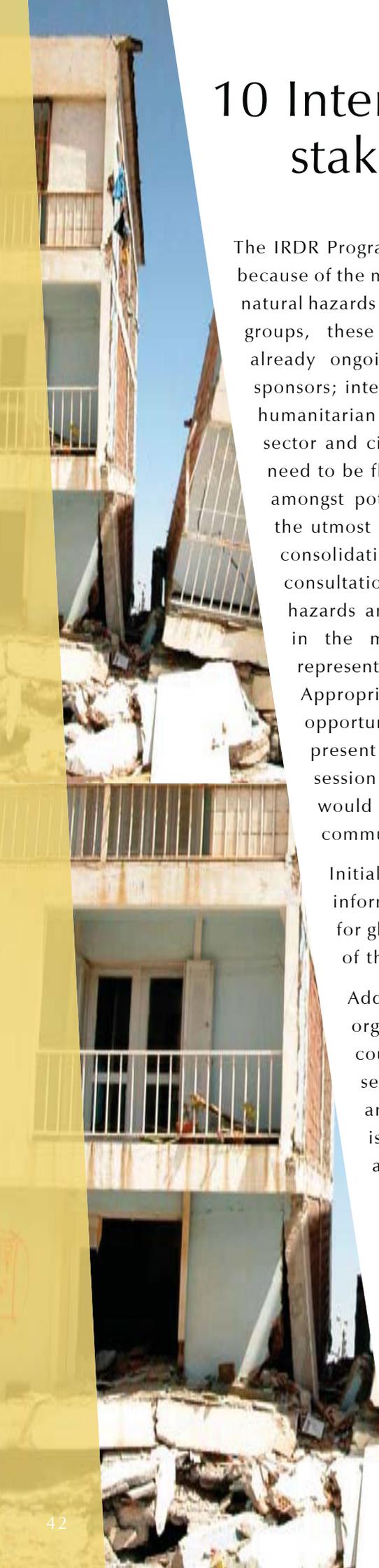
Following the examples of the International Polar Year (co-sponsors: ICSU and WMO) and the World Climate Research Programme (co-sponsors: ICSU, WMO and IOC), an agreement among the co-sponsors would be negotiated that would agree on the definition of the Programme (based on this document), the terms of reference, structure and functions of the Programme guidance, oversight and consultation mechanisms and financial arrangements.

It is proposed that the new research Programme be guided by a Scientific Committee (SC) of eight members, each of whom would serve a three-year term, renewable once. Members and Chair of the SC would be selected by mutual agreement between the joint sponsoring organizations of the Programme, on the basis of their standing in the international scientific community and their commitment to the strategic objectives of the Programme, with due consideration being given to disciplinary, geographical and gender balance.

A Consultative Forum attended by representatives of component and complementary programmes and initiatives would be created and convened regularly.

As has been described in Chapter 8, the Programme would need to interact with a wide variety of existing international programmes. To effect this interaction, the SC would need to have mechanisms of on-going involvement with these programmes. Where certain projects are key ingredients of the Programme, nominated representatives on the SC or joint working groups or other formal mechanism might be needed. In some other cases, this would be done by having observer status at appropriate meetings (as is done amongst the Global Environmental Change Programmes). In other cases, regular communication would be sufficient. As the Programme is constructed and executed, there would be an ongoing challenge to maintain these linkages in an effective and time-efficient way.

Further planning and development of the IRDR would be serviced by a small Secretariat within an International Project Office (IPO). The Project Office would be created in early 2009, and its location and establishment would be the subject of negotiations with interested partners, as well as the completion of an MoU between ICSU and the host organization. In addition to supporting the work of the Scientific Committee, the Secretariat of the Office would help promote the Programme and disseminate its scientific results to target audiences at various levels.



10 Interactions with stakeholder groups

The IRDR Programme being proposed is a very complex and challenging one, not least because of the many international initiatives and activities already existing in the field of natural hazards and disasters (see above and Appendix III). There are several stakeholder groups, these include: the international and national scientific programmes either already ongoing or potentially to be initiated, on hazards research and their sponsors; international and national organizations who are involved in development, humanitarian assistance and similar issues; and, in general, governments, private sector and civil society. Each requires a special and defined approach, which will need to be flexible and probably evolve as the Programme progresses. Consultation amongst potential collaborators and co-sponsors on the international stage is of the utmost importance if the new Programme is to fulfil its role of building upon, consolidating and complementing research being carried out elsewhere. Broad consultation with international organizations and associations in the field of natural hazards and their management – many within the ICSU family – will continue in the months to come. A one-day Consultation Forum was held with representatives of both the science and funding communities (29 October 2007, Paris). Appropriate ICSU Union or Association general assemblies would be used as opportunities to present and discuss the evolution of the Programme and to present the scientific results as they are obtained. A mooted joint ISSC-ICSU session on Hazards and Disasters at the May 2009 World Social Science Forum would serve part of the purpose of more fully involving the social sciences communities.

Initial contacts have been made with national funding agencies through informal discussions at the International Group of Funding Agencies (IGFA) for global environmental change research, potential major funders of aspects of this Programme.

Additionally, bilateral discussions will continue with international organizations to further identify and define the contributions that they could specifically make to the Research Programme. Such discussions will serve to make the consultative process more inclusive and will address any remaining concerns about overlap with ongoing activities. There is also special need to consult, and then work with, the development agencies, humanitarian assistance agencies (including UN bodies and NGOs); and governmental policy-makers. Other stakeholder groups (e.g. people living in areas vulnerable to natural hazards) will need a new and different approach, to be developed through appropriate consultation and, where appropriate, with the aid of the ICSU Regional Offices, or those of other co-sponsors.

It is proposed that a Consultative Forum be established, through a series of informal forums during the first three years and then, based on the input from that process, an ongoing forum to continue thereafter. Use of other forums would also be appropriate. The ISDR Global Platform meetings, to be held bi-annually, might provide one such opportunity, and special sessions may be

possible. The International Disaster and Risk Conference (IDRC) is a major event held periodically, mostly in Davos, Switzerland, involving both governments and a broad range of civil society and business, and discussions with the organizers have indicated that this event could be used for consultation processes. As the formal and informal sponsorship and partners are clarified and confirmed, the variety of broad stakeholder consultation forums will be apparent and considered for use by the Programme. A guiding principle should be that the creation of new stand-alone forums should be avoided, unless necessary.



11 Added value of an internationally integrated, multidisciplinary, all-hazards research programme

The Hyogo Framework for Action provides an internationally-agreed-upon template for disaster risk reduction. As noted earlier, it calls for all-hazards approaches, people-centred systems and overall risk assessment. The assessment of the Planning Group is that, despite all the present activities ongoing on natural hazards, there is an imperative for a research programme, sustained for a decade or more, that is integrated across the hazards, the disciplines and the geographical regions, wherein would lie its value-added nature. Part of IRDR's value would be in filling the gaps and bringing together some of the as-yet un-connected initiatives. The coupling of the natural sciences' examination of hazards with the socio-economic analysis of vulnerability and mechanisms for engaging policy decision-making processes will be a major value added.



Although research has been undertaken on decision-making processes in the risk and disaster theme, this has neither been systematic or sufficient in itself. Few case studies exist and the topic seems to be more led by premises as to cost-benefit and project-planning principles than by understanding of the multiple factors of a cultural, economic, social and political nature that may intervene in any particular decision. Few research endeavours exist as regards decision making and policy formulation which seek to integrate, from the beginning, social and physical science aspects; normally one or the other is added on as a foreseen relevant aspect but methodologically the needed integration of both perspectives is not achieved. Hazards need to be taken as having a given dimension, detailed to the extent that is scientifically justified. This information must be examined and considered in the light of cultural, economic, social and political processes which serve to modify or put in context the natural science information and thus influence decision-making. Scientific information needs to be combined to more adequately understand how information and knowledge is considered, incorporated and acted on, or not.

Hyogo Priority 4 is to 'reduce the underlying risk factors'. Significantly, the 'risk factors' so identified are all socio-political and economic (basic, root causes of disaster) and the research proposed would enhance understanding of these by considering the role of decision-making at all levels, from intergovernmental and multinational organizations down to the individual citizen. A unifying assumption for the research proposed is that it is possible to make sense of decision-making at all these levels by starting with an analysis of the anticipated incentives and constraints to action as perceived by decision-makers, together with the personal and societal values that can lead them to prioritize certain outcomes.

The legacy of IRDR would be an enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their impacts. The legacy will be the development of science and development of broadly-based capacity. The legacy will also be the repository of information and data that have been acquired and that will be of continuing availability and value to the global community.

This would represent value-added for the scientific community, both in producing better forecasts as well as in knowing how to communicate them and persuade decision-makers to use the information. It would also bring value-added for the policy-making community in that there would be improved uptake by communities of their decisions and a better understanding of how to use scientific information. Communities would benefit through a better appreciation of the variety of forms of cultural adaptation to hazards and their relation to direct experience of natural events. It should also be construed where possible in an action-research framework whereby the stakeholders at the community level are part and parcel of research and action.

12 Moving ahead

During its first three years, IRDR would be focused on building partnerships and undertaking scientific analysis to put in place longer-term projects towards meeting its declared scientific objectives with the aim of meeting its overall vision and leaving the desired legacy. In the following sections, some targeted research for those first three years is identified. Possible criteria for evaluation are suggested.

