Science and Technology for Disaster Risk Reduction: A review of application and coordination needs

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Executive summary

The task of managing disaster risks and disaster events is heavily dependent on scientific knowledge and evidence-based technique. The application of science and technology can substantially reduce losses of lives and property, as is illustrated by the following examples.

- In China, flooding in 1931 and 1959 caused millions of fatalities, but now with early warning and evacuation systems, as part of risk reduction policies, such great loss of life no longer occurs.
- In Bangladesh, a national flood warning system provides warnings up to 10 days ahead to millions of villagers, helping them defend against the regular flooding and preserve household assets. Studies indicate savings of about US$40 for every dollar invested.
- In The Netherlands, a long term US$3 billion programme “Room for the River“ is undertaking dozens of infrastructure projects to mitigate the likely impacts of climate change and to support development that reduces flood risks and negative environmental impacts.
- In the shared Caribbean island of Saint Martin (French) and Sint Maarten (Dutch), the damage from Hurricane Luis in 1995 was substantially less on the French side owing to better construction, particular through the checking processes of engineering “bureaux de contrôle.”
- In New Zealand, the severe 2011 Christchurch earthquake confirmed the benefits of national building codes and property insurance. But scientific knowledge on soil liquefaction had been neglected in planning laws, resulting in billions of dollars damage to houses and infrastructure.

This report is concerned with how disaster risks and losses can be further reduced through the greater use of science and technology - including the natural and social sciences and the applied fields such as environment, health, agriculture, water and engineering. Commissioned by the United Nations secretariat of the International Strategy for Disaster Reduction (ISDR), the report describes how science and technology is organised and how it contributes to disaster risk reduction. It reviews the importance of science and technology in the Hyogo Framework for Action, the world’s blueprint for action to reduce disaster risks, and it examines the opportunities and barriers to policymaker adoption of science and technology. Lastly, it makes proposals for how the ISDR can better promote and coordinate science and technology for disaster risk reduction.

The report is largely directed at policymakers, the partner agencies of the ISDR, and other organisations that generate or apply scientific and technical knowledge. It aims to help inform disaster risk reduction strategy for the era after 2015 when the Hyogo Framework for Action ends.

The way that people deal with the threat of disasters, including their use of science and technology, is fundamentally dependent on how they view disasters and risk. There are many different conceptual framings of the disaster problem, which has often led to confusion, crossed purposes and disagreement. For example, the rich and the poor experience disasters differently, and disaster risk will be viewed very differently, for example, by a land developer, a finance ministry official, an emergency manager, a hazard scientist, a community leader or a subsistence villager.

The conceptual basis for disaster risk reduction is undergoing significant change, partly as a result of scientific study. The common view of disasters as simply hazards or events is now challenged by the view that disaster risk is the outcome of both natural and human-influenced factors, with risk expressed in terms of potential losses of lives, assets or income. This is shaping new approaches to science and practice in disaster risk reduction, resilience building and climate change adaptation. Also, greater attention is being given to other sources of disaster risk, beyond natural hazards alone.

The social sciences have played a central role in developing new thinking on risk, vulnerability and poverty, the risk process and human roles in the accumulation of risk. The social sciences also provide core knowledge on risk perception, individual risk–related behaviour and decision-making processes. They are intimately engaged in integrated modelling of global processes of development, industrial transformation, urbanisation and other aspects of global change. Social science concepts and techniques are essential to risk management practice, especially in community settings.

Do policymakers readily endorse the use of science and technology for disaster risk reduction? This report argues that most people will readily accept scientific and technical information when it is understandable, relevant to the interests of those involved, and affordable. However there can be many barriers to uptake that need to be overcome, such as lack of political interest, conflicting views on priorities, inadequate institutional mechanisms, and lack of access to knowledge, technical capacity and funding. Developing countries can face major problems of access to information and resources along with handicaps to practical application such as policy and institutional shortcomings, scarce resources, lack of necessary data and limited capacities of vulnerable affected communities.

The task of making the case to policymakers for investing in disaster risk reduction is substantively dependent on the social sciences, not only for their insights into risk processes and impacts, but also for their inputs on politics, economics and administration and their specific contributions to the collection and analysis of disaster-related data. The 2010 World Bank report on the economics of disaster risk reduction, for example, in addition to considering cost-effectiveness questions, pointed out the importance of broader policy settings such as information availability, good functioning of markets, good public infrastructure, and effective public institutions.

Investment in disaster risk reduction requires evidence-based risk management methods. The methods should be well proven and backed by information on the scope of application, costs, implementation process, and expected reductions of risk or losses. Whether as policies or projects, they should be tailored to the specific risk problems faced by countries and communities, which arise from specific hazards and socio-economic circumstances. Generic arguments and examples of good practice have their place, but serious investment needs specific information, analysis and tools.

Climate change policy has overlapping concerns with disaster risk policy and offers considerable additional potential for leveraging and mainstreaming disaster risk reduction. The recently published Intergovernmental Panel on Climate Change special report on managing the risk of extreme events and disasters provides an important evidence base to this end. The climate change policy arena demands high scientific standards, and its acceptance and use of disaster risk reduction methods will require much more systematic and proven sets of data, methods and tools and much stronger scientific and technical support capacities than is the case at present.

Many natural and social sciences are very active in work related to disaster risk, particularly the geosciences and the applied fields of agriculture, environment, water management, health, planning, economics, construction, and emergency management. This provides a substantial base of expertise for supporting policy and practice in disaster risk reduction. By contrast, disaster risk reduction, as a coherent field of scientific enquiry of its own, is by contrast relatively new and small.

Science and technology activities are mostly undertaken by national publicly funded institutions, such as national research institutes, universities and government agencies. In some cases a national committee may coordinate activities related to disaster risk and provide advice on priorities and appropriate funding levels. National coordination is particularly valuable owing to the multi-sectoral, multidisciplinary nature of disaster risk and the need for extensive collaboration on disaster risk reduction policies and projects.

Science research and applied science have a strong international character, with international publications and peer reviewing, extensive sharing of data and results, foreign training, and much interaction among individual scientists. These processes are critical to shaping and achieving high quality research and to providing solid foundations for public policy and action, including for disaster risk reduction. They also contribute to the rapid dissemination and application of information.

International collaboration on science and technology, for research, data gathering and applications, is strongly supported through national academies of science and engineering, international associations of scientists, United Nations organisations, and various specialist organisations. There are international programmes on most hazards and their impacts, as well as a number of multi-disciplinary programmes on global change and other systems issues. A few are devoted solely to disaster risk reduction, such as the Integrated Research on Disaster Risk programme, the Integrated Risk Governance project, and the ISDR Global Assessment Report series.

Over the period 1990-1999, the United Nations International Decade for Natural Disaster Reduction (IDNDR) sought to galvanise international action to reduce the loss of life, property damage and social and economic disruption caused by natural disasters. The IDNDR was strongly supported by national scientific bodies and international geophysical science organisations, but its achievements were constrained by inadequate attention to the political and social aspects of disaster risk. This gap was a prime target of United Nations follow-up actions to establish the International Strategy for Disaster Reduction and to develop the Hyogo Framework for Action 2005-2015.

The Hyogo Framework for Action put a strong emphasis on political and social factors in disaster risk reduction and set expectations for the better integration of the political/social aspects and the scientific/technical aspects. However, this shift in emphasis has led to a neglect of science and technology in the implementation of the Framework and to inadequate stimulation and coordination of science and technology in the ISDR system.

The Mid-Term Review of the Hyogo Framework for Action has revealed unmet demands in countries for science and technology inputs, particularly for risk assessment, practical tools to address specific risks, ways to implement multi-hazard approaches, methods tailored to adaptation needs, economics-based evidence for advocacy purposes, and greater standardisation of methods. There is a desire for initiatives to reduce the barriers to science and technology access and transfer and to support the development of technical capacities in developing countries. These growing demands for practical methods are a natural evolution of advocacy efforts and raised awareness.

Science and technology are accelerants of progress. They create new insights and methods, solve old problems, and establish higher standards and better evidence-based policies. People trained in the sciences - both social and natural - are essential to good decision-making and cost-effective implementation. But science and technology progress does not happen by chance; it needs active leadership, support and coordination, at both national level and international level.

Expanded action on science and technology for disaster risk reduction should be made a key element of the post-2015 regime to follow the end of the Hyogo Framework for Action. There is good opportunity for leveraging and value creation far beyond the costs involved, as well as for improving outcomes and avoiding potential waste and confusion of efforts. These benefits will also accrue to related work in the development and climate change adaptation fields.

The ISDR system has a United Nations mandate to promote international efforts on science and technology for disaster risk reduction. Its institutional mechanisms should be strengthened to address systemic issues in the use or non-use of science and technology and to support agenda setting, coordination, standardization, validation, and information provision. The key strategy should be to mobilize action by existing scientific and technical organisations particularly through the Global Platform for Disaster Risk Reduction. Efforts should be directed to three areas: practical risk reduction, science and technology capability, and advocacy purposes. Specific tasks for each are proposed in the report.

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PART 1: THE ISSUE AT STAKE

1 Scoping the problem

1.1 Science and technology at the core of disaster risk reduction

The task of managing disaster risks and disaster events is necessarily dependent on scientific knowledge and evidence-based technique.

It would be impossible to deal with earthquakes, for example, without understanding where and how the Earth's crust moves and buckles and how different building materials and structures react to the shock waves that result. Earthquake resistant buildings depend on proven methods of design and construction.

Equally, it would be impossible to implement disaster risk reduction measures and achieve increased resilience of communities without knowledge of the social factors and cultural setting of the affected society and without use of social sciences concepts and tools.

The public generally expect their leaders to take steps to reduce the threat of disasters, through sound policies and investments. Neglect of scientific knowledge and technology can cause great loss of life, severe property losses and potentially far-reaching economic and political consequences. This was sadly shown in the overtopping of dykes and flooding of New Orleans in 2005 during Hurricane Katrina and in the crisis in Japan in 2011 when the Fukushima Daiichi nuclear power plant failed after the Tohoku earthquake and tsunami.

A growing concern for all countries and people is the increasing scale of disaster occurrence and disaster impact globally over the last fifty years. This trend has been revealed as a direct result of systematic scientific collection of disaster-related data.[i] Scientific studies such as the UNISDR Global Assessment Report[ii] show that the increase in disasters is largely a result of the growth of population and wealth, which puts more people and assets in harms way. Increases in relative exposure and vulnerability also play a part, for example from resort development along exposed shorelines and from pressures on the poor to settle in hazardous zones such as floodplains or unstable hill slopes.

Poverty, conflict, food insecurity, scarce water supplies, air pollution and industrial risks together exacerbate the risks of disaster. On top of this, climate change is already occurring and is likely to make matters worse, through more extreme conditions and greater vulnerability of populations.

Many countries have achieved sustained reductions in risk, for example through systematic risk assessments, land use controls, flood management schemes, building codes and their enforcement, hazard monitoring and warning systems, and public education. Drawing on long experience, the 2005 Hyogo Framework for Action[iii] set out a comprehensive guide for the key political and technical areas of action to reduce disaster risk. The efforts on its implementation to date have contributed to rising political awareness and commitment to disaster risk reduction.

However, the evidence worldwide points to continuing shortcomings in how disaster risk is recognized and managed in practice. Among the underlying causes is an inadequate appreciation of the potential of science and technology to cut risk and losses. Many fields of sciences and technology are important to understanding and reducing disaster risk, including the natural and social sciences and various applied sciences. A major challenge is to coordinate and integrate their potential inputs to produce the comprehensive knowledge and practical tools needed to routinely manage and reduce risks.

1.2 Examples of the power of science and technology

One of the great risk-reduction achievements of the last century has been the development of accurate early warning systems for hurricanes, tornadoes, thunderstorms, heavy rainfall, flooding, drought, snowfall, high winds and other extreme weather hazards. Based on years of public investment in scientific research and data gathering systems, sophisticated computer models can now replicate the physics of the atmosphere and its weather systems and the behaviour of water on the land. National meteorological and hydrological services routinely provide timely and detailed forecasts allowing organisations and individuals to better prepare and protect themselves.

When coupled with effective communication systems, well-informed and well-prepared populations and good leadership, these warning services can hugely reduce loss of life and property. Millions of people worldwide owe their lives to these advances. For example, whereas in China 3,700,000 lives were reported lost in floods in 1931, and 2,000,000 in 1959, now the figure is routinely less than 2000 per annum.[iv] China has implemented comprehensive national and regional "five-year" plans for disaster risk reduction based on scientific understanding of temporal and spatial variation of hazards and risk and including warning and evacuation systems.

In Bangladesh, a unique flood warning system has helped millions of villagers defend against the regular flooding that occurs across the Ganges–Brahmaputra delta.[v] Drawing on international high-tech rainfall predictions made up to 10 days in advance, the national Flood Forecast and Warning Centre prepares and distributes forecasts to district offices and other organisations. Networks of community leaders then disseminate information to villagers on expected flood levels along with advice on evacuation action and other responses, such as storing food and water, protecting household assets, and early harvesting. Recent studies have indicated that approximately US$40 was saved for every dollar invested in the forecasting and warning system and that the savings were US$400-500 per affected household (locally about one year's income).

Informed approaches to land use planning and management, and to construction and building codes, can target the root causes of risk, as is illustrated by the cases below.

The Netherlands, for example, is highly experienced in the use of dykes and other engineering structures to secure its low-lying farmlands and towns against the threat of flooding from rivers and the adjacent seas. However, in recent years there has been a realisation that thinking must shift away from relying on dykes alone toward a resilience approach that combines traditional engineering actions with other risk-reducing innovations, particularly controlled flooding of specific farmland areas for temporary floodwater storage.[vi] The country is now engaged in a decades-long US$3 billion program "Room for the River" that involves dozens of infrastructure projects to mitigate the likely impacts of climate change and to encourage development that reduces risk and environmental impacts.

