HAZARDS AND DISASTERS – A RESEARCH CHALLENGE

Gordon McBean (Canada)
Chair, ICSU Planning Group on Natural and Human-Induced Environmental Hazards and Disasters

Presentation to the Regional Conference on Natural and Human-Induced Environmental Hazards and Disasters

in conjunction with the
Inauguration of the ICSU Regional Office for Asia and the Pacific
Kuala Lumpur, Malaysia
18-19 September 2006

Abstract:
The frequency of recorded natural disasters rose markedly during the last century, from about 100 per decade up to 1940 to nearly 2800 per decade during the 1990s. Three-quarters of these disasters are triggered by weather-related events but the impacts of earthquakes and resulting tsunamis are horrific when they occur. Population growth in hazardous areas means that more and more people are at risk, and the increasing dependence of urban communities on complex infrastructure brings with it an increasing vulnerability to disruption. The 2002 World Summit on Sustainable Development highlighted the extent to which progress in development can be wiped out by natural disasters. The severity of the impacts of weather-related extreme events will increase in concert with global warming.

The ICSU General Assembly in 2005 established an International Planning Group on Natural and Human-Induced Environmental Hazards and Disasters and the group has begun the process of defining a major programme of research aimed at strengthening international science to provide a firmer basis for policies to prevent natural hazards from becoming disasters. The international collaborative research programme, lasting a decade or more, would combine the insights of the natural, health, social and engineering sciences, engage populations living in hazardous areas and policy makers at all levels, undertake research to understand better the social and cultural determinants of choice in the hazards context and provide a focus on delivering new scientific insights for the primary customers development agencies, humanitarian assistance agencies and governmental policy-makers.

The research focus would be on hydrometeorological and geophysical trigger events and related events and the role of human activities, with an interdisciplinary cohesion examining the intersection of natural-social and political issues. The objective of the Research Programme is to undertake coordinated international multi-disciplinary research leading to more effective global societal responses to the risks of hazards.

The research themes would span: improved understanding, monitoring and prediction of natural hazards; integrated risk analysis incorporating socio-economic factors; societal resilience to hazards; interplay of risks across different temporal and spatial scales; and understanding effective science-policy interactions and the role of scientific assessments.

1. Introduction

People and our natural environment interact especially due to the impacts of weather-related (e.g., storms, floods, droughts) and geophysical hazards (e.g., earthquakes, volcanoes) on humans. A hazard can be defined as "*a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.*"[1] It is important to note that the event is only potentially damaging. The magnitude of the impacts or damage depends on the vulnerability of the impacted system or population. Vulnerability can be defined as "*conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards."*[2] Disasters result when hazards and vulnerable systems intersect. Reducing disasters requires a multi-disciplinary approach to the study of both hazards and vulnerable systems. Although some disasters make the front pages of newspapers around the globe, most do not and their impacts are only recognized by the communities impacted. A disaster is defined as "*a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources"* [3] and the categorization of a disaster takes into account the ability of a community to cope on its own. Thus, disasters are very much defined in terms of the local community which reinforces the notion that the study of disasters requires a multi-disciplinary approach with the addition of a community focus. The community focus avoids arbitrary definitions of disasters in terms of financial loss, which would bias any tabulations to wealthier societies or lives lost, which would be a bias towards areas of higher population density.

2. Increasing impacts of natural hazards

Based on this definition, global statistics on the occurrence of disasters have been prepared. The number of disaster events has risen from averaging about 10 per year up to 1940 to nearly 28 per year during the 1990s to 47 per year since the beginning of this century[4], a dramatic increase. Most of the disasters and the dominated factor in the increase are the dramatic rise in disasters of hydrometeorological origin. For the period 1994 to 2003, 33% of the disasters were the result of floods, 23% from storms and 15% from droughts. Since most landslides and avalanches are of hydrometeorological origin, hydrometeorological events generated more than ¾ of all disasters. Earthquakes and tsunamis created only 7% of events, but their impacts when they occur can be especially horrific.