12.1 The first three years and possible criteria for evaluation

The proposed initial structure of IRDR is shown schematically in Figure 4. During the first three years, the Programme would establish a team of co-sponsors and make arrangements with existing programmes so as to undertake research with shared outcomes and responsibilities. The Scientific Committee and the Consultative Forum, mandated by the sponsors and with the support from the International Project Office, would have the responsibility for building the formal linkages with partners in research. The collaborating organizations, working through the Consultative Forum, would become significant actors in the Programme.

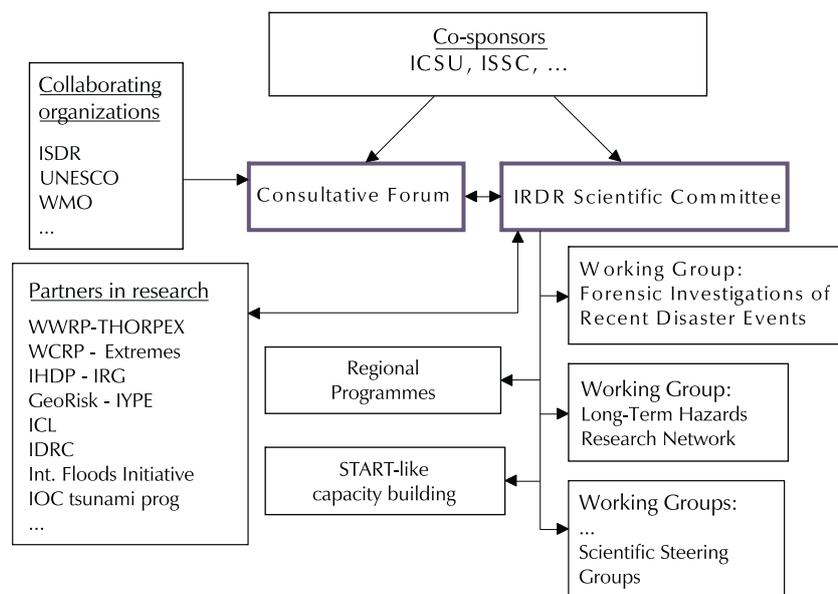


Figure 4. Proposed schematic structure for the IRDR Programme

In addition, new projects would be initiated to put in place, in a priority sense, the elements needed to fully meet the objectives over a ten-year timescale. It is recommended that the Scientific Committee, when in place, create two Working Groups to scope out the programme and lay the firm basis for further programme development. These would be Working Groups for:

- Forensic investigations of recent disaster events, and a
- Long-term hazards research network.

The case studies discussed earlier would be linked to the forensic investigations.

12.2 Forensic investigations of recent disaster events

One of the underlying questions that began the momentum towards the proposed new IRDR initiative launched by ICSU was the conundrum: why when so much more is known about the science and technology of disasters (the exception being some regions in the developing world) are the losses from extreme events continuing to rise at a rapid rate? There has been a substantial expansion of knowledge about the potential magnitude and frequency of natural events and the places in which they are more likely to occur. Sometimes the growth in losses is attributed to the growth of the human population and increasing wealth, including the material property exposed to nature's extremes. This is certainly part of the explanation for increasing losses.

It might be expected, however, that the effective application of new and better knowledge and stronger technology would allow for a decrease in losses or at least stabilization, even as population and wealth increase. To some extent this has happened in developed countries, where it seems (subject to some limitations in the available data) that losses have just about kept level with economic growth; in other words, they are a more or less constant proportion of GDP. Surely, given the available science and technology, we could do better. In the developing countries the 'success' rate has been even less satisfactory, and there are indications that, in the highly vulnerable and exposed countries at least, losses are increasing faster than wealth, and serve as an impediment to development and a barrier to the achievement of the Millennium Development Goals. In developing countries it is not enough to say that we could do better; we must do better.

After a major disaster event it sometimes happens that an enquiry is made into the causes. When such an enquiry is conducted it typically focuses heavily on either the geophysical and atmospheric processes or the technological and structural aspects of the damage. It may also examine the emergency preparedness and the disaster relief and rehabilitation response. Sometimes the enquiry may extend to the effectiveness of existing policy or make recommendations for future policy alterations. These efforts rarely seem to probe very deeply into the underlying and sometimes long-term causes of the disaster. Nor are the enquiries usually carried out at arms-length from those most intimately involved; this is understandable because those most involved and on the spot have the most intimate knowledge of what occurred. One consequence appears to be that enquiries sometimes tend to leave certain questions unanswered or even not asked. Is it the case, as some would have it, that in the aftermath of a disaster there may be reluctance to risk the creation of more distress by probing too deeply into the causes?

The IRDR initiative therefore intends that more penetrating studies be carried out as a first step in the decade-long programme. These studies would search for other and additional, wider and more fundamental explanations for the current rise in disaster losses. These might extend from the inadequacy of the science in some instances, to the use and application of the science and available technology, to poor building standards, planning and design, or to any number of other considerations, including how and why important decisions were made or management options chosen. Possibly there might be new factors operating, such as the effects of modern technology and communications, or the globalization of the world economy. For the moment these are hypotheses to be explored. It is planned and expected that within the early scope of IRDR these hypotheses and ideas can be more rigorously put to the test than appears to have been the norm in recent years.

The proposal is that in the first (three-year) phase of IRDR a series of in-depth, post-disaster, multi-disciplinary investigations be carried out, with the primary objective of describing the limits to existing knowledge and identifying a set of key research questions. The investigations might be described as 'forensic', to suggest the qualities of serious, all-encompassing, arms-length, careful and detailed analysis that we would wish to see, as for example is common practice following any major international transportation or airline 'accident'. The use of the word 'forensic' should not be taken to imply that lessons and insights can only be derived from 'failures' or cases where mistakes were made. It would also be important to conduct forensic investigations of success stories to help accumulate evidence of good practices or other success factors.

Clearly the organization, implementation and wider utility of such an exercise will depend on the way it is designed and the non-partisan and professional integrity with which it is executed. IRDR might therefore propose to develop a common 'template' or methodological design for the studies. Such a template would serve two main purposes. First, it would help to guide the studies by specifying crucial topics to be investigated, with suggestions of the sorts of questions that might be asked. Second, by moulding the studies into a similar pattern it could facilitate a type of meta-analysis, looking at all the case studies, or groups of them, as a set. The purpose of the meta-analysis would be to generate insights, interim research results and further research directions that could not be obtained from singular case-by-case anecdotal studies. To some extent these purposes might be in conflict. In-depth investigation of particular disasters requires the research teams to be able to follow the evidence wherever it leads. On the other hand the requirements of meta-analysis are such that maximum comparability of the case studies is to a degree necessary. Finding the right balance to this and other design questions is not a simple task.

One important issue to be addressed in the design of the set of forensic studies therefore is the question of the hazard classes to be selected. Given the broad range of IRDR, it may be advisable to have studies of earthquake events, tropical cyclones, droughts and so forth in separate categories for some purposes.

Other questions that require further consideration include the following:

- What are the parameters that would suggest a particular disaster be investigated or included in the list of forensic studies?
- How many case studies should be carried out?
- Should they be limited to a single type of hazard, e.g. natural hazards, or should a wider range of initiating events be included, such as industrial accidents, pollution episodes, environmental degradation and deterioration, and so forth? This may depend to some extent upon a more precisely stated or developed set of objectives for the forensic case studies.
- What should be the geographical distribution of the case studies?
- Would the case studies be limited to locally well-defined and limited disasters such as those involving large cities or dense populations? Alternatively, would widespread disasters such as droughts and famines or events impacting multiple countries (e.g. tsunamis) be eligible for inclusion?
- How much time and financial resources would be required?
- When would studies be initiated in relation to the time of the event? Long enough after the disaster event so as to be far enough removed from the immediate confusion and uncertainties, but close enough in time not to lose the opportunity of access to substantive and accurate recall or documentation?
- Under what or whose authority would the studies be carried out and how would a sufficient degree of 'arms-length' character be guaranteed? In particular, how could the forensic case studies be organized and structured so as to be understood, accepted and respected by a wider recipient audience? How could the full cooperation of the authorities or other entities most immediately affected by or involved in addressing the disaster event be secured?

Considering that the design exercise itself is not a simple one and, considering the diversity of expert perceptions and multidisciplinary research interests and traditions which must be brought to bear, it is suggested that the fashioning of a template and its preliminary testing should itself be the subject of some research collaboration. The Working Group would be selected and appointed to refine the concept (which is only sketched out here) and subsequently design the template. It would then be presented to a workshop attended by an international group of researchers and of professional disaster managers and relevant decision-makers. It would be up to the workshop to adopt the template and/or to suggest possible improvements including field trials.

At first acquaintance this procedure might seem to be slow, exacting and cumbersome. In its defence, however, it should be recognized that the problem being posed – why are disasters getting large and more frequent? – admits no simple answers. The period 1990-1999 was designated by the United Nations as the International Decade for Natural Disaster Reduction (IDNDR). Since then,

numerous other efforts have been mounted, including world disaster conferences and the establishment of the ongoing International Strategy for Disaster Reduction and the Hyogo Framework. It is not the intent of the IRDR initiative to replace these worthwhile efforts, but to build upon them; to seek to add strength to their work; and to produce new understanding and insights that will permit more effective disaster reduction. The Planning Group would provide further guidance for the Working Group to consider.