Consider the case of Hurricane Luis, which in September 1995 passed 50 km to the northeast of the shared Caribbean island of Saint Martin (northern part is French) and Sint Maarten (southern part is Dutch) causing considerable damage. It was found that the damage in Sint Maarten – described as catastrophic with losses about twice the GDP - was significantly more than in Saint Martin, despite Sint Maarten being further from the eye of the storm. Consultations at the time concluded that the difference was probably largely due to superior approaches to construction on the French side, including (i) better attention to conceptual design, (ii) greater consistency and uniformity of standards of design for earthquakes and hurricanes, and (iii) the involvement of respected "bureaux de contrôle" - independent private firms licensed by the state that check the designs, make site visits during construction and provide certification for insurers and lending agencies.[vii] This is a good example of how science, engineering, public administration and the private sector can achieve synergies to substantially reduce disaster risks and losses.

In New Zealand, the severe Christchurch earthquake of 22 February 2011 resulted in 185 deaths and economic losses of about US$18 billion. Once again there were many lessons on the importance of proactive science-based risk reduction. Most of the deaths occurred through the collapse of three multi-storey buildings of relatively modern construction, through faults in design, permitting and construction.[viii] Although many old brick buildings collapsed, most buildings were sufficiently intact to allow people to escape largely unharmed, demonstrating the general value of the country's approach to building safety. This was despite the fact the earthquake greatly exceeded the seismic reference level of the building code. Another positive lesson was the benefit of the mandatory natural hazards component of property insurance, which is now contributing about 80% of the recovery costs, a very high proportion by world standards.[ix] A costly lesson, however, was the failure to apply available scientific knowledge of liquefaction risk to the city's planning laws. Extensive liquefaction of soils across the city resulted in substantial structural damage to buildings and housing and was a primary source of the large economic losses.

1.3 Opportunities for policymaker action

What do policymakers need to know, and do, about the use of science and technology for disaster risk reduction? The examples above provide some clues, and they certainly demonstrate there are potential opportunities with high payoffs. The Hyogo Framework for Action and the national reports on progress on its implementation[x] provide further insight and guidance.

The starting point for any country is a clear understanding of its risks and past experience of losses, and how they are changing. Which hazards are most prominent? Which parts of the country are affected? Which groups in society suffer most? Answers to these questions require systematic research and assessments, drawing on scientific knowledge concerning the hazards and the exposure and vulnerabilities of populations and assets. This in turn requires the availability of scientific and technical institutions and professional cadres knowledgeable in these topics.

Then, with a clearer idea of what is at stake, consideration can be given to potential options for action, weighing up the relative costs and benefits of each option and deciding on the priorities. Specific solutions may need a blend of actions, such as infrastructure investment, public information, changes in laws or regulation, new economic or social policies, and sector-specific programmes.

Disaster risk and its reduction is a crosscutting issue that spans national and local government, key sectors such as agriculture, health and industry, specialist agencies such as emergency management and meteorology, and diverse natural and social sciences. While scientists and engineers often take a lead on disaster risk matters, experience shows that a problem-solving approach that involves a range of experts and lay people is often best, for example including administrators, planners, community leaders, and representatives of key sectors, government agencies and the private sector.

The policymaker can provide critical leadership by keeping the focus on the priority risks and on the target of measurable reductions of risk. He or she should promote political recognition, ensure that the institutional ownership of the problem is clear and accountable, demand cooperation between sectors and between government departments, and support the budgets for the necessary technical capacities. Large investments may be involved, particularly if infrastructure, urban development and national social support policies are involved.

Less glamorous perhaps is the need to invest in underlying technical capacities - education, research, standardisation, testing and validation, training, and international cooperation. Also, promoting public education and awareness of the potential and practice of science and technology will over time encourage all parts of society to access and apply available scientific knowledge and technique.

1.4 Origin, purpose and scope of report

This report does not deal with specific questions of science and technology but instead with the questions of how science and technology can be more effectively used to reduce disaster risk in countries and communities and how to capitalise on the United Nations and its International Strategy for Disaster Reduction (ISDR)[xi] system to better support that objective. It is written largely for policymakers and partner agencies of the ISDR system, and other organisations that generate or apply scientific and technical knowledge.

The United Nations has long recognised that disaster risk is a common concern requiring international action. To this end, it initiated the 1990-1999 International Decade for Natural Disaster Reduction (IDNDR)[xii] and thereafter in 2000 it established the International Strategy for Disaster Reduction. This led to the development of the Hyogo Framework for Action and its adoption by countries in 2005 as a blueprint for comprehensive action over the period 2005-2015.[xiii] These initiatives have contributed to progress on disaster risk reduction by stimulating science and technology applications and increasing the awareness and participation of political and social actors.

A Mid-Term Review of progress on implementing the Hyogo Framework for Action was completed in 2011[xiv] and now a consultative process is underway to consider what sort of international regime for disaster risk reduction should follow the end of the Framework in 2015.[xv] The present report was commissioned by the ISDR secretariat to help inform this process. The report's terms of reference are listed in Annex 1.

In this first Part of the report, the scene is set with the basic rationale for the report and some examples of effective use of science and technology in disaster risk reduction. The diverse frames of reference for addressing the problem are then reviewed, and four key questions regarding policymaker perspectives on the use of science and technology are considered.

In Part 2 of the report a description is given of the "business" of science and technology for disaster risk reduction and its operation at national and international levels. This includes an examination of how the United Nations and ISDR system has fostered and coordinated science and technology in the past. Consideration is given to institutional options to better address the growing demands of countries in this respect.

Part 3 of the report contains conclusions and recommendations.

2. Clarifying the framing of disaster risk

2.1 Multiple and evolving frames of reference

The way that people deal with the threat of disaster is fundamentally dependent on how they view the issue, on how they frame the problem. Unfortunately the commonly used frames of reference differ significantly and are not always explicit or clear. This can often lead to confusion, crossed purposes and disagreement. The use of science and technology is not immune to these difficulties. For example, scientific approaches often assume a rationality that may be valid only in a narrow sense and may not resonate with the different frames of reference of other groups involved.

The social sciences have clearly demonstrated the importance of culture and context in human belief and behaviour and the significance of different frames of reference when dealing with environmental problems. The perception and ongoing experience of disasters and disaster risk by different societies and groups are both shaped by, and reshape, their accepted frames of reference.

For individuals the framing of disaster risk can vary widely depending on interests and perspectives, and certainly it will look very different, for example, to a land developer, a finance ministry official, an emergency manager, a hazard scientist, a community leader or a villager. An appreciation of these different perspectives is essential to the successful application of scientific and technological approaches.

The conventionally held frame of reference for disasters has changed significantly over time, largely as a result of scientific developments[xvi], with three main stages apparent, as follows.

The earliest beliefs held that disasters were unpredictable events, Acts of God comprehensible only as punishment for wrongdoing. This is still a theme for some people, even in technically advanced societies. Next, the emergence of the scientific and engineering age of the past two centuries led to an understanding of natural hazards along with many effective means to predict their impacts and protect societies and people. This knowledge remains a fundamental basis for risk reduction. Lastly, the current era recognises disasters as the result of a "risk process" rather than simply as "events", where human agency and social processes create (and reduce) disaster risk.

Care is needed with terminology[xvii] in this field. In particular, the expression "disaster risk" may be used in two distinct ways, (a) in probability terms, as the chance of an adverse event occurring, or (b) in impact terms, as the measurable negative outcome of physical and socio-economic processes. Both meanings serve a useful purpose, depending on the context.

Also, a distinction should be made between the terms "disaster risk reduction" and "disaster risk management". Disaster risk reduction expresses a desirable social and political policy goal, whereas disaster risk management comprises the practices needed to identify, assess and treat or avoid disaster risk. The goal of disaster risk reduction can be achieved through the development and application of disaster risk management techniques. Some countries prefer to formulate their national programmes on disaster risk in terms of disaster risk management, with risk reduction regarded as one component of this task.

None of the different frames of reference described here need be considered preeminent; rather it is a matter of recognising that such framings exist and that science and policymaking cannot be indifferent to their assumptions, advantages and shortcomings.

2.2 The hazard/event perspective

It is not surprising that disaster risk is usually framed in terms of hazards and events; the unexpected earthquake, the prolonged drought, the flash flood, or the bitter storms that occur in winter. The advantage of this framing is the highly particular nature of each type of hazard event and its impacts, and of the ways to defend against them. For each hazard there is a well-established basis of science and associated techniques and institutional capacities. Building engineers can tell precisely what size of steel bolt is required to keep the roof on in a winter storm; while water managers will be able to advise on water conservation during the spring drought.

Although very common, the hazard/event frame of reference has been widely criticised for failing to address the human factors that put assets and people at risk, such as poverty, unplanned land use decisions and poor construction. Without humans and their assets, a hazard is of no consequence.

Framing disasters as events is the norm for disaster and emergency managers, since their main task is to respond to crises when required. In most countries there are recognised institutions for managing disasters and emergencies, and in some cases they also may have responsibility for disaster risk reduction. Disasters as events usually have a clear beginning and require rapid action for rescue, medical treatment, evacuation, maintenance of law and order, and provision of services such as food, sanitation and temporary housing. This requires preparation, practiced command and control structures, specific resources, and many trained personnel. Preparedness and effective response measures reduce the overall losses in events (and therefore help reduce the magnitude of disaster risk). They are important topics for scientific research and technology application.

2.3 Technical versus social orientation

Technical approaches based on the natural sciences and technologies often bring a perspective and framing that is supply-driven, expert-led and resource demanding. This can be entirely suitable for some situations, but it may not match the expectations of key actors, for example a community that does not trust outside experts or lacks the resources to sustain a proposed technical option. In such cases the adoption of a new option may prove difficult. It is here that social sciences play a key part.

Hazard early warning systems provide a good illustration of the potential limitations of a solely technical framing.[xviii] The conventional view of early warning systems is that of a science-based monitoring and warning service that starts with geophysical observational data and proceeds linearly through modelling and analysis to the generation of a warning product that is disseminated to users who then act upon it. This top-down view assumes that the warning information actually reaches the thousands or millions of people who need it, is understandable and relevant to them, and provides a basis for appropriate action. Often this is not the case. Furthermore, recipients are unlikely to act on the warning alone. A farmer, for example, before deciding a course of action, is likely to check other sources of information, to seek a consensus of view with neighbours, colleagues and family, and to weigh up many other factors such as crop and animal health, produce prices, financial buffers, available family labour, etc.

2.4 Disaster risk as a process

Recent thinking in the disaster risk community has moved beyond the common focus on events and hazards to the idea of disaster risk as a process, whereby multiple causative and influencing factors interact with distributions of population, assets and livelihoods to generate the outcomes of actual or potential loss, and where risk accumulates principally through human agency. This is consistent with the longstanding approaches to risk management used in business.

The framing of risk as an outcome of spatially varying human-influenced factors and its expression in terms of losses of lives, assets or income, is highly informative to current research and thinking on disasters. It blends naturally with systems approaches and the idea of resilience. It provides strong insights and guidance on policy and management and it underpins the concept of “risk governance”.

For example, there are documented cases where the economic development of a valley city has led to the rapid development of housing on unstable nearby slopes that are prone to landslides. This has led to a significant accumulation of risk and the frequent occurrence of destructive and costly events. Knowledge of these risk processes can suggest solutions, such as altering policies and practices for industrial development, land use, housing and public transportation.

2.5 Framing by rich and poor

Different population groups do not experience disaster risk and disaster losses equally. Indeed, there may be externalities, where the actions of one group (often elite) are the primary source of losses to another group (often marginalised). The rich and the poor have different exposures, vulnerabilities and capacities for action, which inevitably results in different framings of disaster risk.

Citizens of very poor countries and marginalised communities are substantially more exposed to and vulnerable to natural hazards than other groups, yet often they will not have the knowledge, capabilities or public services needed to reduce the risks and protect themselves. In these circumstances, development experts and practitioners often regard disaster risk reduction as a useful development tool, to reduce the destruction of precious wealth-creating assets and help support economic independence. In turn these bring benefits of more sustainable growth and the reduction of poverty. In this framing, disaster risk reduction can be seen as a core means to improve resilience of communities and countries and to adapt to climate change.

By contrast the citizens of rich countries are very unlikely to face loss of life in a disaster, owing to existing policies and management for life-threatening risks (notwithstanding failures from time to time, such as in Hurricane Katrina). However, they may face significant financial losses. The bulk of the reported global financial losses and insured losses from disasters occur in OECD countries. More wealth means more assets at risk. Individual financial losses can be substantially reduced or transferred through mechanisms such as private insurance and government-sponsored loss compensation schemes, though in neither case are the underlying sources of risk reduced.

Rich countries generally take pride in their scientific and technological capabilities. They expect these capabilities to be developed and applied to protect the civil population and will hold public officials to account if failures occur. In a recent extreme case, several seismologists were found guilty of neglect and sentenced to six-year prison terms in respect to perceived inadequacies of warnings of the severe earthquake in L'Aquila, Italy, in April 2009. Among other things, this illustrates a marked difference between the legal and scientific framings of disaster risk.

2.6 Expanding dimensions of disaster risk

Disasters are popularly framed in the limited terms of "natural disasters", those arising from the natural geophysical hazards of floods, droughts, storms, landslides, volcanic eruption, earthquakes, tsunami and wildland fire. These are the events commonly seen in the media. A broader expression is used in the United Nations documents on the ISDR, namely "natural and related environmental and technological disasters", which includes other circumstances such as pest outbreaks, epidemics, and industrial accidents arising from natural hazards.

Health impacts associated with such natural disasters may be significant and are typically managed by the health sector as an integral part of emergency services and recovery efforts. However, epidemics not related to geophysical hazards, such as influenza outbreaks, have an ambiguous place in the United Nations framing, as the tasks of epidemic risk management and risk reduction are rather different to those for natural hazards and are usually managed directly by the public health and medical sector.

Nevertheless, even this wider view of disasters that incorporates health-related, environmental and technological hazards may be considered an arbitrary restriction, since countries face many other risk factors which can lead to large scale losses, such as biosecurity threats, industrial vulnerability, trade or financial actions, cyber threats, terrorism, and conflict.