The economic costs of natural disasters are also rising dramatically. In economic costs, the average annual amounts over a 10 year period have increased from $US4B per year in the 1950's, to $US13B per year in the 1970's and to $US65B per year in the 1990's[5] and the first years of this decade indicate that the costs are continuing to escalate. Natural disasters in 2004 are currently estimated to have caused economic losses totalling US$140B[6]. Hurricanes Katrina and Wilma in 2005 are now the largest single event but more horrific ones are likely on the horizon[7].

3. Disasters and development

Since vulnerability is determined by physical, social, economic, and environmental factors of the community, impacts on people are linked to development. This is demonstrated by statistics on disaster related deaths per year per million population. When the Development Index is high, the number is 0.4; when it is medium, the death ratio increases to 10 and it exceeds 40 for countries with low Development Indices[8]. Another similar statistic is the number of deaths per disaster which increases from 22 deaths per disaster in highly developed countries to 145 in medium and over 1000 in least developed countries.[9] While the costs for events in developed countries typically are very large, they are not as large as some events, as a percentage of Gross Domestic Production (GDP), in developing countries. For example, while hurricanes in the USA are typically less than 1% of the national GDP, the 1999 earthquake in Turkey was a cost of about 8% of GDP and the 1998 hurricane in Honduras cost about 75% of its GDP[10]. Major disasters have set the development of countries back years, if not decades.

"*Humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs"*[11] leading to the definition of sustainable development. With the impacts of natural disasters, development can not be sustainable[12]. Societies need to look to the future and make investments now that will allow future generations to meet their needs consistent with those of present generations. Natural disasters and climate change[13] are part of that future and must be considered to make sustainable development a possibility.

4. Increasing trends

Global population has been increasing and there has generally been more exposure of people to hazards with more people and communities are at risk. People are also living by choice or circumstances in more hazardous zones, along coasts, riverbanks and mountain slopes. There has also been a growing inequality between poorer and wealthier sectors of society and the poorer sectors are more vulnerable. There is more expensive infrastructure being damaged. In urban regions (and particularly in very large cities), the complex infrastructural systems that make life and economic activity possible, increase the vulnerability of populations to disruptions caused by natural hazards. The density of buildings has been growing and with investments in infrastructure renewal declining, the average age is increasing. Commercial activities have become more interdependent and vulnerable, including relying more on the transportation of people and goods. Human interventions in the environment can also increase vulnerability to natural hazards. Changes in land cover can increase risks of landslides or flooding and destruction of coastal mangrove areas can increase the susceptibility of coastal areas to storm surges and tsunamis. Climate change adds to the risk and the climate will be changing, at least for the next century[14], while countries take emission reduction actions.

Climate change is expected to change our physical environment in a number of ways, including more frequent and intense hazardous events, sea level rise and various impacts related to changing temperatures. "*The vulnerability of human societies and natural*

systems to climate extremes is demonstrated by the damage, hardship, and death caused by events such as droughts, floods, heat waves, avalanches, and windstorms. While there are uncertainties attached to estimates of such changes, some extreme events are projected to increase in frequency and/or severity during the 21st century due to changes in the mean and/or variability of climate, so it can be expected that the severity of their impacts will also increase in concert with global warming."[15]

5. The World Summit for Sustainable Development and the World Conference on Disaster Reduction

The World Summit for Sustainable Development (WSSD), in 2002 in Johannesburg, adopted a Summit Plan of Implementation[16] as part of the strategy to meet the Millennium Development Goals (MDG). The signatories agreed on a series of actions, one of which included protecting and managing the natural resource base of economic and social development. In the report which followed the Summit, strong connections were drawn between achievement of the MDG and international development and natural hazards and climate change. Actions were called for, including:

> *37. An integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery, is an essential element of a safer world in the twenty-first century. Actions are required at all levels to:*
> *(a) Strengthen the role of the International Strategy for Disaster Reduction and encourage the international community to provide the necessary financial resources to its Trust Fund;*
> *(h) Develop and strengthen early warning systems and information networks in disaster management, consistent with the International Strategy for Disaster Reduction;*
> *(j) Promote cooperation for the prevention and mitigation of, preparedness for, response to and recovery from major technological and other disasters with an adverse impact on the environment in order to enhance the capabilities of affected countries to cope with such situations.*

The participants at the 2005 World Conference on Disaster Reduction[17] agreed to the following declaration:

> *1. We will build upon relevant international commitments and frameworks, as well as internationally agreed development goals, including those contained in the Millennium Declaration, to strengthen global disaster reduction activities for the twenty-first century. Disasters have a tremendous detrimental impact on efforts at all levels to eradicate global poverty; the impact of disasters remains a significant challenge to sustainable development.*
> *2. We recognize the intrinsic relationship between disaster reduction, sustainable development and poverty eradication, among others, and the importance of involving all stakeholders…*

These conferences of nations make explicit connections between natural hazards and development.