12.3 Long-term hazards research network

The two-tiered development of case studies (some number of rapid assessments, plus a smaller number of in-depth forensic case studies) will be of considerable value in and of itself. However, there is a need to assess the feasibility of, and lay the groundwork for, a network of long-term hazard research sites around the world. The creation of such a global network of sites would allow for enduring (decades) place-based, longitudinal studies of natural hazard risk, while leading to progressive building of resiliency across that same network. It would provide a mechanism for reaching out to communities located in the most vulnerable areas and including them in the science agenda. It would also provide a context for comparative analysis (e.g. across time, culture, technology, economic development, hazard, and geography) of public policies and practices associated with risk and recovery that can be used worldwide to lower risk yet further. At each site, collaborative multi-disciplinary teams of scholars, local practitioners, policy officials and private enterprise would comprehensively monitor and record a community experience with recurring hazards over time, make a sustained, ongoing effort to understand the strengths and shortcomings of current disaster risk reduction practice at that site, and to translate that understanding into increasingly effective future action. Note that the monitoring would not only include enhanced monitoring of the natural system, using, for example, the new capabilities that GEOSS portends, but also document the social and economic parameters governing the vulnerability of the community, or conversely, its resilience with respect to natural extremes, and the changes these over time. The global network of long-term hazards research will provide a framework for the full engagement into the IRDR programme of the ICSU Unions and various other organizations working on different aspects of hazards research in different geographical locations. The case studies already described would be instrumental in helping develop criteria for the selection and establishment of such sites, the variables to be measured, and so on. Ecological research, specifically the Long-Term Ecological Research (LTER) and the National Ecological Observatory Network (NEON) programmes, offer analogies and potential models.

Criteria might include considerations such as the following:

- Most, if not, all sites might be located in urban or rapidly urbanizing environments to maximize the positive impact of research and policy.
- Sites might feature strong partner organizations with an acknowledged record of successful multidisciplinary endeavours. Local involvement and commitment to long-term monitoring, research, and appropriate changes in practice over time would be essential. This should not be strictly a research endeavour. It has to build capacity at the same time – communities and societies have to learn, benefit while doing. For the most part, participating organizations would be on site.
- A commitment to further understanding the dynamics of longer-term recovery issues (both at select sites in depth and across the entire project). The social dynamics of the recovery process remain poorly understood at any useful level and require detailed long-term study.
- Provide for, or at least take steps toward, the standardization of data collection and sharing across the hazards community.
- A possible area of study could be the barriers to research uptake by officials and practitioners – a well identified problem in the hazards community but one whose dynamics are still poorly understood.
- Uniqueness (the degree to which a given site expands the parameter space of the mix of natural and social factors contributing to risk provided by other sites).

Each long-term hazard research site would be a microcosm consisting of one (or more) hazards, a particular culture, level of economic development, etc. The aggregated whole of the different sites would then be a parameter space that would foster the understanding of the role of each of these contributors to risk, vulnerability and mitigation. The study of 'changing conditions' (political, social, environmental) would be a major rationale for the longitudinal studies. This would address a major deficiency in most existing hazards research efforts, which tend to look at discrete problems or efforts within a relatively short time horizon.

NEON may ultimately prove to be a better template than LTER. It is a network of nationwide sites that combines local collaborators with a central management structure to facilitate the collection and diffusion of information (as well as project management and logistics). It may be worth exploring the formality of relationships and the financial arrangements between the centre and research nodes to include some initial thoughts on how the project might look in the future. LTER sites, whose loosely affiliated centres are discrete in the project goals and management, will also be worth looking into further – LTER has a long-recognized history of success.

Long-term, sustained funding will be a challenge and will need to come from a variety of sources, both public and private, both national and local. One model that might be used is Project Impact in the United States, where national-level funding was highly leveraged by local contributions, both in-kind and monetary.

The question of site differentiation will need to be addressed.

- Will all the sites have a basic research package to provide for comparative analysis or will each one be focused on a specific set of issues tailored to the particular context and partner strengths? Or some combination?
- Will the type of disaster risk (earthquake vs. hurricane, for example) be a factor for differentiation or will we seek commonality?
- How proximate should the risk be for a community to be considered?

The establishment of such a network has the potential to change culture with respect to hazards, replacing a mind-set focused on emergency-response, followed by rebuild-as-before, with a societal approach based on building resilience in advance, learning from experience, and not repeating mistakes. It might well be that this embryonic cultural shift, emerging initially at the long-term research sites, and then spreading, would be a great legacy of the IRDR.

12.4 Criteria for evaluation and milestones

Criteria for evaluation would be: sponsors in place and active; partnerships agreed to and functioning; and the new projects in place which would have a viable and strong scientific team, with appropriate geographical representation and are funded adequately to meet their objectives, within the overall framework of the Programme's objectives. The establishment of the Working Groups and the development and completion, through the Forensic Investigations, of several case studies in the first three years is to be expected.

As part of the first three-year mandate, IRDR would convene stakeholder consultation forums both to receive input and to review the programme, but also to lead to an ongoing stakeholder forum process. The Consultative Forum would be used as a major part of the evaluation process. In ten years, it would be appropriate for the sponsors, together with the then ongoing consultative forum, to review the programme and the investments made to see how well this vision and legacy has been achieved.

12.5 Conclusions

This report is provided by the Planning Group as a basis for further discussion and consultation across a broad spectrum of organizations and activities, with the intention of using the feedback to further develop and implement an effective Programme on Integrated Research on Disaster Risk and addressing the challenge of natural and human-induced environmental hazards.

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APPENDIX I

Terms of Reference for the ICSU Planning Group on Natural and Human-induced Environmental Hazards and Disasters

1. The Planning Group should formulate a set of detailed objectives for an ICSU Hazards Programme based on a review of ongoing and planned relevant activities. In conducting such a review, ICSU Scientific Union and National Members should be consulted. Interests of the ICSU Interdisciplinary Bodies and Joint Initiatives should also be explored. The report should clearly demonstrate the added value of an ICSU Programme in the area.
2. The Planning Group should take the report on hazards to the ICSU 28th General Assembly as a point of departure, i.e. desired outcomes in terms of how scientific knowledge is used by policy-makers at international, national and/or local level, and in terms of how scientists interact with policy-makers and other stakeholders in the context of natural hazards – and to ensure that these objectives complement and advance existing initiatives within and beyond the ICSU community.
3. To make proposals for broad areas of research to be targeted in the first three years of an ICSU Hazards Programme, to present possible criteria for evaluation, and to define the milestones that should be reached during the life span of the Programme.
4. To stimulate, encourage and organise debate among a wide range of interested parties on the possible objectives and content of an ICSU Hazards Programme, In particular, to consult the proposed target audiences – development agencies; humanitarian assistance agencies (including UN bodies and NGOs); and governmental policy-makers – about how an ICSU Hazards Programme might best meet their needs.
5. To make proposals for how stakeholder groups other than scientists and policy-makers (e.g. people living in areas vulnerable to natural hazards) can contribute to setting the agenda for an ICSU Hazards Programme and can be involved in its progress.
6. To propose a mechanism for guidance and oversight of the Programme.
7. To report to the CSPR by July 2007.

Approved by CSPR, 16-17 February 2006

APPENDIX II

Membership of the ICSU Planning Group on Natural and Human-induced Environmental Hazards and Disasters

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*Representatives of the
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invited to the meetings of the
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- Secretariat of the
International Strategy for
Disaster Reduction (ISDR)
- United Nations Educational,
Scientific and Cultural
Organization (UNESCO)
- World Meteorological
Organization (WMO)

APPENDIX III

International collaboration on Natural Hazards

There exist a number of important programmes designed to undertake research on particular aspects of natural hazards, or on the management and mitigation of natural disasters. It is important that any new international initiative launched by ICSU take account of the work currently being carried out or planned, and that it seek to complement and build on that work. Equally, the concerned organizations or structures may wish to become active partners in the process. This Appendix provides a brief summary of the main international players in the field of natural hazards, and their major programmes or initiatives, with special emphasis on ICSU family members, the UN system and relevant intergovernmental and non-governmental organizations and consortia. The aim is to give a flavour of current work rather than be comprehensive; for this reason, readers are directed to relevant websites for further information.

1 ICSU and the ICSU family

ICSU itself was an active participant in the UN-led International Decade for Natural Disaster Reduction (IDNDR, 1990-1999). It established a committee to oversee its own engagement with IDNDR and to advise ICSU members on harmonizing their activities related to natural disasters. Associated projects included: drought assessment and famine (coordinated with IGU); reducing volcanic disaster (with IAVCEI); global seismic hazard assessment (with IASPEI and ILP); tropical cyclone disasters (with IUTAM and WMO); and engineering for disaster reduction (with the World Federation of Engineering Organizations, WFEO). After the Decade, ICSU replaced its IDNDR committee with the Committee on Disaster Reduction, charged with representing ICSU in the UN International Strategy for Disaster Reduction (ISDR), the successor initiative to IDNDR (see below). The 28th ICSU General Assembly in 2005 decided to discontinue the ICSU Committee on Disaster Reduction and to begin the planning of a new programme.