Recognising this, some countries, for example Australia, take an all-risks, security-based approach that integrates disaster risk issues with other risks. Security as a concept is often preoccupied with terrorism and military action, but if viewed more broadly as human security it provides a good rubric for the work of disaster risk reduction. From a policy perspective there can be synergies in how different types of risk need to be dealt with. The lessons in managing other types of risk may be useful for disaster risk reduction, and possibly vice versa.

Global environmental change is also expanding the nature of risks. In particular, climate change is shaping a major new dimension and frame of reference for disaster risk, through likely increases in hazards such as drought, extreme rainfall and sea level rise, coupled with likely increases in vulnerability of many groups, particularly in dry zones, steep land, river plains and coastal zones. It is also putting a spotlight on existing processes of disaster risk and the role of disaster risk reduction. There is unprecedented pressure on the science community to develop new and comprehensive knowledge and information for policy purposes and practical action on climate change.

The ideas of global change, the risk process and security lead naturally to consideration of complex systems and cascading and magnifying risk in organised societies, where vulnerabilities exist because of the highly interactive and optimised systems of our globalised technological world. This applies particularly in information management, energy systems and product distribution. An often-cited example is the progressive loss of electricity to tens of million people in several north-eastern states of the United States and Ontario Canada in August 2003 as a result of initially small technical failures. A much larger failure occurred in India on July 2012, when 600 million people in nineteen states found themselves without power, in some cases for several days.

But perhaps the greatest fears were raised by the cascading interactions and long term consequences of Japan's March 2011 Tohoku earthquake and tsunami, which included power outages, radioactive pollution, closure of nuclear plants, activation of polluting fossil fuel generation plants, and disruption of global industrial supply chains.

Global change and complex systems are highly relevant to disaster risk and its reduction and will be increasingly important topics for science and technology and for risk reduction policy in future.

3. Selected topics on barriers and opportunities

3.1 Topics examined

The present report is motivated by a desire to better promote policymaker use of science-based disaster risk reduction in national programmes and investments. The Terms of Reference requested the consultant to examine three key questions regarding the application of science in disaster risk reduction, namely: (a) whether policymakers and the disaster risk reduction community readily accept scientific and technical information; (b) the nature of the social sciences contributions to driving demand for disaster risk reduction; and (c) how best to use social sciences to help make the political and economic case for investment in disaster risk reduction.

To these topics the consultant has added a fourth section on climate change policy and its relevance to disaster risk reduction.

3.2 Acceptance and use of science and technology

It is argued here that policymakers and the disaster risk reduction community will readily accept scientific and technical information when it is understandable, relevant to the interests of those involved, and affordable. Most governments recognise, in principle at least, that the use of science and technology and evidence-based policy is a sound way to achieve cost-effective delivery of social and economic goals, and is a mark of good government. However, achieving this in practice can be difficult where political processes and decision-making are strongly influenced by interest groups that do not share these values and priorities.

Other barriers to the use of science and technology for disaster risk reduction include lack of political and public awareness, inadequate institutional mechanisms and technical capacities, and an absence of reliable sustained funding. Technical shortcomings in respect to knowledge availability, standardisation and validation of competing methods, and insufficient input data for particular technical methods also set constraints on uptake and operational application. Developing countries face particular difficulties in these respects (see also section 4.4).

Much depends on the particular circumstances and the actors involved. For example, a remote sensing method that provides simple visual maps of landslide risk will be welcomed by land use planners and community risk activists, but may not be so attractive to some managers if the costs involved - financial or political - are deemed to be high.

Also, it may be very difficult to apply scientific and technically sound methods in situations of chronic or extensive risk if this requires large-scale dislocation of communities, high input of public funds, or appropriation of private assets. The need to seismically strengthen the building stock of whole cities that are vulnerable to earthquakes is a case in point.

Institutional barriers include the competition and lack of communication that is common between sectors and between departments of state, and the relatively low position that offices for science and technology and for disaster risk reduction often have in government departmental rankings. Centres of expertise outside government may be isolated from policy processes and decision-making. Modest institutional interventions can help address these problems, such as establishing national committees or platforms on disaster risk reduction that include participation of national scientific and technical bodies and that report to high levels of government.

Lack of knowledge, understanding and expertise is a common barrier to uptake by non-experts. Some scientific and technical information is intrinsically difficult to understand, such as probabilistic El Niño forecasts, or the economics of uncertain disaster risk. Continual efforts to explain and communicate are essential, along with efforts to link and shape new ideas and information to the need of decision makers. Intermediaries such as extension workers, consultants, teachers, local scientists, applications specialists, development practitioners and journalists can play a crucial role in bridging the gaps between expert and practitioner.

The challenge in converting science and new technology into usable techniques and practice is an important task. This involves not only the well-studied issues of communicating science and transferring technology, but also subtle questions of world views and frames of reference, risk perceptions, political ecology and social structure, and public accountability (for action or inaction). There are also difficult technical issues specific to disaster risk reduction to consider, such as how to deal with rare but very high impact events and making decisions and choices in the context of the great uncertainties inherent in potential disaster loss.

It is normal for the creation of a new scientific idea or technology to be followed by a long period of testing, validation, demonstration, communication and outreach, operationalisation and sometimes commercialisation. The Global Risk Identification Programme (GRIP)[xix], a project that supports countries to develop disaster risk identification and analysis capabilities, provides a good example of this process at work. Partnerships involving scientists, sector experts, policy advisers, decision makers and representatives of affected groups are recognised as effective for designing and implementing new science-based initiatives.

Oversight and coordination mechanisms can significantly accelerate the use of science and technology for disaster risk reduction by removing key barriers to their adoption. At national levels, important tasks include systematically identifying needs and capacities for science and technology, promoting cooperation among agencies, developing inventories and toolkits, and disseminating information and good practice.

At the international level, the ISDR system can undertake similar activities to support national actors. Tasks include mapping the requirements for science and technology, advocating for greater use of science and technology, and promoting processes for international validation, standardisation and dissemination of suitable methods and good practice. Systemic global problems such as database inadequacies and science capacity shortcomings also need to be addressed.

3.3 Contributions of social sciences

The second question posed for the report requested a consideration of "*the contributions of the social sciences to the growing political commitment and social demand for disaster risk reduction since the implementation of the Hyogo Framework for Action in 2005.*" This is no easy task, owing to the enormous range of social science subject areas, study contexts and researcher perspectives. Nevertheless a number of observations are possible concerning areas where the social sciences are key sources of progress.

Social sciences can and should play a central role in the framing of research issues and the formulation of risk reduction strategies, as well as to the conduct of particular research projects. One of the most important contributions in this respect has been the influential work on risk, vulnerability and poverty and their interconnections. The development of ideas of risk as a process and the delineation of human action in the accumulation of risk were instrumental in the conceptual development from the IDNDR to the Hyogo Framework for Action. This reframing of disaster risk is driving new themes in research, practice and risk governance.

Recent work has elaborated finer grained knowledge on local processes of vulnerability and loss, for example in respect to gender, age, entitlement, etc, and as a function of rural change and urban development. The social sciences have also demonstrated the importance of local communities for effective social and environmental action and the potential for community-based action on disaster risk reduction. Social sciences are central contributors to action research and learning projects.

How people perceive and respond to risk information and warnings, in particular concerning low frequency but high impact risks, has long been a topic of behavioural science research. This work continues to inform the development of better means to communicate risk and warning information and to motivate public preparedness and practical risk management action.

Social sciences provide fundamental inputs to the description and integrated modelling of global processes of development, including industrial transformation, urbanisation, environmental loss and other aspects of global change. Rapid advances are occurring in understanding and tool building, including elaborate computer-based earth systems models. In this field, the interdisciplinary International Human Dimensions Programme[xx] (IHDP) aims to generate innovative social science research to inform and improve societal responses to global environmental change.

One of the IHDP programmes, Vulnerability, Resilience and Adaptation, addresses the question: *As increasing risks to health, welfare and safety are distributed very unevenly, how do different human societies cope with and adapt to external stresses and disturbances?* One of its core projects, the Integrated Risk Governance project[xxi], aims to identify risk formation mechanisms and new paradigms in risk governance, especially for new risks that exceed current coping capacity of the highly inter-connected "socio-ecological system." These programmes bring together international alliances of social scientists, natural scientists, economists and engineers.

The Integrated Research on Disaster Risk (IRDR) programme,[xxii] is devoted entirely to disaster risk. It stresses an integrated approach – across hazards, disciplines and scales and seeks a close coupling of the natural, socio-economic, health and engineering sciences. Social scientists are leading its work on the characterization of vulnerability and risk and understanding decision-making in complex and changing risk contexts. A new sub programme has been initiated to undertake the first systematic and critical global assessment of integrated research on disaster risk (the AIRDR project).

Research on global climate change scenarios and climate change response pathways is highly dependent on the social science expertise concerning the evolution of societies and economies and individual perspectives and choices on current and future risks.

Groups within the fields of health, development and insurance are prominent in the operation of the main databases on disaster risks and are active in the summary and analysis of disaster occurrence and losses. The resulting information is fundamental to understanding the risk process and to supporting advocacy and investment in disaster reduction. The data sets support the development of risk modelling and risk transfer tools and products, particularly insurance, and provide a primary basis for researching the economics of disasters and disaster risk management.

Many other social science topics are very relevant to disaster risk reduction, and can contribute to its advancement, such as the processes of institutional development and change, policy formation and implementation, technology transfer, and environmental economics. Social sciences can play important roles in supporting internal development and evaluation in risk-related organisations.

The World Social Science Report 2010[xxiii] published by the International Social Sciences Council provides a comprehensive review of the organisation and production of social sciences in general. It examines the issues that affect their contributions, such as inequalities in capacity across regions and countries, divides and bridges between disciplines, trends in social science themes, methods and disciplines, and the relationship between social scientists, policy-makers and society. The scientific focus of the next 2013 report in this series will be “the changing global environment”.

It is important to recognise that although the social sciences are very influential internationally in disaster risk reduction, they are not structured, resourced and coordinated in the way the natural sciences and related applied fields are. In many cases they comprise very small capacities at national levels (perhaps with the exception of economics). This can set limitations on the proper contribution of social sciences to particular risk reduction policies and initiatives.

At the same time, expert social science capacities are increasingly being used within applied and sector-specific science fields such as environment, rural development, agriculture and health. In this role they can inform and leverage substantial sector capacities and efforts on disaster risk reduction.

3.4 Making the case for investing in disaster risk reduction

The third question referred in the terms of reference addresses “*the strengths and weaknesses of existing knowledge and approaches generated in the social sciences for making the political and economic case of investment in disaster risk reduction*.” Making this case is a recognised priority for the ISDR system and the risk reduction community generally, particularly given the Hyogo Framework’s emphasis on overcoming lack of political understanding and commitment.

The Hyogo Framework states that: “*The promotion of a culture of prevention, including through the mobilization of adequate resources for disaster risk reduction, is an investment for the future with substantial returns.”* (paragraph 13(i)). The evidence available at the time indicates that this is a plausible assertion, though the range of studies was, and is still, rather limited. In 2007, partly inspired by the success of the Stern Report on climate change economics, the UNISDR initiated plans for a major cooperative study on the economic costs and benefits of disaster risk reduction. The task was subsequently undertaken by the World Bank and published in 2010 as the landmark report “*Natural Hazards, UnNatural Disasters; The Economics of Effective Prevention”.*[xxiv]

The World Bank report considers not just the cost-effectiveness of specific risk reduction actions but also the role of broader policy settings. In particular it emphasises the importance of information availability, the functioning of markets, the role of public infrastructure and the effectiveness of public institutions, and suggests that relatively inexpensive interventions in these areas could lead to substantial reductions in risk. The report is summarised by means of a hypothetical Memorandum to a Concerned Finance Minister, which among other comments notes that "*Prevention pays, but you do not always have to pay more for prevention.*"

Advocacy for investment in disaster risk reduction needs to blend three key motivators: the basic data on disaster occurrence and losses (to establish the scale of the problem); the narrative on risk, vulnerability, poverty and development (to invoke insight and emotional awareness); and the economics of disasters and risk reduction measures (to provide the rationales and options for action). The social sciences are already well placed and able to support thinking and information generation for each of the three motivators.

However, the major weakness at present, however, is that the available information is often quite general and insufficiently detailed for specific action by policymakers in particular countries and settings. For example, statements by UNISDR tend to emphasise the first two elements of the blend, which establish the importance of the problem, but then refer only to strategic responses of the sort noted in the Hyogo Framework for Action, such as decentralization of roles and responsibilities, allocation of budgets, building capacities, and the virtues of inclusivity, accountability and transparency.

Strategy is important of course, but what is needed now, eight years into the Hyogo Framework for Action decade, is an expanded suite of practical investment options supported by well-documented examples and quantitative assessments of the costs involved and likely reduction of losses.

Advocacy should make more use of the evidence and ideas of disaster risk economics, including those in the World Bank report described above. The focus of the discussion needs to migrate from concept to practice, from understanding to engineering, and from problem to solution. This is a challenge for the whole scientific and technical community, not just for the social science community. It will require much more systematic and coordinated action to gather and analyse methods and practice than has been the case to date.

3.5 Disaster risk reduction and the climate change policy process

The climate change policy process offers important opportunities and lessons for disaster risk reduction. Of course, there are many differences between the two areas of policy, but there are also important overlaps of concern, particularly with respect to risk and development and the interaction between scientific/technical factors and political/social factors.

A central feature of climate change policy is its overt and high dependence on scientific information, not just on the state of the climate, but also on relevant economic and environmental factors such as sources of greenhouse gas emissions and the state of land and forest management. Parties to the UN Framework Convention on Climate Change[xxv] (UNFCCC) demand high quality data, information and evidence, including through systematic research and observations and notably the work of the Intergovernmental Panel on Climate Change (IPCC). At the outset, the Convention established two subsidiary bodies to support the work of the Parties to the Convention, one being the Subsidiary Body on Scientific and Technical Advice, whose role was to deal with methodological issues and to function as a link between the scientific, technical and technological assessments of information provided by international bodies and the policy-oriented needs of the Conference of the Parties.