6. Disaster Management

The United Nations International Strategy for Disaster Reduction (UN ISDR) was created to follow and build upon the United Nations International Decade for Disaster Reduction (IDNDR) of which ICSU was a co-sponsor. Disaster management refers to policies and practices developed and implemented to manage the impacts of disasters. Effective disaster management requires extensive planning before a disaster, targeted at four elements[18]: preparedness (policies and procedures designed to facilitate effective response); response (actions taken immediately before, during and after a disaster to protect people and property and to enhance recovery); recovery (actions taken after a disaster to restore critical systems and return a community to pre-disaster conditions); and mitigation (actions taken before or after a disaster to reduce the impacts on people and property of future hazards). Mitigation with its focus on preventing natural hazards from becoming natural disasters, includes policies and actions such as building public awareness and support; development of local and regional plans for land use to prevent inappropriate development in hazardous areas; changing building codes and standards to protect people, property and infrastructure from "reasonable" extremes; structural engineering to increase resistance; and forecasting and warning systems which provide information to citizens and advise them regarding an appropriate response strategy.

Disaster management has traditionally included both structural and non-structural approaches. Structural approaches include making structures (dykes, levees, buildings, power lines, etc.) more resistance to natural hazards. This is accomplished by governments in part through building codes. Loss of electricity during a natural hazard is one of the major concerns and the practice has been the build transmission towers to withstand strong loads. Unfortunately, some natural hazard will eventually occur that exceeds the design specifications and it will break, often catastrophically. Newer approaches now include the concept of resilience, so that transmission towers are built with break away arms, so that they can more easily be rebuilt when failure occurs, reducing the time before power is re-established.

Non-structural approaches to disaster management and responding to climate change include better land-use planning, using insurance (especially to create incentives) and educational programs to have a better informed population. Government policies and laws need to reflect the needs to reduce impacts. To quote G. White, one of the pioneers in disaster management, "If you build in a flood plain, there is no solution". In the context of climate change, a similar expression could be: "If you assume the climate is static, there is no wisdom."

7. ICSU's consideration of natural hazards

Following a review of all ICSU programs on the environment and sustainable development, an ICSU Scoping Group on Natural and Human-induced Environmental

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

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

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

The ICSU General Assembly (2005) endorsed the recommendations and created an International Planning Group on Natural and Human-Induced Environmental Hazards and Disasters (the list of members is given as Appendix 1). The Planning Group was tasked to formulate a set of detailed objectives for an ICSU Hazards Programme based on a review of ongoing and planned relevant activities, in consultation with ICSU Scientific Union and National Members, Interdisciplinary Bodies and Joint Initiatives. If a new Programme is proposed, the report should clearly demonstrate the added value of an ICSU Programme in the area. The Planning Group should take the report on hazards to the ICSU 28th General Assembly with proposals for broad areas of research to be targeted in the first three years and define the milestones that should be reached during the life span of the Programme.

The Planning Group is to stimulate, encourage and organise debate among a wide range of interested parties on the possible objectives and content of an ICSU Hazards Programme, In particular, to consult the proposed target audiences (development agencies; humanitarian assistance agencies (including UN bodies and NGOs); and governmental policy-makers) about how an ICSU Hazards Programme might best meet their needs. It will also make proposals for how stakeholder groups other than scientists and policy-makers *(e. g*., people living in areas vulnerable to natural hazards) can contribute to setting the agenda for an ICSU Hazards Programme and can be involved in its progress

8. Initial Considerations of the International Planning Group

The Group met for the first time in Paris on June 20-21, 2006. The Group agreed, within the scope of natural and human-induced environmental hazards that the focus was on hydrometeorological and geophysical trigger events and related events such as fires and locusts. Human-induced included land-use practices and climate change. Epidemics

would be included only when they are consequences of the forenamed events while technical, industrial hazards; warfare and associated activities would not be included but it was recognized that there was lessons to be learned from study of these events. The Group concluded that the most significant research gaps were in terms of interdisciplinary cohesion, the intersection of natural-social and political issues; public perception-decision making and related issues of risk and uncertainty; human behaviour and cultural contexts; and how knowledge about hazards is put to use.