World Summit on Sustainable Development

At the World Summit on Sustainable Development (WSSD), Johannesburg, South Africa, 26 August-4 September 2002, where ICSU played an important part in putting science on the agenda, government leaders adopted a Summit Plan of Implementation that drew strong connections between international development and natural hazards, and in which they stated the need for an 'integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery'. In the same document, they also called for proper financial support for the ISDR, and put forward a series of more specific proposals concerned mainly with S&T capacity building and the applications of science that were later to be picked up at the Kobe Conference and promoted in the Hyogo Framework. (www.icsu.org)

Committee on Data for Science and Technology (CODATA)

At its 25th General Assembly (Beijing 2006) CODATA established a new Task Group for the development of a CODATA Comprehensive Information System on Natural Disaster Mitigation (CISDM). The CISDM Task group will work on the major natural hazards and disaster mitigation, establishment of a natural disaster database, both historic and real-time, and will set up an integrative S&T model system for disaster preparedness and disaster mitigation in one or two developing countries or regions. During 2007-2008 the group is to organize a survey on disaster data resources worldwide and set up a portal of the CISDM.

CODATA has recently taken the lead on GEOSS Task DA-06-01: 'Furthering the practical application of GEOSS data sharing principles'. As part of this effort, CODATA is addressing the issue of open access to remote sensing and other environmental and socioeconomic data needed not only for immediate disaster response but also for disaster prevention, recovery and reconstruction. (www.codata.org)

Committee on Space Research (COSPAR)

COSPAR was established by ICSU in 1958 to provide the world scientific community with the means to exploit the possibilities of satellites for scientific purposes, and exchange of results on a cooperative basis.

COSPAR has interdisciplinary Scientific Sub-Commissions (SSC) devoted to Earth's atmosphere, oceans and land. Natural and human-induced hazards and disasters are part of each SSC. The atmosphere, oceans, and land SSC support tropical storms and hurricanes, harmful algal blooms and oil spills, and earthquakes and tsunamis, respectively. COSPAR has recently become a Co-chair of the Group on Earth Observations (GEO) Science and Technology Committee.

(cosparhq.cnes.fr)

International Astronomical Union (IAU)

In addition to various studies carried out on Near-Earth Objects by its national members, the International Astronomical Union has had a long-established international expert Working Group (WGNEO) on the field. This has now been replaced by an Advisory Committee on Hazards of Near-Earth Objects, reporting to the IAU Executive Committee.

The Advisory Committee is charged with: maintaining liaison with, and advising on coordination of, NEO activities worldwide, on reporting of NEO hazards, and on research relevant to NEOs. When a close approach to Earth by an asteroid is predicted, the Committee advises the IAU on the reliability of the prediction. The results of their evaluations, as well as other related public statements, are all linked from the NEO Committee website. (www.iau.org)

International Geographical Union (IGU)

The IGU has Commissions on 36 varied topics, including: hazards and risks; land degradation and desertification; land use and land cover change; and population and vulnerability. The Commission on Hazards and Risks takes as its starting point the fact that disasters arise from interactions between natural phenomena and societal conditions; it therefore focuses particularly on the vulnerability of ecosystems, societies and individuals. It carries out comparative international geographical studies to contribute to the creation of an interdisciplinary language of hazards, risks and vulnerability. One of four IGU Task Forces is devoted to vulnerability.

The International Association for Engineering Geology and the Environment, an affiliate of the IGU, has established a committee on landslides and engineered slopes, whose objectives include the development and application of the relevant science and engineering expertise. (www.igu-net.org)

Scientific Committee on the Lithosphere/International Lithosphere Programme (SCL/ILP)

Established by ICSU in 1980 at the instigation of IUGG and IUGS, the SCL/ILP promotes and directs research on first-order problems in modern integrated solid earth science centred on the lithosphere.

It includes:

- the Global Earthquake Potential project (to produce a reliable estimate of earthquake potential valid throughout the world that would be useful as a source model for seismic hazard calculations);
- the Global Seismic Hazard Assessment Programme (launched in 1992 by ILP and ICSU in the context of IDNDR to create a global seismic hazard map based on advanced methods in probabilistic seismic hazard assessments, and completed in 1998); and
- the Earthquakes and Megacities Initiative (creating a network of large metropolises exposed to the threat of earthquakes in order that they can share their experiences and coordinate their activities to increase capacity for disaster preparedness, response and recovery. Themes include the evaluation of seismic exposure, impact on society, economic consequences, preparedness and emergency response capabilities.)

Since the ICSU 28th General Assembly in 2005, responsibility for SCL/ILP has been taken over by IUGG and IUGS. (sclilp.gfz-potsdam.de)

International Society for Photogrammetry and Remote Sensing (ISPRS)

ISPRS has established a working group on Hazards, disasters and public health, for the development of appropriate tools and methodologies for disaster management using remote sensing and GIS technologies, including the generation of vulnerability and hazard zone maps for various types of disaster (forest fires, cyclone, floods, drought, volcanoes, earthquake, landslides) and the integration of remotely sensed data observation and communication strategies with enhanced predictive modeling capabilities for disaster management, and applying remote sensing data products to public health and other environmentally-induced events that may affect people. It will run until 2008. (www.commission8.isprs.org/wg2)

International Union of Geodesy and Geophysics (IUGG)

The objectives of the IUGG are the promotion and coordination of physical, chemical and mathematical studies of the Earth and its environment in space. IUGG is not only dedicated to the scientific study of the Earth but also applications of the knowledge gained by such studies to the needs of society, such as geographical information systems, climate change, water quality, and reduction of the effects of natural hazards. The IUGG XXIV General Assembly (July 2007) devoted a Union session Symposium to Early warning of natural hazards, at which were discussed applications of remote sensing in mapping, monitoring and early warning of various natural hazards. (www.iugg.org)

International Association of Seismology and Physics of the Earth's Interior (IASPEI)

One of eight semi-autonomous associations of IUGG, IASPEI promotes the study of earthquakes and other seismic sources, the propagation of seismic waves, and the Earth's internal structure, properties, and processes. It currently has commissions on a range of earthquake issues (Earth structure and geodynamics; Earthquake sources - prediction and modelling; Tectonophysics; Earthquake hazard, risk, and strong ground motion; and Seismological observation and interpretation) relevant mainly to scientific aspects of the theme of natural hazards.

IASPEI projects include:

- Earthquakes and Megacities Initiative
- International Handbook of Earthquake and Engineering Seismology
- Manual of Seismological Observatory Practice
- Global Seismic Hazard Assessment Programme (GSHAP)

(www.iaspei.org)

International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI)

IAVCEI is the primary international focus for research in volcanology and related disciplines, and efforts to mitigate volcanic disasters. Among its active commissions are those on cities and volcanoes (to provide a linkage between the volcanology community and emergency managers, and to promote applied research involving the collaboration of physical and social scientists and city officials); mitigation of volcanic disasters (focused on the preparation of hazard maps as a tool for designing monitoring systems, emergency plans and socio-economic development strategies for a given region); and the international volcanic health hazard network (to produce and disseminate protocols and volcanic health hazard information to volcano observatories, scientists, governments, emergency managers, health practitioners and the general public). (www.iavcei.org)

The World Organization of Volcano Observatories (WOVO) is the foremost international body dealing with volcanic eruptions, and is run under the auspices of IAVCEI. Members are institutions that are engaged in volcano surveillance and, in most cases, are responsible for warning authorities and the public about hazardous volcanic unrest. (www.wovo.org)

IASPEI and IAVCEI have a joint working group on Subduction zones located in developing countries, which organized a workshop on earthquake and volcanic hazard mitigation at the IASPEI General Assembly in October 2005. That Assembly also saw workshops on Tsunamis: case studies, warning system and hazard assessment, and Effects of earthquakes on megacities.

International Association of Hydrological Sciences (IAHS)

IAHS promotes the study of all aspects of hydrology through discussion, comparison and publication of research results and through the initiation of research that requires international cooperation. Its International Commission on Surface Water (ICSW) is responsible for promoting research in surface water hydrology and its interaction with other aspects of the hydrological cycle. The primary objectives of activities are to advance knowledge of the dynamics and statistics of surface water hydrology and to encourage the transfer of this knowledge to the international scientific hydrological community and the water industry to improve the design and operation of hydrological systems. Core activities include flood and drought prediction, mitigation and forecasting, with high priority given to interdisciplinary research, including socio-economic aspects.

One of the IAHS Working Groups, Predictions in Ungauged Basins (PUB) is an IAHS ten-year research project (2003-2012) for reducing predictive uncertainty in hydrology. It promotes better understanding of hydrological process and tries to replace model calibration by physical knowledge as much as possible. PUB also seeks to assemble the technology to provide the best prediction to ungauged or information-poor basins. (iahs.info)

International Association of Meteorology and Atmospheric Sciences (IAMAS)

IAMAS provides the scientific community with platforms to present, discuss and promote the newest achievements in meteorology, atmospheric science and related fields. It also facilitates and coordinates research which requires international cooperation. (www.iamas.org)

International Association of Cryospheric Sciences (IACS)

IACS promotes all scientific aspects related to the cryosphere and actively supports the transfer of knowledge. A variety of local-scale hazard types are due to cryospheric components and their ongoing changes: snow avalanches, ice avalanches, development of glacier lakes due to ice shrinkage and the high risk of their outbursts (GLOFs) (all three can be triggered by earthquakes and can, thus, reach regional scale impact), floods due to extreme melt-water peaks, mudflows and rock avalanches due to permafrost degradation and volcano–ice interactions. They all provide considerable risk for down-valley settlements and infrastructure. Land ice melt is one of the governing drivers for sea-level rise and ice-stream dynamics are the key for understanding the instability of the Greenland and the West Antarctic ice sheets. IACS faces the respective scientific challenges and provides respective organisational support by running, among five Divisions, its Divisions I, ‘Snow and Avalanches’, and II ‘Glaciers and Ice Sheets’, by hosting the Working Group on ‘Glacier and Permafrost Hazards in Mountains’ (GAPHAZ) jointly with the International Permafrost Association (IPA) and by hosting the World Glacier Monitoring Service that collects and compiles worldwide data of glacier mass changes that provide the basis for determining the respective impact on sea level. An Inter-Association Commission on ‘Volcano–Ice Interactions’ is in formation, jointly with IAVCEI. (www.cryosphericsscience.org)