UNFCCC Parties are increasingly aware of disaster risk reduction and its relevance to the objectives of the Convention, partly through the many years of advocacy efforts of the UNISDR and its partner organisations. The UNFCCC and UNISDR secretariats cooperate closely to assist governments with practical information to assist adaptation.

It is widely assumed that the higher political profile and significant resources associated with climate change policy will provide great potential for leveraging and mainstreaming action to reduce disaster risks. However, serious moves in this direction will require the disaster risk reduction community to provide much more systematic and proven sets of data, methods and tools and much stronger scientific and technical support capacities than is the case at present.

This point is strongly underlined by the IPCC Special Report on Managing the Risk of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)[xxvi]. Although the report arose from the initiative and lobbying of the UNISDR secretariat and was highly informed by disaster risk reduction experts, its scientific quality and stature with governments arise primarily from the discipline and rigour of the IPCC scientific assessment processes.

The IPCC Special Report is a particularly valuable resource of evidence for disaster risk reduction action. It contains a comprehensive assessment of knowledge on climate extremes, the nature and sources of risks, and the means for managing them and achieving a sustainable and resilient future. Its conclusions note that risk management measures that provide benefits under current conditions can be starting points for addressing projected trends in exposure, vulnerability and climate extremes, and that effective risk management generally involves a portfolio of actions to reduce and transfer risk and respond to events. A set of summaries and guides to the Special Report, addressing different regions and sectors, has been produced for policymakers and practitioners[xxvii].

PART 2: THE INSTITUTIONS

4. Science and technology and their organisation

4.1 Diverse scientific foundations

Disaster risk reduction involves many sciences and technologies, particularly those concerning hazards and human behaviour, and including the natural, social and applied sciences, and relevant technologies and techniques.

For hazards, the relevant applied sciences are geology, seismology, volcanology, meteorology, hydrology, oceanography, ecology, geography, medicine and engineering. For human and socio-economic processes, the relevant social sciences (or topics, as some do not consider themselves as sciences) are psychology, sociology, anthropology, cultural studies, organisational behaviour, communication, ethics, political science, law and economics. The natural and social sciences together feed the integrative applied fields such as environmental sciences, health sciences, building science and architecture, development studies, risk management, business and finance, information science, geospatial science, natural resources, agriculture and water sciences, coastal management, rural and urban planning, systems analysis, public administration, policy studies and management.

With such diversity of scientific roots, and as a relatively new concept, disaster risk reduction cannot yet claim to be a strong and coherent field of science. Over time, however, it is likely to grow, in terms of research centres dedicated to the subject, systematic research and teaching programmes, cadres of academics committed to the topic, bodies of structured knowledge in expert reviews and textbooks, and regular workshops and conferences. In this respect, disaster risk reduction can be compared with the case of environmental science fifty years ago when it began the struggle to create the systematic realm of knowledge that is recognised today.

Disaster risk reduction has few if any unique technologies and techniques, but it is heavily dependent on a wide range of technology capabilities, such as computer databases and modelling tools, remote sensing and monitoring systems, hazard warning and communication systems, geographical information systems, water management techniques, civil engineering design standards, risk analysis, financial risk transfer tools, cost-benefit analysis, social survey tools, and community participation methods.

4.2 The role of scientists

Scientists and scientific institutes often are highly motivated by the potential of their knowledge and actively promote action to reduce risks, both within government and in the public arena. Development academics for example have played a key role in the emergence of thinking on disaster risk as a process that disproportionately affects the poor and on the character of interventions needed to build resilience to natural hazards. The influence and leverage of a few people with new insights or new tools can be enormous.

At times of major disaster events, scientists are often prominent in communicating warnings and advice and providing information and explanations to the public and to government leaders. After the devastating 2004 Indian Ocean tsunami disaster, seismologists and tsunami experts were very active in the development of the now-operational regional Indian Ocean tsunami warning system. In fact in the years before the event, experts had warned of the great risk of earthquakes on the undersea faults west of Sumatra and had unsuccessfully lobbied for the development of a tsunami warning system similar to that operating for the Pacific Ocean.

4.3 National science institutions

Relatively few scientific institutions are solely concerned with disaster risk, but thousands are active in sciences that are relevant to disaster risk. Science institutions principally operate within the national context but also actively engage in international cooperation and contribute to and draw upon the major international institutions and programmes.

Most countries allocate public funds to support scientific academies, universities and research institutes, along with in-house specialist research groups in government departments such as for defence, agriculture, forestry, environment, health, social welfare, energy and transportation. Agencies that provide operational services for meteorology, hydrology, oceanography, geology, etc are also supported. National research goals and priorities are usually set or guided by governments while the disbursement of funds is often managed by dedicated funding bodies that operate competitive bidding processes and monitor research output performance.

Research programmes typically include a strong orientation to the particular circumstances and needs of the country but they also endeavour to maintain standing with similar scientific efforts in other countries. The commonly experienced hazards are normally recognised in the national strategies, funding priorities and research programmes, but integrated disaster risk reduction and complex or future risks often lack of sponsorship by a leading constituency in the scientific agencies or government departments and may not be well addressed.

National academies of science and national scientific societies play overseeing roles in advising government, undertaking reviews and assessments, guiding science agendas, stimulating debate, and supporting professional development and quality standards. Specialist bodies and associations often exist for different sectors of the economy and particular fields of work, for example meteorology or risk management. These bodies and associations also have coordinating roles and serve to link scientists of like interest together with applications specialists, practitioners and interested client groups. Such national mechanisms offer valuable potential support for the pursuit of disaster risk reduction.

The private sector is engaged in providing technology for implementing research, such as advanced instrumentation, communication systems and information processing and also may be directly engaged in undertaking research. Private consultants often provide advice on specialist topics.

National coordination of disaster risk reduction is particularly important because of the multi-sectoral, multidisciplinary nature of disaster risk and need for the cross-disciplinary collaboration on disaster risk reduction projects. Lack of coordination can result in gaps in coverage of risks and “silo” effects if (as is often the case) organisations are obliged to promote and concentrate on their own particular disciplinary or sector mandates.

Coordination mechanisms such as national platforms for hazards mitigation or disaster risk reduction[xxviii] should have, and often do have, strong engagement of scientific and technological institutions and experts.

A well-developed example of national coordination is that of the United States’ Subcommittee on Disaster Reduction, a Federal interagency body of the U.S. National Science and Technology Council under the Committee on Environment, Natural Resources and Sustainability. The Subcommittee provides the Federal forum for information sharing, development of collaborative opportunities and formulation of science- and technology-based guidance for policy makers, and for dialogue with the United States policy community. Members comprise eleven government departments and ten other technical and administrative bodies, including the National Science Foundation. It has developed a ten-year national strategy document, Grand Challenges for Disaster Reduction[xxix], for prioritizing Federal investments in science and technology to reduce disaster risks and promote resilient communities. It has followed this with a series of complementary, hazard-specific implementation plans for Federal agency action in collaboration with other organizations.

In Great Britain, the Government Office for Science has just completed an extensive "Foresight" review on "Reducing the risk of future disasters" which sets out directions for different actors including the science community.[xxx]

4.4 Developing country capacities

The scope of national scientific effort partly depends on the relative wealth of the country, and for this reason, developing countries often have difficulty to maintain well functioning tertiary institutes and science research programmes and may struggle to provide even basic levels of operational and educational capabilities.

A senior African scientist has identified a number of reasons why developing countries in Africa and elsewhere lag behind in the application of science and technology in disaster risk reduction.[xxxi]

- A lack of relevant policies and institutional frameworks for science and technology.
- Limited resources for funding research and science and technology, by all institutions and at all levels.
- The high cost of some science and technology systems, which inhibits accessibility and effective application.
- The lack of data and observations required for baseline statistics on hazards, exposure and vulnerability and the lack of projections of future scenarios, especially at local levels.
- A lack of multi-disciplinary approaches in science and technology applications that can link disaster risk reduction, climate change responses and sustainable development.
- The limited capacity of vulnerable communities and countries to use available science and technology products owing to lack of education, illiteracy and inability to speak the language of technical communication (e.g. English or French in Africa).

At the same time, there are many successful institutions and initiatives in developing countries that can provide good models for the future. Regional collaboration, for example in meteorology and climate, is an effective way to efficiently build capacity while also providing valuable products and services for risk management and risk reduction.[xxxii] Development assistance funding and voluntary cooperation with foreign science institutions can play important roles in building science institutions and programs in developing countries.

4.5 International science mechanisms

Science research and applied science have a strong international character. International publications and peer reviewing are the norm, along with extensive sharing of data and results, foreign training, and much interaction among individual scientists of different countries in their specialist fields. Scientists are heavy users of personal computers, email and the Internet. For any specialised topic, it is usual for researchers to look to highly influential international centres and meetings for leadership and validation.

The processes of international interaction are critical to shaping and achieving high quality research and to rapidly disseminating and applying the results. They are also necessary for building the solid foundations needed for public policy, as is well demonstrated in the climate change field. The situation is the same for disaster risk; international science collaboration is essential. Moreover, the institutions involved can be powerful allies in the pursuit of disaster risk reduction policy.

International scientific research collaboration is coordinated through a range of mechanisms, starting at the level of academies of science through the International Council for Science[xxxiii] (ICSU). Its constituent bodies include the International Union for Geodesy and Geophysics, which addresses earth sciences and natural hazards and includes a Commission on Geophysical Risk and Sustainability (GeoRisk).[xxxiv] Another is the International Association of Volcanology and Chemistry of the Earth's Interior, which among other roles guides the World Organization of Volcano Observatories. The International Social Science Council[xxxv] (ISSC) addresses social and behavioural sciences and how humans behave and change in interaction with each other and with the natural world. ICSU, ISSC and UNISDR jointly sponsor the Integrated Research on Disaster Risk (IRDR) programme.[xxxvi]

The United Nations system supports cooperation on science and technology matters in general. For example, The UN Commission for Sustainable Development services a Science and Technology Major Group, one of nine such groups supporting the Rio+20 agenda. The Rio+20 outcome document[xxxvii] emphasises governments' recognition of the importance of science and technology to sustainable development and their commitment to: collaboration among the academic, scientific and technological community; strengthening the science-policy interface; and fostering international research, with particular concern for developing countries (paragraph 48). The document also sets out the main issues for disaster risk reduction, noting the importance of early warning systems and comprehensive hazard and risk assessments (paragraphs 186-189). Related matters for climate change may be found in paragraphs 190-192.

The UN technical agencies most relevant to disaster risk reduction are UNESCO, WMO, UNEP, WHO, UNOCHA, UNU and UNOOSA but many others are involved. UNESCO coordinates tsunami-warning systems, and WMO oversees extensive activities on weather, climate and water hazards. In both cases this includes related research, training and the development of products and services. WHO undertakes similar activities in health related areas. In the development field, UNDP actively embraces disaster risk reduction, and UNDESA supports a number of relevant S&T activities. A United Nations survey of early warning systems was undertaken following the Indian Ocean tsunami disaster. It called for a globally comprehensive early warning system for all hazards and among other things recommended strengthening the scientific and data foundations for early warning systems.[xxxviii]

The 1990-1999 International Decade for Natural Disaster Reduction (IDNDR),[xxxix] initiated by the United Nations, was strongly supported by national scientific bodies and international geophysical science organisation. Some countries established national IDNDR committees to capitalise on the cooperation and emerging new approaches. The IDNDR's Scientific and Technical Committee promoted several important science-based initiatives, such as an inter-agency programme to develop the production and use of El Niño climate forecasts and the 93-city RADIUS programme on earthquake risk reduction.[xl] At the end of the decade, the Committee provided a detailed final report, while a major scientific conference in association with the IDNDR International Programme Forum identified a growing contribution of science and technology to disaster risk reduction.[xli]

Many other international and regional organisations contribute significantly to scientific and technical aspects of disaster risk reduction. Some examples include the following. Following the 2004 Indian Ocean tsunami the InterAcademy Panel on International Issues, a global network of science academies, convened a study panel whose report, *Natural Disaster Mitigation – A Scientific and Practical Approach*[xlii], made ten specific science-related recommendations for action by the InterAcademy Panel and its member national academies. The World Bank's Global Facility for Disaster Reduction and Recovery has produced various studies, including the already-noted study on the economics of disaster risk reduction.[xliii] FAO has published numerous publications related to managing risk in agriculture, such as the 2011 report *Resilient Livelihoods – Disaster Risk Reduction for Food and Nutrition Safety.*[xliv] The Yogyakarta Declaration of the 5th Asian Ministerial Conference on Disaster Risk Reduction in 2012 included an annex with a set of commitments and proposals for specific actions and targets by the region's scientific, academic and research community.[xlv]

Reports focusing on risk assessment include the broad-based reviews of global risks prepared annually by the World Economic Forum from 2008 to 2012;[xlvi] the annual World Disasters Report produced by the International Federation of Red Cross Red Crescent Societies;[xlvii] the biennial Global Assessment Reports[xlviii] published by UNISDR; and the World Risk Report[xlix] published by the Alliance Development Works in cooperation with the United Nations University. The latter report includes a world risk index calculated for 173 countries. Regional assessments include the biennial Asia Pacific Disaster Reports[l], published jointly by UNESCAP and UNISDR since 2010.

There are numerous other international collaborations on specialist topics, including some that directly associate with the ISDR system (see section 6.2). One example is the Global Earthquake Model, a partnership of hundreds of organisations and individuals working together to develop uniform global databases, methodologies, tools and open-source software.[li]

4.6 Scientific data and information

Disaster risk management relies on good data, on disasters, hazards, exposure and vulnerability, risk factors and risk management practices. Global archives for disaster data include, among others, the EM-DAT database maintained by the Centre for Research on the Epidemiology of Disasters[lii] (CRED), the NatCat database[liii] on natural catastrophes operated by the reinsurer MunichRe, and the multi-agency PREVIEW global risk data platform.[liv] Some countries maintain systematic national databases on disasters, for example as in the case of nine Latin American countries that use the common methodology of the Desinventar[lv] system.