Commission on Geophysical Risk and Sustainability (GeoRisk)

GeoRisk was established by the IUGG Bureau in August 2000 to study the interaction between hazards, their likelihood and their wider social consequences as a result of the vulnerability of societies. It is maintained by all seven IUGG Associations. Projects include a series of symposia (four to date) on geohazards, risks and sustainable development in cities, intended both to explore scientific issues and to raise awareness among policy-makers; and production of a ‘Webcyclopedia’ of urban risk and sustainability giving information ordered by city, hazard and risk. Participants in a NATO Advanced Workshop in June 2002 organised jointly by Georisk and Euroscience agreed the Budapest Manifesto, which stressed the need for scientists to work with local communities in evaluating risk from natural hazards and ways to respond to risk. These principles were included in the research agenda for the Hazards theme of the International Year of Planet Earth (see below). (www.iugg-georisk.org)

International Union of Geological Sciences (IUGS)

IUGS promotes the development of the earth sciences through support of broad-based scientific studies relevant to the entire earth system, and applies the results of these and other studies to preserving the Earth’s natural environment, using natural resources wisely and improving the prosperity of nations and the quality of life. Through a number of affiliated organizations (International Associations of Engineering Geology, Hydrogeology, Permafrost, etc.), IUGS is engaged in the investigation of both endogenous (earthquakes, volcanoes) and exogenous (landslides, collapses, rockfalls, earth subsidence, karst, mudflows, erosion, permafrost) geological hazards through the study of development mechanisms, distribution regularities and mapping of these processes. IUGS and UNESCO collaborate as partners in the International Consortium on Landslides (ICL, see below), the International Geoscience Programme (IGCP), IGOS (see below), the Scientific Committee on the Lithosphere/International Lithosphere Programme (SCL/ILP, see above) and the GeoIndicators Initiative. Several IUGS Affiliated Organisations also have interests relevant to hazards issues.

(www.iugs.org)

The Presidents of the five Geo-Unions of ICSU – IUGG, IUGS, IUSS, IGU and ISPRS – collaborate on a number of issues, including natural hazards. The GeoUnions Science Initiative in this area has been working closely with the International Year of the Planet Earth team to develop key research questions (see below).

International Year of the Planet Earth (IYPE)

The United Nations General Assembly declared 2008 as the International Year of Planet Earth, and a sequence of activities for IYPE are being planned and promoted by IUGS, IGU, ILP, INQUA, IUGG, IUSS, UNESCO and others to run 2007-2009. With the subtitle Earth sciences for society, IYPE sponsors multidisciplinary international research within a number of society-relevant, broadly based themes, and raises awareness among decision-makers and the public of the importance of earth sciences to society at large. One of the themes is Hazards – minimizing risk, maximizing awareness, under which four broad, overlapping research questions have been identified:

- How have humans altered the geosphere, the biosphere and the landscape, thereby promoting and/or triggering certain hazards and increasing societal vulnerability to geohazards?
- What technologies and methodologies are required to assess the vulnerability of people and places to hazards and how might these be used at a variety of spatial scales?
- How does our current ability to monitor, predict and mitigate vary from one geohazard to another? What methodologies and new technologies can improve such capabilities, and so help civil protection locally and globally?
- What are the barriers, for each geohazard, that prevent governments (and other entities) from using risk and vulnerability information to create policies and plans to reduce both?

The IYPE Science Plan envisages a major international conference on Natural and Human Induced Environmental Hazards and Disasters in 2008 under the auspices of ICSU, IYPE and UN-ISDR to explore the linkages between the key research questions of IYPE, the priorities of the Hyogo Framework for Action, and the science themes of this new Research Programme. (www.esfs.org)

International Union for Quaternary Research (INQUA)

INQUA seeks to improve understanding of environmental change during the Quaternary (the past 2.6 million years), the most recent period of Earth history. The Union’s mission is to promote improved communication and international collaboration in basic and applied aspects of Quaternary research. It achieves its goals mainly through the activities of five commissions. With regard to natural hazards and risk, research supported by the Palaeoclimate Commission (PALCOMM) plays a key role in helping evaluate the possible future course of climate change on our planet. Several of the projects of the Terrestrial Processes and Deposits (TERPRO) Commission are concerned directly with natural hazards and risk, for example the ‘Dark Nature’ Project, which examined the impacts of natural disasters on society, and the ‘INQUA Scale’ Project, which developed a novel earthquake macrointensity scale based on identifiable effects of earthquakes on

the natural environment.

In addition to its own research activities, INQUA actively collaborates with other organizations and programmes, including for example, the International Glaciological Union, the Past Global Changes (PAGES) programme of the International Geosphere-Biosphere Programme (IGBP), and the International Geoscience Programme (IGCP). INQUA is also a partner in the IYPE programme and provides financial support. It works with the other ICSU geo-unions (IGU, ISPRS, IUGG, IUGS and IUSS) on natural hazards and other issues of common interest. (www.inqua.nlh.no)

Scientific Committee on Antarctic Research (SCAR)

SCAR is an inter-disciplinary committee of ICSU charged with the initiation, development and coordination of high-quality international scientific research in the Antarctic region, and on the role of the Antarctic region in the Earth system. It has an important function to provide scientific advice to the Antarctic Treaty System.

The main interest SCAR has in natural hazards and disasters concerns: (i) the likelihood of rapid climate change and its effects on the Greenland and or West Antarctic Ice Sheets ice sheets, and thence on sea-level; and (ii) the likelihood of gradual climate change leading to a tipping point at which the disintegration of those ice sheets becomes rapid and extensive. Either scenario may produce a rise in sea-level of one to several metres; even if the process were gradual it would constitute a major natural disaster for coastal populations. (www.scar.org)

Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)

As one of ICSU's Interdisciplinary Bodies, SCOSTEP has organized and conducted international solar-terrestrial research programmes for over three decades. In recent years its main research programmes have been focused on space weather. SCOSTEP currently sponsors the Climate and Weather of the Sun–Earth System (CAWSES) programme, an international initiative established in 2004 with the aim of significantly enhancing understanding of the space environment and its impacts on life and society. The main functions of CAWSES are to coordinate international activities in observations, modelling and applications crucial to achieving this understanding, to involve scientists in both developed and developing countries, and to provide educational opportunities for students at all levels. CAWSES is the main ICSU programme dealing with space weather research and application. (www.scostep.ucar.edu) (www.bu.edu/cawses)

International Union of Radio Science (URSI)

The objective of URSI is to stimulate and co-ordinate, on an international basis, studies and research, applications, scientific exchange and communication in the fields of radio, telecommunication and electronic sciences.

URSI has ten scientific Commissions organized to advance research, applications and exchange of information in various fields of radio science. One such is devoted to Waves in Plasmas, and has, as one of its goals, encouragement of the application of studies of waves in plasmas, particularly to solar/planetary plasma interactions, space weather, and the exploitation of space as a research laboratory. (www.ursi.org)

2 ICSU Regional Offices

ICSU Regional Office for Asia and the Pacific (ICSU ROAP)

The inaugural conference for ICSU ROAP held in Kuala Lumpur on 18-19 September 2006 was devoted to Natural and Human-induced Environmental Hazards and Disasters, which had been identified as the principal priority of the Regional Office. An ICSU Asia-Pacific Strategic Planning Group on Hazards and Disasters (STRAPGHAD) has been established to help plan a regional programme, whose focus will be on geophysical and hydrometeorological hazards. Access to data has been identified as an issue, as has the need for a regional inventory. One role of the regional programme could be to link and integrate ICSU-related programmes (such as IYPE). Two Science Plans on Hazards and Disasters have so far been prepared, reflecting identified priorities: one deals with Earthquakes, Floods and Landslides, a second is devoted to the Special Vulnerability of Islands.

(www.icsu-asia-pacific.org)

ICSU Regional Office for Africa (ICSU ROA)

A Second Regional Consultative Forum hosted by Regional Office in Johannesburg on 25-27 September 2006 examined a draft plan on Natural and Human-induced hazards and disasters in Sub-Saharan Africa – one of four priority actions of the Regional Office – prepared by a regional planning group set up for the purpose. The implementation of the ICSU ROA science plan on hazards and disasters was subsequently launched at the International Workshop on Natural and Human-Induced Hazards and Disasters in Africa (Kampala, Uganda, 21-22 July 2007). Two major projects were retained at the Kampala workshop, namely: (i) Project HD1. Geohazards in Africa and linkage with the International Year of Planet Earth (IYPE); and (ii) Project HD2. Hydro-meteorological Hazards in Africa: Vulnerability and Resilience. (www.icsu-africa.org)

ICSU Regional Office for Latin America and the Caribbean (ICSU ROLAC)

The ICSU Regional Committee for Latin America and the Caribbean, meeting in October 2006, decided that Hazards and natural disasters would be one of four priorities for the newly founded Regional Office in Rio de Janeiro, Brazil. A Scientific Planning Group in Natural Disasters (SPGND) was formed, and at its second meeting in Montevideo (March 2008) SPGND presented recommendations and proposals on key scientific aspects that need to be addressed in establishing a science plan in prevention and mitigation of risks and disasters in the region. (www.icsu-lac.org)

3 World Climate Research Programme (WCRP)

The WCRP established by ICSU and WMO (also sponsored by the IOC of UNESCO) aims to develop the fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent of human influence on climate. WCRP studies are specifically directed to provide scientifically founded quantitative answers to the questions being raised on climate and the range of natural climate variability, as well as to establish the basis for predictions of global and regional climatic variations and of changes in the frequency and severity of extreme events.

The **Global Energy and Water Cycle Experiment (GEWEX)** is the scientific focus in WCRP for studies of atmospheric and thermodynamic processes that determine the Global hydrological cycle and water budget and their adjustment to global changes such as the increase in greenhouse gases. One

of the programmes within this is GEWEX–WISE (World Integrated Study of Extremes <http://www.meteo.mcgill.ca/wise>) to understand and model the occurrence, evolution and role of extremes within the climate system and to contribute to their better prediction that is initially focusing on droughts and extended wet periods. (www.wmo.int)

4 Earth observation initiatives

ICSU is actively involved in a series of interlocking initiatives addressing various aspects of Earth observation. The overall objective relates to the global agenda for sustainable development and sound environmental management but, within this, there is a specific focus on natural hazards.

Since the early 1990s, ICSU and others have been co-sponsoring systematic observing programmes for the oceans (Global Ocean Observing System, GOOS [1991]), the climate (Global Climate Observing System, GCOS [1992]), the land (Global Terrestrial Observing System, GTOS [1996]), and the Earth's shape, gravity field and rotational motion (Global Geodetic Observing System, GGOS [2003]).

(www.ioc-goos.org) (www.wmo.ch/web/gcos/gcoshome.html) (www.fao.org/gtos)

GCOS, GOOS, GTOS and GGOS, together with ICSU itself and other organizations, are partners in the Integrated Global Observing Strategy (IGOS), established in 1998. The role of IGOS is to address strategic issues across all the main observing systems and to guide their priority-setting. IGOS has defined a number of themes to facilitate the coherent definition and development of an overall strategy for observing selected fields of common interest among IGOS Partners. One of the ten themes established so far is Geohazards, 'to respond to the scientific and operational geospatial information needs for the prediction and monitoring of geophysical hazards, namely earthquakes, volcanoes and land instability'. The GeoHazards Theme was scoped in 2001, and a preliminary prospectus published in April 2004. The Theme established its own funded secretariat in late 2004 and has its own website (igos.brgm.fr). The overall aim is to bring together active practitioners from a range of geohazard disciplines and techniques in order to stimulate collaboration and identify priorities for earth observation. IGOS GeoHazards sees its main target audiences as responsible civil authorities, scientists in monitoring and advisory agencies, and research scientists. It has undertaken two tasks: developing a GeoHazData system to provide a metadata editor for, and a global inventory of, hazard maps; and GeoHazNet designed as a Community of Practice to bring together key researchers and data users. (www.igospartners.org)

The Group on Earth Observations (GEO) is an inter-governmental initiative, the planning of which was launched in July 2003 in response to the WSSD commitment to develop comprehensive, coordinated and sustained Earth observation. At the 3rd Earth Observation Summit in February 2005, a 10-year implementation plan (starting January 2006) for the Global Earth Observation System of Systems (GEOSS) was approved. It defines nine societal benefits, of which the first is 'Reducing loss of life and property from natural and human-induced disasters'. Its overarching vision for disasters is 'to further enhance coordination among operational observing systems with global coverage. These need to be capable of supporting effective disaster warnings, responses and recovery...collaborative framework to permit free exchange and efficient use of data, together with support for continuity of operations for all essential systems.' The plan sets out activities on 2-, 6- and 10-year timeframes for each of the defined benefits. (www.noaa.gov/eos.html)

5 The United Nations system

International Strategy for Disaster Reduction (ISDR)

ISDR was established within the UN Office for the Coordination of Humanitarian Affairs as the successor initiative to IDNDR. Its four primary functions are: policy and strategy; advocacy; information and networks; and partnerships for applications. Its policy framework was set by the Yokohama Strategy and by the 'Geneva statement': A Safer World in the 21st Century: Risk and Disaster Reduction, emanating from the final IDNDR forum in July 1999. One of the overarching themes of the framework is to locate the goal of reducing vulnerability to natural disasters within the context of sustainable development strategies. The central task of ISDR is to coordinate the global implementation of the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters adopted at the World Conference on Disaster Reduction in Kobe, Japan, working with a range of international bodies, Member States and other stakeholders.

Global Platform for Disaster Risk Reduction

The Global Platform for Disaster Risk Reduction represents a major new impetus in the pursuit of the aims and objectives of the Hyogo Framework, and its establishment took place at an inaugural conference hosted by ISDR on 5-7 June 2007 in Geneva. The Platform provides a forum for devising strategies and policies to reduce disaster risk, monitoring progress, and identifying gaps in policies and programmes and recommending remedial action. It also aims at ensuring complementarity of action at all levels of implementation through increased cooperation and coordination. The Platform will build on and expand the membership of the Inter-Agency Task Force on Disaster Reduction; hereon participation will be open to Member States. An extensive consultative process has been launched by ISDR to consider practical ways of strengthening the ISDR system, with a background document available on its website. (www.unisdr.org)

World Bank Global Facility for Disaster Reduction and Recovery (GFDRR)

Approved by the World Bank Board in 2006, the GFDRR is a partnership that recognizes disaster reduction as a critical dimension of the global poverty reduction agenda. This is an operation essentially supporting the ISDR in the implementation of the Hyogo Plan of Action, organized on a three-track basis in order to achieve its global objectives at the global, regional and country levels.

Track 1: Support to ISDR's global and regional processes to enable leveraging of country resources for ex-ante investment in prevention, mitigation and preparedness activities, particularly in low- and middle-income countries. Includes regional and subregional initiatives in benchmarking of risks and resilience, regional/subregional EW strategies, promoting/strengthening partnerships in DRR, particularly with universities, scientific and technological institutions, the private sector, research organizations and professional bodies; establishing a virtual clearinghouse for DRR. Standardizing hazard risk management tools, methodologies and practices; reporting on good practices in DRR, developing country-owned and country-driven risk assessment methodologies, country-based damage and needs assessment techniques. US\$ 5 million available per year.

Track 2: Provision of technical assistance to low- and middle-income countries to mainstream DRR in strategic planning, esp. Poverty reduction Strategies. Grants totalling US\$350 million (US\$4 million per country).

Track 3: Accelerated Disaster Recovery in Low-Income Countries – to meet immediate needs (but on condition that pre-disaster preparedness instruments

(Track 2) have been put in place.

(www.unisdr.org/eng/partner-netw/wb-isdr/wb-isdr.htm)

GFDRR/ISDR Global Partnership with Universities, Academic Institutions, Research Organizations

An initiative that seeks to create a 'network of networks' to provide a platform for sustained cooperation in research, innovation and education as a means of meeting the overarching goals of the Hyogo Framework for Action: effective integration of disaster risk considerations into sustainable development policies, planning and programming; and strengthening institutions, mechanisms and capacities at all levels.

Universities and research centres were present at the first meeting in Geneva in December 2006.

United Nations Environment Programme (UNEP)

UNEP has a strong focus on the interplay between environmental issues and natural disasters. In its various initiatives responding to the Indian Ocean tsunami, for example, it has stressed the need to respect environmental requirements during reconstruction and has documented the role of mangroves and coral reefs in protecting some parts of Sri Lanka from the worst effects of the tsunami. It is surveying the environmental consequences throughout the affected region and offering practical assistance in the reconstruction efforts.

More generally, UNEP is active in assessing the impact of deforestation and other practices on vulnerability to natural disasters. Its Global Environment Outlook project, initiated in response to Agenda 21, has delivered systematic scientific assessments of vulnerability to natural disasters for many regions of the world.

UNEP, the UN Office for the Coordination of Humanitarian Affairs and the Global Fire Monitoring Center are mandated to coordinate action to combat large international forest fire emergencies. The GFMC, established at Freiburg in 1998, monitors, forecasts and archives information on vegetation fires at global level. It is a designated activity of ISDR, facilitates the ISDR Global Wildland Fire Network and serves as Secretariat of the ISDR Wildland Fire Advisory Group. (www.gfmc.org)

UNEP has established a finance initiative to work with a range of financial institutions throughout the world on interactions between environmental and financial performance. This includes detailed assessment of the financial aspects of natural disasters. (www.unep.org)

UNESCO

UNESCO has in place scientific and engineering programmes in earth, water, ecological and oceanographic sciences that contribute to the study and mitigation of natural hazards. It works to provide intergovernmental coordination and policy support in the establishment and operation of monitoring networks and early warning and risk mitigation systems for natural hazards, with particular emphasis on earthquakes, tsunamis, floods and landslides. It also promotes multi-stakeholder strategies for enhancing disaster education and awareness as an intrinsic part of the UN Decade on Education for Sustainable Development (led by UNESCO), especially in communities at risk located in Africa, LDCs and SIDS. As an active promoter of the Cluster/Platform on Knowledge and Education, UNESCO contributes to the achievements of the ISDR Joint Work Plan relative to Priority 3 of the Hyogo Framework for Action.