Disaster data of somewhat consistent quality date back several decades at most. Disaster data archiving is a complex task, and faces significant methodological problems of collection and standardisation, notably the difficulties of defining and quantifying disasters and of collecting accurate data from varied and sometimes ad hoc sources. There are often considerable differences in data sets between the different archives.[lvi] Similar issues can affect the generation of data sets for exposure, vulnerability and risk. Spatial data sets for these factors can be estimated from spatial data on population, land use, terrain data, and other types of data, while more explicit and targeted information may be obtainable from national social and economic data sets and from research studies on particular locations or events.

Hazard data sets maintained by national and international scientific agencies, for example on extreme rainfall and high winds, may extend back a century or more. These data provide the basis for estimating the likelihood of extreme conditions and they are also critical to the analysis of trends and research on climate change. Formal arrangements for exchanging historical and real-time data on hazards between countries are in place under the auspices of the United Nations and international and national scientific agencies for most hazards including extreme weather, earthquakes, tsunamis, volcanic eruption and forest fires. WMO in particular coordinates the global exchange of vast volumes of real-time data collected by its Member States for the production of weather forecasts and warnings, including for heatwaves, fire risk and volcanic threats to aviation.[lvii]

Literature resources for disaster risk reduction science reflect the somewhat embryonic nature of the field and the high dependence it has on other long established fields of science. The number of journals and books directly on disaster risk science are relatively new and few, compared to those for say meteorology and public health that span more than a century. Nevertheless there has been an explosion of interest in the field over the past few decades with a growing body of research papers, reports and books. In 2012, a new journal devoted solely to the topic was started, the International Journal of Disaster Risk Reduction.[lviii] The UNISDR-sponsored PreventionWeb[lix] provides an accessible portal to a large and comprehensive information base on disaster risk reduction.

Important venues for international interaction among scientists concerned with disaster risk and its reduction include the Annual Natural Hazards Research and Applications Workshop[lx] at the University of Colorado, the Global Risk Forum[lxi] at Davos, side meetings of the Global Platform for Disaster Risk Reduction[lxii] in Geneva, symposia associated with the International Human Dimensions Programme,[lxiii] and risk-related sessions at the numerous international conferences organised by the geophysical sciences.[lxiv]

5. Science and technology in the Hyogo Framework for Action

5.1 An emphasis on the political and social

The Hyogo Framework for Action[lxv] forms a blueprint for global efforts to reduce disaster risk. It was adopted by countries at the World Conference on Disaster Reduction in 2005 following a detailed review of experience with the prior 1994 Yokohama Strategy and Plan of Action for a Safer World and.[lxvi] Its aim is to pursue a "substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries" over the decade to 2015. The thinking of the moment is well summarised by the following paragraphs extracted from the Hyogo Framework for Action Mid Term Review report.[lxvii]

> *"The Yokohama Strategy marked the beginning of a significant shift in the political and analytical context within which disaster reduction was being considered: while the IDNDR was largely influenced by scientific and technical approaches, the Yokohama Strategy attributed great importance to socio-economic vulnerability in disaster risk analysis, emphasizing the crucial role of human actions in reducing the vulnerability of societies to natural hazards and disasters. The review of the Yokohama Strategy found evidence of greater official and public understanding of the effects of disasters on the economic, social, and political fabric of societies, but also stated that significantly greater commitment in practice was required, and that challenges and gaps in five main areas: governance; risk identification, assessment, monitoring, and early warning; knowledge management and education; reducing underlying risk factors; and preparedness for effective response and recovery."*

The Hyogo Framework for Action therefore devoted considerable attention to matters relating to political and social context, including governance, the need for institution building, the role of communities and the idea of a culture of prevention.

In terms of implementation, it emphasised the preeminent role of states and the importance of partnerships and cooperation, and it stressed the need to integrate disaster risk reduction considerations into sustainable development policy, planning and programming. It spelled out the roles of international and regional organisations and the ISDR to support national efforts and assist in monitoring progress.

5.2 The place of science and technology

Did this new Hyogo Framework formulation mean that disaster risk reduction is no longer to be *influenced by scientific and technical approaches*? The answer is very clearly no, as can be seen by an examination of the Framework's individual paragraphs and particularly the five Priorities for Action. Numerous tasks and requirements are identified that are explicitly or indirectly scientific and technical in nature.

This is especially so in Priority for Action 2 (Identify, assess and monitor disaster risks and enhance early warning) and Priority for Action 4 (Reduce the underlying risk factors). Even the more socially-oriented tasks, such as integrating gender perspective, taking into account cultural diversity, age, and vulnerable groups, or promoting activities on risk in schools, need to be informed by relevant social sciences and basic scientific and technical knowledge on hazards.

In fact, it is clear that the Hyogo Framework for Action achieves a well-balanced appreciation of what is required to reduce disaster risk, one that involves the close integration of both the political/social aspects and the scientific/technical aspects.

However, one result of this new approach was the loss of the leading place that scientific institutions had had in respect to promoting and guiding disaster risk reduction. The new "one among many" place of science is apparent in Part VI, Implementation and Follow-up, where paragraph 21 states as follows "*Civil society, including volunteers and community-based organizations, the scientific community and the private sector, are vital stakeholders …*"

Additionally, although there are some references to scientific institutions and capacities in Part VI, there are none in the section on the responsibilities of States; nor is there any explicit accountability stated for international organisations or the ISDR secretariat to ensure coordination of scientific requirements and inputs or to nurture the development of necessary scientific capacities. This is a remarkable gap. Perhaps it was just assumed that the science and technological institutions, as committed and well-organised parts of global society, would take care of themselves and contribute strongly as they had in the past.

5.3 Insights from the Mid-Term Review and post 2015 process

The Mid-Term Review,[lxviii] released in 2011, reported significant progress in disaster risk reduction and a decisive role of the Hyogo Framework for Action in promoting action. Nevertheless progress was found to be uneven across the world, and there are many areas of shortcomings, both in substantive risk reduction tasks and in organisation and coordination at both national and international levels.

Several matters of scientific and technical concern are touched on in the review. Difficulties have been experienced in standardising and linking the technical aspects of risk assessments and early warning systems with development processes and local action. There are challenges in progressing multi-hazard approaches and in integrating risk reduction and climate change adaptation. The need for better cost-benefit information, and for more research and analytical studies on the extent to which disaster risk reduction initiatives actually reduce damage and losses was noted. Several countries ascribed their lack of progress to a lack of the necessary technical, financial, and human resources.

The review referred to the potential use of the IPCC Special Report on Managing the Risk of Extreme Events and Disasters to Advance Climate Change Adaptation, and to the role of the Global Assessment Report on Disaster Risk Reduction as a important reference document on risk information and on progress and policy challenges for risk reduction. The work and recommendations of the ISDR Scientific and Technical Committee were referred to.

In its section on the United Nations, the Mid-Term Review indicated the continuing presence of a dichotomy between scientific/technical aspects and the political/social aspects of disaster risk reduction, noting that "*it would seem that technical staff tend to consider disaster risk reduction as a strategic approach, whereas staff at the strategic level often perceive disaster risk reduction as a technical issue.*"

The technical-social dichotomy is pervasive in many fields of endeavour, arising from the separate specialist concepts and language of different areas of expert knowledge, but at the same time it is a false stance and unhelpful. The reality is that disaster risk reduction is both a technical and a social challenge, and can only be achieved with the simultaneous and integrated inputs of political, social, technological and scientific inputs.

The Mid-Term Review suggestions for accelerating action are focused on the major systemic topics of development processes, governance for disaster risk reduction, accountability for Hyogo Framework implementation, targets for risk reduction, and international support mechanisms.

Some attention was also given to tools for disaster risk reduction, such as standards and guidance tools, and to the need for improved data sets, the development of standardized risk assessment methodologies, and the need for better links with climate change policy processes. Scientific innovation and technological progress were noted in passing as being likely to open up better and more cost-effective means to tackle disaster risk in future.

However, the Mid-Term Review made no suggestions for setting agendas, improving coordination or other steps toward addressing the identified science-related requirements and the demands from many countries for assistance with technical capacities. This is an omission. Science-based progress does not happen by chance; it needs active leadership, support and coordination, at both national level and international level.

The UNISDR working paper on the post-2015 framework[lxix] provides a succinct account of the main issues and options for the future, building upon the Mid-Term Review. Among other things, it gives a strong emphasis to the importance of disaster risk management techniques, including risk assessment and disaster loss assessment, and to the need for better guidance, principles and tools on how good practice is achieved.

Of particular note is the working paper's discussion on the use of quantitative targets, where the examples provided are largely ones in which science and technology has a critical role, for example in risk assessment, early warning, water risk management and land use planning.

6. Coordination of science and technology in the ISDR system

6.1 Recognition of science and technology

The importance of promoting and coordinating science and technology for disaster risk reduction has been regularly noted in United Nations processes. In the initial resolution to establish the ISDR[lxx] the UN General Assembly emphasized "*the urgent need to develop further and make use of the existing scientific and technical knowledge to reduce vulnerability to natural disasters, bearing in mind the particular needs of developing countries, and, in this regard, calls upon all countries to strengthen scientific research and training of experts in universities and specialized institutions and to promote the exchange of information.*"

The Chair's summary of the 2011 Global Platform for Disaster Risk Reduction[lxxi] noted the need to "*actively engage and support scientific and technical communities to inform decision-making*" and it referred to several other priorities that intrinsically require scientific input or participation. Throughout its life, the ISDR has benefited from the active participation of science actors and has engaged in promoting and coordinating various activities related to science and technology.

6.2 Early coordination mechanisms

The original organisational elements of the ISDR "system" comprised a trust fund, an inter-agency secretariat and an Inter-Agency Task Force (IATF). The IATF guided the work of the ISDR, eventually meeting twice yearly and comprising about 40 organisations, many of which had strong scientific and technical mandates and capabilities.[lxxii] Many governments participated as observers.

The IATF sustained a number of multi-stakeholder working groups that were mostly concerned with matters of largely scientific and technical interest, on Climate and disasters; Early warning; Wildland fires; Disaster reduction in Africa; Risk, vulnerability and disaster impact assessment; and a discussion group on Drought risk reduction. Following a request from the first IATF meeting (IATF-1), a focus paper on the application of research, science and technology was introduced at IATF-2; this was followed by a further background paper at IATF-3 together with a proposal for an overall ISDR Advisory Scientific and Technical Group.[lxxiii] However the proposal was not endorsed by the meeting.

Over time, some of the working groups concluded their work, others evolved into different forms, and a number of new partnerships developed. For example, the inter-agency Working Group on Climate Change and Disaster Risk Reduction was established in 2004 and has actively developed ISDR system positions and papers as inputs to the UNFCCC process. The Global Assessment Report process owes much to the collaboration established by the earlier Working group on risk, vulnerability and disaster impact assessment. Reports and other outputs from the various groups may be found on the UNISDR and PreventionWeb websites.

The IATF held its last, twelfth, meeting, on 22-24 November 2005. About that time, work had begun to develop an expanded concept for guiding the ISDR system that would include a more active role for governments, recognising that it was governments that were principally responsible for the implementation of the Hyogo Framework for Action. This led to the development of the Global Platform for Disaster Risk Reduction, which met for the first time on 5-7 June 2007.

6.3 Scientific and technical coordination 2006-2012

It was generally accepted in the draft concepts for the Global Platform for Disaster Risk Reduction that a mechanism, such as a high level committee, would be needed to continue and develop the IATF's role of promoting and coordinating scientific and technical inputs to disaster risk reduction. A preparatory workshop was held in April 2007 to consider, among other things, "*mechanisms for the ISDR system to pose, and address, important questions of a scientific and technical nature, including technology-related questions, and to coordinate scientific and technical activities within the ISDR system.*"[lxxiv] This initiative was partly influenced by the United Kingdom proposal for a high-level international science panel for natural hazard assessment.[lxxv]

The workshop prepared recommendations for a new committee and reported its findings to the first meeting of the Global Platform that year.[lxxvi] Subsequently the ISDR Scientific and Technical Committee was formed.[lxxvii] Its terms of reference were finalised at its first meeting, in Paris, in January 2008 (attached below as Annex 2).

The Scientific and Technical Committee has endeavoured to stimulate more action on disaster risk reduction science, including through its report *Reducing Disaster Risks Through Science*[lxxviii] prepared for the 2009 session of the Global Platform for Disaster Risk Reduction and its statement and recommendations[lxxix] to the 2011 session.

The 2009 report focused on the selected topics of climate change, early warning systems, public health, and socio-economic resilience. It made four key recommendations (set out below in Annex 3) related to: promoting knowledge into practical action; using problem-solving approaches that integrate all hazards and disciplines; supporting systematic science programmes; and guiding good practice through strengthened Committee capacities.

The Committee endeavoured to establish sub-groups to undertake tasks on specific key issues, such as early warning, and data quality, but in the absence of resources for meetings and work activities, little could be done. One product was a paper prepared for the Hyogo Framework for Action Mid Term Review that reviewed the status of databases and sources of evidence for disaster risk management.[lxxx] It argued for strengthened evidence for all aspects of disaster risk management and greater investment in standardised collection and use of high-quality data, information and evidence, including baselines against which disaster risk management action can be evaluated.

The 2011 proposals addressed a number of systemic issues and sought the following: to intensify efforts on science-based decision making processes in disaster risk reduction; to support a collaborative review of the status of science and technology on disaster risk reduction to aid discussion on post 2015 arrangements; to encourage the mechanisms for funding science and technology to support research on disaster risk reduction and management; and to hold an ISDR system science and technical forum at the 2013 Global Platform for Disaster Risk Reduction session.

The last formally reported meeting of the Committee (STC-3) was held in Geneva in June 2009. Some informal meetings have been held on occasion since then to help prepare inputs to sessions of the Global Platform for Disaster Risk Reduction. Recently a new Scientific and Technical Advisory Group has been formed by the Secretariat to undertake similar work.

Another feature of this period was the development of self-organising cooperative partnerships on particular themes, such as flood risk and wildland fire. Some of the groups sought more formal recognition by the ISDR system and in response the secretariat in 2008 issued a policy note[lxxxi] to identify the various entities and to set out a basis for formal involvement in the ISDR system. Platforms, partnerships and networks are particularly valuable for disaster risk reduction, as tools to overcome the weak incentives for cross-disciplinary, cross-institution collaboration within organisations. At present, the UNISDR website lists 13 thematic platforms, many of which have a scientific or largely technical character, as follows:[lxxxii]

Capacity for Disaster Reduction Initiative (CADRI)
Global Earthquake Model (GEM)
Global Fire Monitoring Center (GFMC)
Global Risk Forum (GRF Davos)
Gender and Disaster Network (GDN)
Global Risk Identification Programme (GRIP)
International Flood Initiative (IFI)
International Consortium on Landslides (ICL)
International Platform for Reducing Earthquake Disasters (IPRED)
International Recovery Platform (IRP)
Partnership for Environment and Disaster Risk Reduction (PEDRR)
Thematic Platform on Knowledge and Education
United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)

Notable science-related, multi-agency projects undertaken under ISDR auspices include: the biennial Global Assessment Reports;[lxxxiii] the promotion of linkages with the climate change policy process;[lxxxiv] the collaboration and publications on drought risk management;[lxxxv] and the major revision of the UNISDR terminology.[lxxxvi] Climate change related outputs included several technical policy briefs and the original proposal for the IPCC special report on managing extremes. Various events related to the application of science and technology have been held at the three sessions of the Global Platform for Disaster Risk Reduction, in 2007, 2009 and 2011.[lxxxvii]

6.4 Shortcomings and options

The overview above indicates considerable cooperative activity over the years by ISDR partners and consortia on science and technology and its application and some very significant and influential outputs. In some areas, ISDR partners provide ample ongoing attention to matters of international development and coordination, for example in respect to meteorological hazards.

However, when it comes to systematic efforts to stimulate and coordinate science and technology across the whole disaster risk reduction spectrum, we see that little has been done within the ISDR system, and that there has been an overall decline in such efforts since the end of the IATF era. Minimal work has been done to get to grips with the systemic issues for applying science and technology in disaster risk reduction or to follow up on the many recommendations made over the years on the topic. The available institutional tools for action have been neglected and under-resourced in this respect.

Given the importance of science and technology to disaster risk reduction and the rapid growth in science and technology, this must be regarded as a decided shortcoming.

Is a committee the best means to make progress with this problem? Group structures such as committees, steering groups, programme area groups, panels and platforms are common in most organisations and can play important roles in undertaking critical technical work or providing oversight on behalf of their constituencies. However, they may be ineffective if not well designed and tailored to the organisational circumstances. Experience in a variety of international settings indicates that the main criteria for success for such groups are:

- A well-defined task or area of responsibility.
- Hard working participants who are very knowledgeable in the task/responsibility.
- An energetic, committed expert leader.
- Necessary resources of time and funds (to undertake work and meetings).
- Credibility in the eyes of the constituent organisations and networks.

It could be argued that the relative success of the various ISDR thematic platforms and ISDR projects is closely related to the degree to which these requirements were present in each case.

Bearing the criteria in mind, it is proposed here that the responsibility for ISDR system action on science and technology for disaster risk reduction should lie primarily with the ISDR system's science and technology constituents, including relevant national actors, and that the tasks and mechanisms involved should be forged in and made accountable to the biennial sessions of the Global Platform for Disaster Risk Reduction.

The effectiveness of the mechanism adopted should be judged by how well it galvanises action by relevant parties and what it achieves. This will depend heavily on the sense of ownership and degree of commitment of the key parties, and close consideration to the aforementioned criteria.

A simple starting option would be to convene voluntary action groups at each session of the Global Platform for Disaster Reduction to formulate action plans on selected key issues and thereafter to pursue these over the ensuing biennium and report back at the following session of the Global Platform. This process would be simple and may work well if the initial excitement is backed by incentives for sustained efforts.

A more structured option is to engage the existing ISDR thematic platforms and associated projects. Specific objectives could be adopted by each, through events at the sessions of the Global Platform.

Where there are gaps in topic coverage, efforts could be made to stimulate the development of additional platforms or projects. By using existing organisational entities that already meet most of the above criteria there would be improved prospects for the achievement of desired objectives.

The option of a revitalised overall ISDR scientific and technical committee or advisory group remains, though it could not provide the outcomes expected from the above options. Nevertheless, some sort of overall coordination would be needed, including for the basic task of organising events at the Global Platform. While this effort might come from the ISDR secretariat, it would be better from an overseeing group of ISDR partners and experts, preferably a group that is accountable to the Global Platform and that has high standing with the science and technology community.

Whatever the chosen option, it should be developed with strong intent and serious commitment by ISDR partners and the ISDR secretariat. In particular, this means allocating staff time and financial resources for meetings and other expenses. Without these, the results will be limited and of transitory interest and impact.

PART 3. THE PATH FORWARD

7. Conclusions

7.1 The current setting

Concepts of disasters and disaster risk are undergoing considerable change. Scientific research and thinking has played a large part in this evolution. The traditional focus on hazard events is being displaced by a frame of reference in which disasters are seen as the outcome of a risk process that is largely social and political in origin. This has led to improved understanding of the mutually reinforcing relationship of poverty and disaster risk, and to the idea of seeking resilience in societies.

The linkages between disaster risk reduction and the task of dealing with climate change are becoming clearer. Further still, concepts of risk management are strengthening and extending beyond the bounds of natural hazards to consider multiple and cascading risks and complexity.

Disaster risk and its reduction is a growing topic for science and technology. However as a unique field of scientific study it is relatively small and ill defined. It does not have a single disciplinary home or a well-established place in the scientific world but instead draws on a rich pool of diverse natural, engineering and social sciences. Typically, it does not enjoy the benefits of sponsorship by a leading sector or department of government. This presents difficulties for securing strong recognition in the agendas of science funding institutions and sector programmes and for guiding and coordinating research that integrates inputs from all sciences.

The Hyogo Framework for Action provides balanced and integrated expectations in respect to political/social needs and science/technical needs for disaster risk reduction. However in practice, there remains an unhelpful dichotomy between the natural and social sciences, which continues to impede the effective implementation of disaster risk reduction. This gap has been exacerbated by the diminution of science as a priority in the predominant global discourse on disaster risk reduction over the past decade.

Only two years remain of the term of the Hyogo Framework for Action. Planning is already advancing on what regime should follow. While many themes necessarily will continue in 2015 and beyond, there is likely to be a new emphasis on specific action to build country capacities, to develop practical methodologies, and to guide measurable programmatic action. The demand for such action has been well expressed. The role of science and technology therefore will become increasingly important in the post 2015 regime.

7.2 Primary opportunities

Science is an accelerant of progress. Scientific and technical fields create new insights and methods that solve problems and bring new benefits. Good data and analysis make for better policies. The knowledge and skills of people trained in the sciences helps support better decision-making and more cost-effective implementations. Science involves long time frames – but sustained efforts are needed to deliver sustained benefits.

Numerous scientific and technical organizations with extensive capabilities have been long engaged in the management and reduction of particular risks, for example in agriculture, water management, construction and public health. Scientific and technical organizations are important actors in projects for development, resilience building and adaptation to climate change. Cooperation and coordination on science and technology can improve disaster risk reduction outcomes and help avoid potential waste and confusion of efforts among the many organizations involved.

Climate change policymakers have acknowledged the importance of disaster risk reduction as an important adaptation strategy for the future. This represents a potential fast-track opportunity to reduce disaster risk and to implement the Hyogo Framework (and its post 2015 successor) but it will require greater effort to develop a scientifically well-informed base of information and technique sufficient to satisfy the standards of climate change policy making.

At national levels, a multidisciplinary problem solving approach together with structured multi-agency cooperation offers an effective way to stimulate and coordinate scientific and technology inputs to disaster risk reduction. It can help avoid gaps in programmes as well as the "silo" effects of organisations working solely on their own particular disciplinary or sector mandates.

Better linkages between disaster risk reduction agendas and national funding processes for science and technology will pay dividends. This can be facilitated by direct lobbying to funding agencies and by incorporating science and technology agencies into existing national platforms or equivalent high-level bodies for disaster risk reduction.

7.3 Demands for science and technology

Countries and organizations have identified a range of science and technology related needs, including through the Hyogo Framework for Action Mid-Term Review. Developing countries, particularly the poorer and more vulnerable among them, are particularly in need of assistance to address the gaps they face in scientific capacities and information.

Demands are growing for quality information, particularly for practical tools and methods for risk assessment, risk reduction and adaptation, along with evidence for advocacy purposes and support for national technical capacity development. There are needs for improved data collection and analysis and for standardisation of methods and benchmarking. There is a desire for initiatives to reduce the barriers to effective access and transfer of science and technology, including assistance to overcome challenges in communicating and acting on scientific knowledge.

Three distinct areas of need for science and technology in disaster risk reduction can be identified.

1. For practical risk reduction: to develop, communicate, transfer, prove and mainstream an array of practical methods and tools to reduce disaster risk in all sectors.

2. For science capability: to support education, research, innovation and problem solving and to develop the necessary supporting institutions and scientific cadres.

3. For advocacy purposes: to build the evidence base needed to inform and persuade leaders and the public on the wisdom and cost-effectiveness of disaster risk reduction.

The growing demand for specific practical methods is a natural evolution of advocacy efforts and raised awareness. It reflects the ongoing maturing of disaster risk reduction activity and will need to be well recognised in the post 2015 framework.

In this respect it is worth recalling that countries and communities do not face some sort of generic disaster risk that can be dealt with generic disaster risk reduction tools, but specific risks of tangible loss that arise from specific hazards and socio-economic circumstances. These can only be managed and reduced through good knowledge of the particular hazards and circumstances and the use of practical tools designed for specific tasks and tailored to the needs of the situation.

7.4 International coordination

As a cross-disciplinary and relatively new field of science and technology, disaster risk reduction has a particular need for international coordination and collaboration, in order to identify and make accessible a respected repertoire of proven concepts and methodologies.

Extensive and highly motivated communities of scientists and related technical intermediaries are engaged in risk management and disaster risk reduction. They have supported several notable ISDR system initiatives and outputs and are ready to do more. Many specific fields already have well-established coordination mechanisms to build upon. But there are also many gaps in activity, and the incentives for multi-disciplinary, cross-institution collaboration are often weak.

The ISDR system has the United Nations mandate and responsibility to promote international collaboration on disaster risk reduction, particularly among governments, including for agenda setting, coordination, validation and standardization processes, and consideration of systemic issues in the use or non-use of science and technology. These tasks present an opportunity for leveraged action and value creation far beyond the costs involved.

To date, the ISDR system has not energetically pursued the level of structured international coordination and agenda setting on science and technology that is needed for disaster risk reduction and the implementation of the Hyogo Framework for Action. Some institutional initiatives have been made but generally they have not been given priority or resourced to do what is required.

The ISDR system thus faces a point of decision – how in future will it recognise, support and drive the development of the science and technology capabilities needed by countries to systematically reduce disaster risk?

8. Practical recommendations

8.1 Main principles

For disaster risk reduction, scientific capacities must be interpreted broadly to include all relevant matters of a scientific and technical nature, where science is considered in its widest sense to include the natural, environmental, social, economic, health and engineering sciences. Similarly, the term “technical” includes relevant matters of technology, engineering practice and implementation. Scientific and technical work often requires the participation of practitioners and other intermediaries in addition to scholars and scientists.

The principal strategy must be to mobilize and guide the scientific and technical capacities that are already available, and to foster the development of greater coherency and recognition of efforts on disaster risk and its reduction. High priority should be given to stimulating existing organisations and networks to shape and drive the required initiatives.

At national level this requires the systematic identification of the relevant science and technology organisations and capacities, and the strengthening of mechanisms to stimulate, fund and coordinate vigorous cooperative action on national priorities for disaster risk reduction.

At international level, within the ISDR system, it means developing a more effective mechanism to stimulate and coordinate action on neglected areas of science and technology and on overarching issues such as capacity inventories, methodology standardisation, and the promotion of disaster concerns in science and technology agendas. Formal processes and earmarked resources are required to develop necessary priorities and strategies, to galvanise action by key actors and to support underpinning meetings, networking, publications and follow-up activities.

8.2 Tasks for the ISDR system

The following tasks are collated from various sources as suggestions for possible future action by ISDR system bodies. They each stand on their own merits and are not intended to represent a comprehensive coherent programme of action.

It is recommended that ISDR system action should be aligned to three output areas, namely practical risk reduction, science and technology capability, and advocacy purposes. The various recommendations of the Scientific and Technical Committee fit this typology well and are included in lists below.

Practical risk reduction:

- Prepare guidance products on practical risk reduction derived from the IPCC SREX report.
- Prepare guidance products on practical risk reduction measures derived from the World Bank report on economics and disaster risk.
- Stimulate efforts to develop systematically structured, validated and accessible knowledge bases of practical risk reduction methods (including through use of PreventionWeb).
- Support the Integrated Research on Disaster Risk initiative to compile a comprehensive assessment of integrated research on disaster risk.
- Seek the standardisation of the common technical methodologies used by development assistance organisations (such as national risk assessment).
- Prepare guidance on data requirements for disaster risk reduction and develop standardised methods for national data collection and spatial modelling of disaster risk.
- Prepare a standardised series of technical notes for key areas of risk management areas (e.g. flood management, etc) to guide practitioners on key methods and sources of information.
- Develop guidance and standardised methods for the quantitative measurement of risk and its reduction for use in the assessment of policies and projects.