UNESCO supports regional partnerships and networks devoted to the collection and dissemination of relevant information and knowledge on hazards, vulnerabilities and risk mitigation capacities. Attention is paid to gender-sensitive and socio-culturally relevant approaches and to the promotion of local and indigenous practices for risk reduction, the use of formal and informal channels to mobilize and sensitize community leaders, women, youth and children, and to the dissemination of guidelines for the protection of schools and cultural heritage at risk.

UNESCO is involved in numerous collaborative initiatives related to aspects of hazards such as: the International Consortium on Landslides; an International Flood Initiative (IFI) to be located at a new International Centre for Water Hazard and Risk Management at Tsukuba, Japan (with WMO, the UN University, ISDR and IAHS – see below); IYPE; and a coalition on education to integrate disaster reduction education into school programmes and to make school buildings safer.

Through its **Intergovernmental Oceanographic Commission (IOC)**, UNESCO promotes the concept of 'end-to-end' tsunami warning systems, in cooperation with ISDR, WMO, in the Indian and Pacific Oceans, as well as expanding early warning systems to Africa, the South Pacific, the Mediterranean, NE Atlantic and the Caribbean. Emphasis is given to mitigation, educational recovery, restoring biological and cultural diversity, and integrated water management. (www.unesco.org)

International Centre for Water Hazard and Risk Management (ICHARM)

ICHARM is a UNESCO water centre within IHP and is serving as a centre of excellence to develop and help implement best practicable strategies for the globe, regions, nations and localities for reducing water-related disaster risks, especially in the first-phase, flood-related disasters. It is serving as the secretariat of International Flood Initiative (IFI), and has assumed responsibility for the risk management chapter of the *World Water Development Report*. It is engaged in research, training and information networking. Research and development of flood alert system, community flood defence, future flood risk assessment, flood preparedness indices are some on-going activities. It has an academic flood master course offered for practitioners in developing countries.

(www.icharm.pwri.go.jp)

World Meteorological Organization (WMO)

WMO Natural Disaster Prevention and Mitigation Programme

Through the coordinated network of National Meteorological and Hydrological Services (NMHSs) of its 188 Member States, WHO contributes to different stages of disaster risk reduction, including prevention, preparedness, response and recovery and reconstruction, through research, monitoring, detecting, analysing, forecasting, and the development and issuance of warnings for weather-, water- and climate-related hazards (source of nearly 90% of disasters caused by natural hazards).

The Natural Disaster Prevention and Mitigation (DPM) Programme, established in 2003, has conducted detailed country-level and regional-level surveys to map scientific and technical capacities, requirements and opportunities in support of disaster risk reduction at national and regional levels. Through an organization-wide coordinating framework building on the activities of its 10 WMO scientific and technical programmes, eight technical commissions, NMHSs of its Member States and strategic partnerships with other agencies, WMO is working to assist its Members towards the protection of lives, livelihoods and property. The strategic priorities of WMO for disaster risk reduction are: (i) early warning systems; (ii) hazard information and analysis for risk assessment and informed

decision-making; (iii) capacity development and training programmes; (iv) better integration of NMHS products and services in disaster risk reduction structures, planning and operations; and (v) public outreach programmes.

As a partner in the ISDR System, WMO is working with other agencies such as UNESCO, UNDP, IFRC, the World Bank, OCHA and UNOSAT towards development of activities to provide coherent and coordinated assistance to its Member States for strengthening their capacities in disaster risk reduction and implementation of the Hyogo Framework for Action 2005-2015. (www.wmo.ch/disasters)

THORPEX

THORPEX is a ten-year international global atmospheric research and development programme that is a component of the WMO World Weather Research Programme. THORPEX aims to reduce and mitigate natural disasters by transforming timely and accurate weather forecasts into specific and definite information in support of decisions that produce the desired societal and economic outcomes by:

1. Extending the range of skilful weather forecasts to timescales of value in decision-making (up to 14 days) using probabilistic ensemble forecast techniques.
2. Developing accurate and timely weather warnings in a form that can be readily used in decision-making support tools.
3. Assessing the impact of weather forecasts and associated outcomes on the development of mitigation strategies to minimize the impact of natural hazards.

(www.wmo.ch/thorpex)

Inter-governmental Panel on Climate Change (IPCC)

In 1988, WMO and the United Nations Environment Programme (UNEP) established the IPCC with the goal of assessing both available scientific information on climate change, and its environmental and socio-economic impacts. The Third Assessment Report of IPCC in 2001 concluded that the duration, location, frequency and intensity of extreme events are likely to change, with more hot days and heat waves and fewer cold and frost days over nearly all land areas, and increases in the amplitude and frequency of extreme precipitation events over many areas. IPCC is currently finalizing its Fourth Assessment Report 'Climate Change 2007' which will be released in 2007. The reports by the three Working Groups provide a comprehensive and up-to-date assessment of the current state of knowledge on climate change. The Synthesis Report integrates the information around six topic areas. (www.ipcc.ch)

Food and Agriculture Organization (FAO)

Through its Global Information and Early Warning System (GIEWS) FAO keeps the world food supply/demand situation under continuous review, is able to issue reports on the world food situation (publications include: Food Outlook, Crop Prospects and Food Situation), and provide early warnings of impending food crises in individual countries, including those provoked by natural hazards. GIEWS uses many sources of information on weather and other natural conditions for agriculture, as well as on economic, social and political factors. Sources include meteorological information, agencies operating satellites for earth observation, news services such as Reuters, Associated Press, other news organizations, information from national institutions available through publications or web sites, various reports and studies.

For countries facing a serious food emergency, FAO/GIEWS and the World Food Programme also carry out joint Crop and Food Supply Assessment Missions (CFSAMs). Their purpose is to provide timely and reliable information so that appropriate actions can be taken by the governments, the international community, and other parties. (www.fao.org/giews)

United Nations University (UNU)

The United Nations University's Institute for Environment and Human Security (UNU-EHS) in Bonn, Germany, explores threats to human security arising from natural and human-induced hazards. The Institute carries out research, capacity building and policy-relevant advisory activities relating to the broad interdisciplinary field of 'risk and vulnerability'.

The research and training activities of UNU-EHS in its initial 2004-2005 biennium focussed on flood plains, deltas and coastal zones, with emphasis on urban agglomerations. Drought and its impact on rural communities have been an added priority from 2006 onwards. With GFMC joining UNU-EHS as an associate Institute in 2005 the global wildland fire problem is being addressed cooperatively.

UNU-EHS is a partner in the inter-agency initiative, the International Flood Initiative (IFI), with UNESCO, WMO, UN-ISDR and the International Association of Hydrological Science. Launched on the occasion of the Kobe Conference in January 2005, the initiative aims at minimizing loss of life and reducing damage caused by floods. (www.ehs.unu.edu)

United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)

UN-SPIDER is a new United Nations programme that seeks to: «ensure that all countries have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle». Whereas there have been a number of initiatives in recent years that have contributed to making space technologies available for humanitarian and emergency response, UN-SPIDER is the first to focus on the need to ensure access to and use of such solutions during all phases of the disaster, including the risk reduction phase which will significantly contribute to an increasing reduction in loss of lives and property.

The new programme achieves this by focusing on being a gateway to space information for disaster management support, serving as a bridge to connect the disaster management and space communities and being a facilitator of capacity-building and institutional strengthening, in particular for developing countries.

UN-SPIDER is being implemented by the United Nations Office for Outer Space Affairs (UNOOSA) as an open network of providers of space-based solutions to support disaster management activities. Besides Vienna (where UNOOSA is located), the programme will also have offices in Beijing, China and Bonn, Germany.

The UN-SPIDER programme will, within its outreach activities, ensure the participation of expert speakers in relevant conferences and meetings, provide support to regional and international seminars and workshops and organize its own workshops and expert meetings. It maintains a Calendar of Events with upcoming conferences, meetings and events relevant to the area of space-based solutions for disaster management and emergency response, and issues an on-line UN SPIDER Newsletter. (www.unoosa.org/oosa/unspider/index.html)

6 Other major international initiatives

European Union (EU)

The overall aim of EU research policy is to promote scientific excellence and innovation to advance knowledge and understanding, and to support the implementation of related European policies.

The European Commission (EC) has been supporting research related to natural hazards and disasters since the late 1980s through its successive Framework Programmes (FP) for Research and Technological Development.

In the present FP7 programme, different specific programmes are addressing, through yearly calls for research proposals (see web links), focused and/or complementary topics related to natural hazards research issues.

In summary, multinational and interdisciplinary research is focusing in an integrated framework on the assessment of «hazards, vulnerability and risks» of geological and climate-related hazards including their socio-economic components. Furthermore, research efforts are also focussing on the use of Earth observation (GEO, GMES) or on Information and Communication Technologies (ICT) in support of risk and crisis management. Further initiatives are also being taken in the field of common infrastructures research.

Overall information on FP7: http://cordis.europa.eu/fp7/home_en.html

In FP7 , under 'Cooperation'

- Information and Communication Technologies (ICT): see <http://cordis.europa.eu/fp7/ict/>
- Environment (including climate change): see http://cordis.europa.eu/fp7/environment/home_en.html
- Space (Global monitoring for environment and security-GMES aspects): see http://cordis.europa.eu/fp7/cooperation/space_en.html

In FP7 , under 'Facilities'

- Infrastructures: see http://cordis.europa.eu/fp7/capacities/research-infrastructures_en.html

ProVention Consortium

Launched in February 2000 to reduce disaster risk in developing countries and to make disaster prevention and mitigation an integral part of development efforts, ProVention is a global coalition of governments, IGOs, academic institutions, private sector and civil society organizations. It works closely with World Bank Hazard Risk Management operation, and functions as a network to share knowledge and connect and leverage resources aimed at reducing disaster risk.