Science and technology capability:

- Identify and promote successful interaction between national committees for science and technology and national committees or platforms for disaster risk reduction.
- Formulate a methodology to guide countries on preparing inventories and assessments of national scientific and technology capacities.
- Institute a contact group on the economics of disaster risk reduction to promote and guide more work in this area and guide its use in ISDR processes.
- Form a contact group to prioritise and promote follow-up action on the UN Global Survey of Early Warning Systems.
- Develop a structured review of science and technology for disaster risk reduction to inform the post Hyogo Framework consultation process.
- Identify and promote priority areas for disaster risk reduction research and promote international conferences such as a biennial ISDR science and technology forum.
- Prepare a major international conference for 2015 to update progress on science and technology for disaster risk reduction since the 1999 IDNDR Sub-Forum on this topic.
- Develop regional inventories of centres and programmes for graduate research and training in disaster risk reduction and risk management.
- Stimulate the development of standards for graduate programmes in disaster risk reduction.
- Review and where necessary upgrade the archives and information resources on science and technology and its coordination in the UNISDR and PreventionWeb websites.
- Strengthen the role of ISDR platforms and projects as a means to stimulate and coordinate action on science and technology and ensure participation by developing country scientists.
- Establish an institutional mechanism to guide ISDR action on science and technology.

Advocacy purposes:

- Prepare messages to raise awareness of the role of science and technology in disaster risk reduction and the need for science and technology capacities in developing countries.
- Prepare a promotional brief on the significance of research and promote participation in research programmes such as the Integrated Research on Disaster Risk programme.
- Prepare a briefing note for promoting disaster risk reduction to national academies and science funding agencies, and undertake advocacy action with these groups.
- Develop further well-documented cases of quantitative risk reduction and formulate these into advocacy messages.
- Prepare a short policy note on the economics of disaster risk reduction, drawing on the World Bank study and other materials.
- Continue the Global Assessment Report and widen the formal engagement of the scientific and technical community in its processes.

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Annex 1. Terms of reference for study on science and disaster risk reduction

Duties and responsibilities

The consultant will work under the overall guidance of the Senior Coordinator of the Post-HFA process. The consultancy aims to assess how: natural and social sciences and technology have helped increase information and knowledge on disaster risk reduction; the current status of cooperation between the scientific community and policy makers on risk reduction; and successes, challenges and opportunities in applying scientific knowledge and tools to disaster risk reduction and resilience building. Based on this analysis, the consultant will draft a set of principles for enhancing the application of scientific and technological research results to policy and decision making processes towards resilience building. These principles may then be considered in the *Post-2015 Framework for Disaster Risk Reduction*. The tasks are as follows:

1. Study the current status of the kinds of knowledge generated by natural science and technology for disaster risk reduction, which have contributed to the paradigm shift from disaster response to risk reduction, and then to resilience building. The study will also examine the current level of application and acceptance in the disaster risk reduction community of scientific knowledge and technological tools available, especially policy-makers in the governments.

2. Study the contributions of the social sciences to the growing political commitment and social demand for disaster risk reduction since the implementation of the Hyogo Framework for Action in 2005. The study will also assess the strengths and weaknesses of existing knowledge and approaches generated in the social sciences for making the political and economic case of investment in disaster risk reduction.

3. Identify opportunities and solutions for bridging existing gaps in research and overcoming the challenges for further increasing political commitment, economic investment and social demand for disaster risk reduction. This should be done in close cooperation with UNISDR partners, both individual experts and institutions in the science and technological communities.

4. Put forward a set of principles for guiding the disaster risk reduction community, especially policy and decision makers, in the application of science and technology to reducing risk. A set of practical recommendations should be also included to bridge the existing gaps identified in knowledge and research on disaster risk reduction.

Expected Outputs

A draft analytical working paper will be produced at the end of the first six weeks for UNISDR comments, which will be followed by experts peer review and on-line consultations. The study will then reflect and integrate inputs received and submit the final report at the end of eight weeks work spread over a five-month period.

Annex 2. Terms of reference of the Scientific and Technical Committee

As agreed at the committee's first meeting and recorded as Annex 3 of the meeting's report (*Scientific and Technical Committee, International Strategy for Disaster Reduction, Report of the First Meeting, Paris, 31 January – 1 February 2008*)

Scientific and Technical Committee
International Strategy for Disaster Reduction

Terms of reference

1. Recognizing that scientific information is the basis of informed decision making and public awareness, the main aims of the Committee are (i) to identify and address important questions of a scientific and technical nature; (ii) to provide scientific and technical advice to the Global Platform for Disaster Risk Reduction; and (iii) to assist in the coordination of scientific and technical activities within the ISDR system.

2. The Committee addresses policy matters of a scientific and technical nature, where science is considered in its widest sense to include the natural, environmental, social, economic, health and engineering sciences. The term "technical" includes relevant matters of technology, engineering practice and implementation.

3. The Committee's functions are:

   a) To provide advice on policy-relevant scientific and technical issues related to the reduction of disaster risks and implementation of the Hyogo Framework for Action, including making recommendations on priorities for scientific and technical attention by the ISDR system.

   b) To propose and organize specific enquiries, including the setting up of working groups or specialist panels of leading experts as may be required, to investigate and report on priority matters.

   c) To make proposals for the development of the scientific and technical elements of the Joint Work Programme of the ISDR system. *(Author note: this Joint Work Programme concept has been abandoned by the ISDR.)*

   d) To review reports on, and provide guidance to, the scientific and technical work of relevant ISDR thematic partnerships[1].

   e) To stimulate dialogue and innovation on scientific and technical issues within the ISDR system, including the promotion of good practice.

   f) To report annually to the Chair of the ISDR system on the matters within its mandate, including the functioning of the overall scientific and technical mechanisms for the ISDR system.

4. The Committee develops concepts, priorities, recommendations and proposals for follow-up and action on scientific and technical issues, and advocates and seeks support for

[1] Currently a term to describe the varied working groups, clusters, networks and platforms that are associated with the ISDR system, such as for early warning, climate change, education, wild land fire, disaster recovery, capacity development, academic networking, and specialized regional collaborative centres, etc.

these within the ISDR system including through the biennial sessions of the Global Platform for Disaster Risk Reduction.

5. The Committee is established by the Chair of the ISDR system (the Under-Secretary for Humanitarian Affairs) as an independent subsidiary body of the Global Platform for Disaster Risk Reduction. The Committee will receive policy guidance from, and report to, the Global Platform at its biennial sessions.

6. The Committee's members and Chair are appointed by the Chair of the ISDR system, following consultations with relevant ISDR system partners through the ISDR secretariat, for a minimum term of two years.

7. The membership of the Committee comprises senior representatives of the main scientific and technical institutions of the ISDR system, together with renowned experts, spanning the relevant scientific disciplines, with two representatives of development policy and parliamentarian communities, and should not exceed 20 members.

8. The Committee develops its own programme of work and meets face to face at least once each year. Additional meetings, including by means of telephone and video conferences, may be held if required.

9. Where appropriate, the work activities carried out by the Committee will be included in the Joint Work Programme of the ISDR system and thus included in associated resource mobilization packages.

10. The Committee may wish to focus on one or two major issues during a given biennium and to address these through time-bound task groups or panels of leading independent scientists and technical experts commissioned to address specific questions posed by the Committee. The members of such groups are appointed by the Chair of the ISDR system, upon the recommendation of the Committee.

11. The work of the Committee, along with that of any task groups or panels, is supported by the ISDR secretariat, augmented from time to time by secondments of additional staff from scientific and technical institutions of the ISDR system.

Annex 3: Recommendations of ISDR Scientific and Technical Committee, 2009

Extracted from *Reducing Disaster Risks through Science - Issues and Actions. The Full Report of the ISDR Scientific and Technical Committee 2009* (see Endnote 78.)

(i) Promote knowledge into action

Greater priority should be put on sharing and disseminating scientific information and translating it into practical methods that can readily be integrated into policies, regulations and implementation plans concerning disaster risk reduction. Education on all levels, comprehensive knowledge management, and greater involvement of science in public awareness-raising and education campaigns should be strengthened. Specific innovations should be developed to facilitate the incorporation of science inputs in policymaking.

(ii) Use a problem-solving approach that integrates all hazards and disciplines

A holistic, all-hazards, risk-based, problem-solving approach should be used to address the multi-factorial nature of disaster risk and disaster risk reduction and to achieve improved solutions and better-optimised use of resources. This requires the collaboration of all stakeholders, including suitable representatives of governmental institutions, scientific and technical specialists and members of the communities at risk. Knowledge sharing and collaboration between disciplines and sectors should be made a central feature of the approach, in order to guide scientific research, to make knowledge available for faster implementation, to bridge the various gaps between risks, disciplines, and the stake-holders, and to support education and training, and information and media communication.

(iii) Support systematic science programmes

Systematic programmes of scientific research, observations and capacity building should be supported at national, regional and international levels to address current problems and emerging risks such as are identified in this report. The international Integrated Research on Disaster Risk (IRDR) Programme, which is co-sponsored by ICSU, ISSC, and UNISDR, provides a new and important framework for global collaboration. The ISDR Scientific and Technical Committee should provide strategic guidance on research needs for disaster risk reduction and oversight of progress.

(iv) Guide good practice in scientific and technical aspects of disaster risk reduction

The ISDR Scientific and Technical Committee should be strengthened to serve as a neutral, credible international resource to support practitioners at all levels, from local through national to international levels, by overseeing the collection, vetting and publicising of information on good practices carried out on the basis of sound science and up-to-date scientific and technological knowledge, as well as on those inadequate practices or concepts that may be hindering progress. The Committee should further develop its recommendations for follow-up on the areas of concern highlighted in the present report, including on the themes of disaster risk reduction and climate change adaptation, preparedness and early warning systems, health impacts of disasters, and the association of disaster risk and socioeconomic factors.

References

(The websites listed were valid as at 25 March 2013.)

[i] (i) Data from EM-DAT, the OFDA/CRED International Disaster Database managed by the Centre for Epidemiology of Disasters (CRED) at the Université catholique de Louvain, Brussels, Belgium. (ii) See websites www.emdat.be and http://www.unisdr.org/we/inform/disaster-statistics

[ii] UNISDR, 2011. Global Assessment Report on Disaster Risk Reduction - revealing risk, redefining development. UNISDR, Geneva. This and earlier Global Assessment Reports are obtainable at http://www.unisdr.org/we/inform/gar and http://www.preventionweb.net/english/hyogo/gar/

[iii] United Nations, 2005. Report of the World Conference on Disaster Reduction, Kobe, Hyogo, Japan, 18-22 January 2005. A/CONF.206/6. http://www.preventionweb.net/files/resolutions/G0561029.pdf Also available in seven languages as Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters at http://www.unisdr.org/we/inform/publications/1037

[iv] See Endnote 1 for the source of data.

[v] Webster P, 2013. Improve weather forecasts for the developing world. Nature, 493:17-19.

[vi] (i) van Alphen, J, Alberts, F and Kors, A, 2003. Dig or Dike? Resilience of the Dutch River Rhine System in view of increased discharges: strategy, measures and first examples. Ministry of Transport Public Works and Water Management, The Netherlands. (ii) Kimmelmann, M, 2013. Going with the flow. New York Times, February 13, 2013.

[vii] (i) Gibbs, T, 2003. The Use of Check Consultants in the Design and Construction of Health-care Facilities. 6p. Presentation to PAHO Leaders Course, Ocho Rios, Jamaica, 11 February 2003. (ii) See related presentation at:
http://www.caribengineering.com/istructe/Conference2009/2_9CheckConsultants.pdf

[viii] Canterbury Earthquakes Royal Commission, 2012. Final Report (multiple volumes) available at http://canterbury.royalcommission.govt.nz/Commission-Reports

[ix] NHRP, 2012. Newsletter, November 2012. Natural Hazards Research Platform, Wellington. See website http://www.naturalhazards.org.nz/

[x] Hyogo Framework for Action Progress Reports (regional, national and local). Available at http://www.preventionweb.net/english/hyogo/progress/?pid:3&pil:1

[xi] (i) United Nations, General Assembly Resolution 54/219, 3 February 2000. (ii) United Nations, General Assembly Resolution 56/195, 21 January 2002. UN resolutions available at website http://www.un.org/documents/resga.htm Those related to disaster risk reduction are also accessible at UNISDR website http://www.unisdr.org/we/inform/resolutions-reports

[xii] (i) The IDNDR was established by United Nations General Assembly resolution A/RES/44/236 on 22 December 1989, available at http://www.un.org/documents/ga/res/44/a44r236.htm. (ii) The IDNDR International Programme Forum concluded the Decade with a final declaration, UN document A/54/132, paragraph 82, Final Declaration adopted by the IDNDR programme forum. 2p. Available at http://www.unisdr.org/2011/docs/genevamandate/Geneva-mandate-EN.pdf

[xiii] See Endnote 3.

[xiv] UNISDR, 2011. Hyogo Framework for Action 2005-2015 Mid-Term Review. 67p. plus extensive annexes. See http://www.unisdr.org/we/inform/publications/18197

[xv] UNISDR, 2012. Towards a post-2015 framework for disaster risk reduction. 10p. Available in the 6 UN languages at website http://www.unisdr.org/we/inform/publications/25129

[xvi] A very readable account of the development of disaster risk science may be found in Alexander D, 2012. Starting Point, Int. J. Disaster Risk Reduction, 1, p1-4 (Introduction to the new journal by Editor in Chief.) Available at http://www.sciencedirect.com/science/article/pii/S2212420912000106

[xvii] UNISDR, 2009. 2009 UNISDR terminology on disaster risk reduction. 30p. Available in 19 languages, including a comparative version in Chinese, Japanese and Korean, at website http://www.unisdr.org/we/inform/publications/7817

[xviii] Basher, R. 2006. Global early warning systems for natural hazards: systematic and people-centred. Philosophical Transactions of the Royal Society A, 364(1845), 2167-2182. See http://rsta.royalsocietypublishing.org/content/364/1845/2167

[xix] See http://www.gripweb.org/gripweb/

[xx] See http://www.ihdp.unu.edu/ and http://www.essp.org/index.php?id=21&L=en

[xxi] See http://www.ihdp.unu.edu/article/read/irg-science-plan and http://www.irg-project.org/

[xxii] (i) IRDR founding document: A Science Plan for Integrated Research on Disaster Risk - Addressing the challenge of natural and human-induced environmental hazards, 66p. Available at http://www.icsu.org/publications/reports-and-reviews/IRDR-science-plan/. (ii) Website of IRDR International Programme Office is www.irdrinternational.org/ (iii) Information on the Assessment of Integrated Research on Disaster Risk (AIRDR) project is available at www.irdrinternational.org.