ProVention is currently hosted by the International Federation of Red Cross and Red Crescent Societies, an international humanitarian organisation headquartered in Geneva. The International Federation, as Host Organisation, undertakes the management of the Secretariat and responsible for administering ProVention project funds.

Advisory Committee

To oversee and support the Secretariat by providing ongoing guidance and advice on major strategic, policy and organisational decisions, the governance structure includes an Advisory Committee, comprised of representatives of the founding organisation, host organisation, donors and nominated Consortium partners. The Advisory Committee gives strategic advice and direction to the Secretariat, overseeing the implementation of the work programme and approving the annual budget. The Advisory Committee and Secretariat solicit expert technical advice from independent project reviewers to ensure high quality technical appraisal of ProVention project activities and accountability in project approval and decision making.

ProVention Forum

The critical dialogue and agenda setting that has taken place in the past during ProVention meetings has been broadened and expanded to include a wider range of ProVention partner organisations as part of an annual ProVention Forum. Through the Forum, ProVention seeks to enable broader participation, identify critical gaps in disaster risk management, and generate cutting-edge ideas and catalyse collaborative initiatives in order to help drive the global risk reduction agenda. The Forum dialogue directly informs the evolving ProVention work programme.

Since the creation of ProVention in February 2000, many organisations have been active partners in the Consortium, including international financial institutions (regional development banks and the World Bank), agencies of donor governments, international and regional organizations, universities and research centres, NGOs, networks and the private sector (insurance).

ProVention's thematic priorities

A set of five thematic priorities have been identified by ProVention as key areas of strategic focus where the Consortium can add most value. The strategic direction follows the original focus of ProVention and further develops the following core ProVention themes:

- Mainstreaming Risk Reduction
- Risk Analysis & Application
- Reducing Risks in Recovery
- Risk Transfer & Private Sector Investment
- Expanding Risk Research & Learning.

(www.proventionconsortium.org)

Global Risk Identification Programme (GRIP)

The goal of GRIP is reduced natural hazard-related losses in high risk areas to promote sustainable development. Its objectives are an improved evidence base for disaster risk management and the increased adoption of disaster risk management as an alternative to over-reliance on emergency management at global, regional and national scales; the programme is being pursued by ProVention with UNDP support and WMO involvement. Following the Preparatory phase 2005-2006, a Programme Steering Committee being set up, composed of representatives of

international organizations and governments providing direction, guidance and advice to the Coordinating Team (UNDP and UNEP staff).

GRIP works with international and local expert institutions and authorities in various aspects of risk and loss assessment in five areas. Project activities will be phased in over five years, with an early emphasis on capacity development. (www.gri-p.net)

International Institute for Applied Systems Analysis (IIASA)

The IIASA Risk and Vulnerability (RAV) Programme conducts conceptual and applied analyses that contribute to decreasing the risk and vulnerability of societies and ecosystems, and to promote their adaptation and resilience to stresses imposed by global change phenomena. Its research is relevant mainly, but not exclusively, to developing countries.

- The specific goals of the Programme are to:
- advance the conceptual and methodological development of risk and vulnerability research;
- carry out selected risk and vulnerability assessments;
- undertake integrative stakeholder-led case studies; and
- develop interactive tools to provide training on vulnerability and adaptation.

Its Research Plan (2006-2010) is grouped into themes on Adaptation and Development, Governance and Fairness, and Water and Resilience.

(www.iiasa.ac.at/Research/RAV/index.html)

International Disaster and Risk Conference (IDRC), Davos

IDRC is a global, technical and operational gathering of leading experts in the natural, social and engineering sciences, governments, private sector, civil society, IGOs, NGOs and risk management professionals. It seeks to be a bridge between practice, science, policy-making and decision-making in the search for sustainable solutions to the complex risks facing society today. Co-organized by ISDR, UNESCO, Global Alliance for Disaster Reduction and the Global Disaster Information Network, IDRC is hosted at the Swiss Federal Institute for Snow and Avalanche Research (SLF), Zurich.

The 2008 Davos Conference (25-28 August) will have as its theme: 'Public-private partnership – key for integral risk management and climate change adaptation'. (www.idrc.info)

Organization for Economic Cooperation and Development (OECD)

The OECD's Global Science Forum initiated in 2008 a project to develop a global, open-source earthquake model that will generate information of the highest standard through cooperation between many of the world's top earthquake experts. The project was conceived in the form of a public-private partnership, and will develop a global scientific network of specialists to be coordinated by the Swiss Seismological Service at the Swiss Federal Institute of Technology in Zurich, the Geo Research Centre in Potsdam, and the US Geological Survey. Munich Re is supporting the development of an expert model that in its initial stage will adopt a uniform approach towards representing earthquake risk worldwide and include regions which previous approaches virtually ignored or failed to observe in sufficient detail. (www.oecd.org)

Global Alliance for Disaster Reduction (GADR)

GADR is based at the University of North Carolina Charlotte, and is an association of more than 1000 experts on disaster reduction and related aspects of sustainable development, representing regional, national and international organizations and institutions, among which are the United Nations, the World Bank, national and regional environmental and disaster mitigation agencies, institutes and relief organizations.

The general objectives of GADR are to:

- Mobilize intellectual and material resources to address several issues that will enable businesses and public agencies to mitigate the impacts of natural and technological hazards.
- Serve as a catalyst for ongoing national and international projects by providing opportunities for expansion of technical and political capacity, building of multinational networks, convening of forums and conferences, and capacity enhancements for centres of excellence to implement programmes to reduce the impacts of disasters.
- Bring about major shifts in disaster control from disaster impact focus to disaster prevention in all disciplines, national and regional infrastructure plans, and educational programmes.

(www.gadr.giees.uncc.edu)

Global Disaster Information Network (GDIN)

GDIN is a voluntary, independent, self-sustaining, non-profit association of nations, organizations, and professionals from all sectors of society, including NGOs, industry, academia, governments and international organizations, with an interest in sharing disaster information. (www.gdin.org)

Pacific Science Association (PSA)

The PSA, a regional, non-governmental organization that seeks to advance science and technology in support of sustainable development in the Asia-Pacific, is establishing a task force on natural disaster reduction. (www.pacificscience.org)

EARLY Warning Conferences

ISDR, in collaboration with Germany, has been organizing International Conferences on Early Warning. The third conference in March 2006, addressed different hazards associated water, air and earth; mega events in early warning; multi-hazard approaches; and people, politics, and economics of early warning.

(www.ewc3.org)

Centre for Research on the Epidemiology of Disasters (CRED)

CRED, based at the Université de Louvain, promotes research, training, and information dissemination on disasters, with a special focus on public health, epidemiology, structural and socio-economic aspects. It aims to enhance the effectiveness of developing countries' disaster management capabilities as well as fostering policy-oriented research.

CRED's goals are:

- to promote research and provide information to the international community that ensures sufficient preparedness and improved responses to disasters and populations in danger;
- to train field managers, relief officers, doctors and health professionals in the management of short and long-term disaster situations;
- to introduce emergency preparedness and response in development programmes of disaster-prone countries; and
- to develop autonomy of developing countries to improve their own preparedness for and response capacities for emergencies and critical situations.

(www.cred.be)

International Consortium on Landslides (ICL)

The International Consortium on Landslides, created at the Kyoto Symposium in January 2002, is an international non-governmental and non-profit scientific organization, supported by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO), the Food and Agriculture Organization of the United Nations (FAO), the United Nations International Strategy for Disaster Reduction (UN/ISDR), ICSU, the World Federation of Engineering Organizations (WFEO) and intergovernmental programmes such as the International Hydrological Programme of UNESCO; the Government of Japan; and other governmental bodies.

ICL objectives are:

- to promote landslide research for the benefit of society and the environment, and capacity building, including education, notably in developing countries;
- to integrate geosciences and technology within the appropriate cultural and social contexts in order to evaluate landslide risk in urban, rural and developing areas including cultural and natural heritage sites, as well as contribute to the protection of the natural environment and sites of high societal value;
- to combine and coordinate international expertise in landslide risk assessment and mitigation studies, thereby resulting in an effective international organization which will act as a partner in various international and national projects; and
- to promote a global, multidisciplinary programme on landslides.

ICL is organizing the first World Summit on Landslides in Tokyo, Japan in November 2008.

International Programme on Landslides (IPL)

IPL aims to conduct and foster international cooperative research and capacity building on landslide risk mitigation, notably in developing countries. Protection of cultural and natural heritage will be addressed for the benefit of society and the environment.

IPL Membership is made up of those organizations that support the objectives of ICL intellectually, practically and financially. The activities of IPL include the following:

- Fundamental research on landslides
- Global data base and landslide hazard assessment
- Landslide risk mitigation
- Cultural and societal application
- Capacity building, communication and information

(icl.dpri.kyoto-u.ac.jp)

Insurance industry

Several major international insurance companies have significant involvement in natural and human-induced environmental hazards and disasters, and invest heavily in risk assessment, analysis and resilience. Notable amongst these are Swiss Re, Munich Re and Lloyds of London all of whom regularly publish valuable news alerts, fact files, analyses or data on fatalities, injuries, loss of, and damage to buildings, infrastructure and property (both insured and uninsured).

(www.swissre.com) (www.munichre.com) (www.lloyds.com)



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