[xxiii] ISSC, 2010. World Social Science Report 2010. (i) Accessible at http://www.unesco.org/new/en/social-and-human-sciences/resources/reports/world-social-science-report (ii) See also http://www.worldsocialscience.org/?page_id=62

[xxiv] World Bank, 2011. Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention, 2011. 280p. World Bank, Washington DC. Available in several languages at https://www.gfdrr.org/gfdrr/node/281.

[xxv] United Nations, 1992. United Nations Framework Convention on Climate Change. Available from the UNFCCC secretariat website http://unfccc.int/resource/docs/convkp/conveng.pdf.

[xxvi] IPCC, 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Special Report of the Intergovernmental Panel on Climate Change. 594p. Cambridge University Press, New York. Also available at http://ipcc-wg2.gov/SREX/

[xxvii] Summaries, guides and regional briefings on SREX for Asia, Africa, Latin America and the Caribbean, and for water, agriculture, health and ecosystems sectors, are available at Climate Knowledge and Development Network website http://cdkn.org/srex/

[xxviii] UNISDR, 2007. Guidelines: National platforms for disaster risk reduction. 17p. Available in Chinese, English, French, Russian and Spanish at website http://www.unisdr.org/we/inform/publications/601

[xxix] NSTC, 2005. Grand Challenges for Disaster Reduction, A Report of the Subcommittee on Disaster Reduction, National Science and Technology Council, Washington, USA. 22p. http://www.sdr.gov/docs/SDRGrandChallengesforDisasterReduction.pdf

[xxx] GOS, 2012. Reducing Risks of Future Disasters: Priorities for Decision Makers, final report, Foresight Project, UK Government Office for Science, 139p. Available at http://www.bis.gov.uk/foresight/our-work/policy-futures/disasters

[xxxi] Personal communication, Professor Laban Ogallo, IGAD Climate Prediction and Applications Centre Nairobi, Kenya.

[xxxii] For example, the IGAD Climate Prediction and Applications Centre (ICPAC), Nairobi, Kenya. See website http://www.icpac.net/.

[xxxiii] See website of International Council for Science, http://www.icsu.org/. The ICSU Strategic Plan II, 2012-2017 contains several themes of direct relevance to the ISDR.

[xxxiv] See website http://www.iugg-georisk.org/

[xxxv] (i) International Social Sciences Council (ISSC) website, www.worldsocialscience.org/ (ii) ISSC 2011 Annual Report, Advancing social science knowledge for global priority problems, 44p. (iii) See also Endnote 23.

[xxxvi] See Endnote 22.

[xxxvii] United Nations, 2012. The future we want. (Outcome of Rio + 20 conference.) Resolution adopted by the General Assembly, A/RES/66/288. 53p. Available at http://www.un.org/ga/search/view_doc.asp?symbol=%20A/RES/66/288, and at http://sustainabledevelopment.un.org/content/documents/733FutureWeWant.pdf

[xxxviii] United Nations, 2006. Global Survey of Early Warning Systems: An assessment of capacities, gaps and opportunities towards building a comprehensive global early warning system for all natural hazards. 52p. Available at http://www.preventionweb.net/english/professional/publications/v.php?id=3612&utm_source=pw_search&utm_medium=search&utm_campaign=search

[xxxix] See Endnote 11.

[xl] IDNDR, 1999. RADIUS: risk assessment tools for diagnosis of urban areas against seismic disasters. 23p. Available at http://www.preventionweb.net/files/2752_RADIUSRiskAssessment.pdf

[xli] (i) Final report of the Scientific and Technical Committee of the International Decade for Natural Disaster Reduction. In UN Secretary General Report on ISDR, A/54/132/Add.1 – E/1999/80/Add.1 (ii) WMO, 1990. The Proceedings of the WMO/UNESCO Sub-Forum on Science and Technology in Support of Natural Disaster Reduction, Geneva 6-8 July, 1999, 190p. WMO-No. 914. Available at http://www.whycos.org/hwrp/WWD2004/docs/WMO914.pdf

[xlii] IAP, 2009. Natural Disaster Mitigation – A Scientific and Practical Approach. Inter-Academy Panel for International Issues. 166p. Available at http://www.interacademies.net/File.aspx?id=10292

[xliii] (i) See Endnote 24. (ii) Global Facility for Disaster Reduction and Recovery website https://www.gfdrr.org/

[xliv] FAO, 2011. Resilient Livelihoods – Disaster Risk Reduction for Food and Nutrition Security. 100p. Food and Agriculture Organization, Rome. Available at http://www.fao.org/docrep/015/i2540e/i2540e00.pdf

[xlv] Statement of Scientific, Academic and Research Stakeholders for the 5th Asian Ministerial Conference on Disaster Risk Reduction, 22-25 October 2012, Yogyakarta, Indonesia. Annex 10 of the Conference outcome The Yogyakarta Declaration. 2p. Available at http://www.preventionweb.net/files/29332_10scienceandacademicsfinal3.pdf

[xlvi] WEF, 2012. Global Risks 2012, Seventh Edition. An Initiative of the Risk Response Network. 64pp. World Economic Forum, Geneva. Available at http://www3.weforum.org/docs/WEF_GlobalRisks_Report_2012.pdf

[xlvii] IFRC, 2010. World Disasters report 2010 – Urban Risk. International Federation of Red Cross Red Crescent Societies, Geneva. 220p. Available at http://www.ifrc.org/en/publications-and-reports/world-disasters-report/

[xlviii] See Endnote 2.

[xlix] Bündnis Entwicklung Hilft (Alliance Development Works), 2011. WorldRiskReport 2011, 72p. Available at UNU website http://www.ehs.unu.edu/article/read/worldriskreport-2011

[l] UNESCAP, 2012. Asia Pacific Disaster Report 2012: Reducing Vulnerability and Exposure to Disasters risk report. 164p. UN Economic and Social Commission for Asia and the Pacific, Bangkok. Available at http://www.unescap.org/publications/detail.asp?id=1512. See also previous issue Asia Pacific Disaster Report 2010 - Protecting Development Gains.

[li] See http://www.globalquakemodel.org/

[lii] See Endnote 1 and Guha-Sapir D and Hoyois P, 2012. Measuring human and economic impact of disasters, patterns and trends from EMDAT. Commissioned by Foresight Project, UK Government Office for Science, 50p. Available at http://www.bis.gov.uk/assets/foresight/docs/reducing-risk-management/supporting-evidence/12-1295-measuring-human-economic-impact-disasters.pdf.

[liii] See http://www.munichre.com/en/reinsurance/business/non-life/georisks/natcatservice/default.aspx

[liv] See http://preview.grid.unep.ch/

[lv] See http://www.desinventar.org/

[lvi] (i) Guha-Sapir D and Below, R, 2002. The Quality and Accuracy of Disaster Data – A Comparative Study of Disaster Data. Paper prepared for the Provention Consortium, Geneva. Available at http://www.cred.be/sites/default/files/Quality_accuracy_disaster_data.pdf (ii) Downton, M and Pielke R, 2005. How Accurate are Disaster Loss Data? The Case of U.S. Flood Damage. Natural Hazards, (2005) 35: 211–228. (http://sciencepolicy.colorado.edu/admin/publication_files/resource-796-2005.31.pdf) (iii) Data quality is a core interest of the Global Assessment Report process - e.g. see Annex 2: GAR Disaster Loss Data Universe, GAR-2011, available at http://www.preventionweb.net/english/hyogo/gar/2011/en/bgdocs/Annexes/GAR%2011%20Annex%202%20GAR%20disaster%20loss%20data%20universe.pdf

[lvii] See http://www.wmo.int/pages/prog/www/WIS/index_en.html and WMO, 2007. Climate information for adaptation and development needs. WMO-No.1025, 44p. WMO, Geneva. Available at http://www.wmo.int/pages/publications/showcase/documents/WMO_1025_web_E.pdf

[lviii] See journal home page: www.elsevier.com/locate/ijdrr.

[lix] See http://www.preventionweb.net

[lx] See http://www.colorado.edu/hazards/workshop/

[lxi] See http://www.grforum.org/

[lxii] See http://www.unisdr.org/we/coordinate/global-platform

[lxiii] (i) E.g. http://www.iddri.org/Evenements/Interventions/7th-IHDP-Open-Meeting (ii) Refer also to Endnote 20.

[lxiv] Recent examples include: (i) First IUGG Commission Geophysical Risk and Sustainability Conference on Extreme Natural Hazards and Their Impacts, 2012, Orange, California, USA. (ii) Geohazard symposia, 34th International Geological Congress, Brisbane, Australia, 2012. (iii) (UNESCO/IHP) Africa Water Science, Policy and Management Conference, Dar es Salaam, Tanzania, 2012. (iv) 4th EGU Leonardo Conference on Hydrology and Society - Connections between Hydrology and Population dynamics, Policy making, and Power generation, Torino, Italy, 2012.

[lxv] See Endnote 3.

[lxvi] United Nations, 2004. Review of the Yokohama Strategy and Plan of Action for a Safer World. 23p. Document prepared for the World Conference on Disaster Reduction. A/CONF.206/L.1, available in six UN languages at http://www.unisdr.org/2005/wcdr/intergover/intergov-official-docs.htm

[lxvii] See Endnote 14.

[lxviii] See Endnote 14.

[lxix] See Endnote 15.

[lxx] See Endnote 12.

[lxxi] UNISDR, 2011. Chair's summary, p10-13 in: Proceedings of the Third Session of the Global Platform for Disaster Risk Reduction and World Reconstruction Conference. 82p. UNISDR, Geneva. Available in several languages at http://www.unisdr.org/we/inform/publications/22420

[lxxii] (i) A description of the functions and responsibilities of the Inter Agency Task Force is provided at http://www.unisdr.org/2005/task-force/tf-functions-responsibilities-eng.htm.

[lxxiii] (i) The Application of Research, Science and Technology to Disaster Prevention. Focus Paper No. 2, IATF-2, Geneva, 10-11 October 2000. 5p. (ii) The Application of Research, Science and Technology to Disaster Prevention. Background Paper, IATF-3, Geneva, 3-4 May 2001. 5p. (iii) Establishment of an Advisory Scientific and Technical Group for the ISDR. Document TF3/3, IATF-3, Geneva, 3-4 May 2001. All available via webpage http://www.unisdr.org/2005/task-force/tf-meeting-12th-eng.htm

[lxxiv] UNISDR, 2007. Modalities of a Scientific and Technical Mechanism for the ISDR System. Supporting Document No. 4 (Agenda Item 4), Workshop on Science Mechanisms and Priorities for the ISDR System, Geneva, 2 April 2007.

[lxxv] UKDTI, 2005. The Role of Science in Physical Natural Hazard Assessment. Report to the UK Government by the Natural Hazard Working Group, June 2005. 44p. United Kingdom Department of Trade and Industry. Available at http://www.bis.gov.uk/files/file8511.pdf

[lxxvi] UNISDR, 2007. Report of the Workshop on Science Mechanisms and Priorities for the ISDR System Geneva, 2 April 2007. Document ISDR/GP/2007/5, Global Platform for Disaster Risk Reduction. Available in English and Spanish at http://www.preventionweb.net/globalplatform/2007/first-session/gp-1st-session-docs.html

[lxxvii] Reports of meetings of the Scientific and Technical Committee are available from the UNISDR secretariat.

[lxxviii] UNISDR, 2009. Reducing Disaster Risks through Science - Issues and Actions. The Full Report of the ISDR Scientific and Technical Committee 2009. 34p. UNISDR, Geneva. Available at http://www.unisdr.org/we/inform/publications/11543

[lxxix] UNISDR, 2011. Statement on Science and Technology for the Third Session of the Global Platform for Disaster Risk Reduction. Statement and recommendations of the Scientific and Technical Committee. 5p. Available at http://www.preventionweb.net/files/globalplatform/scientificandacademiccommunitiesand.pdf

[lxxx] Murray, V, 2011. Evidence for Disaster Risk Management – Information and knowledge needs for policy makers and field practitioners, paper submitted to HFA Mid Term Review. Available at http://www.unisdr.org/files/18197_205murray.evidencefordisasterriskma.pdf

[lxxxi] UNISDR, 2008. Thematic partnerships for disaster risk reduction and the development of ISDR Thematic Platforms, ISDR Policy Note, 2 June 2008. 10p. Available at http://www.preventionweb.net/english/professional/publications/v.php?id=2764

[lxxxii] See http://www.unisdr.org/partners/thematic-platforms

[lxxxiii] See Endnote 2.

[lxxxiv] See http://www.unisdr.org/we/advocate/climate-change and the briefing notes on the topic, e.g. Briefing note 01: climate change and disaster risk reduction, which is available at http://www.unisdr.org/files/4146_ClimateChangeDRR.pdf

[lxxxv] (i) UNISDR, 2007. Drought, Desertification and Water Scarcity. Biblio 2 (bibliography, 2nd edition). 44p. Available at http://www.preventionweb.net/english/professional/publications/v.php?id=3815 (ii) UNISDR, 2009. Drought Risk Reduction Framework and Practices: Contributing to the implementation of the Hyogo Framework for Action. 214p. Available at http://www.preventionweb.net/english/professional/publications/v.php?id=11541

[lxxxvi] See Endnote 17.

[lxxxvii] Information on the Global Platform for Disaster Risk Reduction and its past sessions is accessible at http://www.unisdr.org/we/coordinate/global-platform