9. A Potential International Research programme

The International Research Programme will undertake quality science for a purpose of reducing the impacts of natural hazards on humans and their socio-economic activities and infrastructure. The legacy of the Program will be an enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their impacts, such that in ten years, result will be, that when comparable events occur, there is a reduction in relative loss of life and fewer adversely impacted and wiser investments and choices are made by civil society

The Research Themes are proposed to be:

1. Improved understanding, monitoring and prediction of natural hazards
2. Integrated risk analysis incorporating socio-economic factors
3. Societal resilience to hazards
4. Interplay of risks across different temporal and spatial scales
5. Understanding effective science-policy interactions and the role of scientific assessments

The Programme will also need to address how to build international and national capacity to understand and reduce risk and vulnerabilities and how to better communicate, foster education and outreach and engage the policy community. The Programme would also contribute to the methodological excellence in assessing risk and response strategies to natural and human-induced environmental hazards and disasters

Organizational structure of and implementation for the Programme is to be developed. It is anticipated that the Programme would have co-sponsorship by UN agencies such as the International Strategy for Disaster Reduction, the World Meteorological Organization and Unesco and its Intergovernmental Oceanographic Commission, and with other interested and appropriate scientific and intergovernmental agencies.

10. Concluding Remarks

This Regional Conference on Natural and Human-Induced Environmental Hazards and Disasters, held with the inauguration of the ICSU Regional Office for Asia and the Pacific provides an excellent opportunity for expanding the discussions on the scope, focus and other attributes of the proposed international research programme.

Acknowledgements. The author thanks all members of both the Scoping and Planning groups for their inputs, commitments and the depth of the discussions.

Appendix 1
ICSU Planning Group on Natural and Human-Induced Environmental Hazards and Disasters - Members of Planning Group

Gordon **McBean** *(Chairman)* Institute for Catastrophic Loss Reduction University of Western Ontario Canada	Allan **Lavell** Facultad Latinoamericana de Ciencias Sociales (FLACSO) Costa Rica
Tom **Beer** CSIRO Environmental Risk Network Australia	Daniel **Murdiyarso** Center for International Forestry Research (CIFOR) Indonesia
Ian **Burton** Professor Emeritus, University of Toronto Scientist Emeritus, Meteorological Service of Canada Canada	Victor **Osipov** Institute of Environmental Geosciences Russian Academy of Sciences Russia
Chien-Jen **Chen** Graduate Institute of Epidemiology National Taiwan University Taiwan	Stephen **Sparks** Department of Earth Sciences University of Bristol UK
Opha Pauline **Dube** Department of Environmental Science Faculty of Science Botswana	Reid **Basher** Senior Coordinator, Interagency and Policy Coordination Unit, ISDR secretariat Switzerland
J. Richard **Eiser** Professor of Psychology University of Sheffield UK	Badaoui **Rouhban** Chief, Section for Disaster Reduction UNESCO France
Filipe Domingos **Freires Lúcio** National Institute of Meteorology of Mozambique Mozambique	Dieter **Schiessl** Director, Responsible for Crosscutting Coordination WMO Switzerland
Harsh **Gupta** *(CSPR Liaison)* National Geophysical Research Institute India	Thomas **Rosswall** Executive Director International Council for Science (ICSU) France
William **Hooke** American Meteorological Society USA	Howard **Moore** Senior Consultant to the Executive Director

Richard **Keller** University of Wisconsin-Madison Medical Sciences Center USA	International Council for Science (ICSU) France

[1] United Nations International Strategy for Disaster Reduction (UN ISDR). (www.unisdr.org)
[2] UN ISDR
[3] UN ISDR
[4] EM-DAT: The OFDA/CRED International Disaster Database http://www.em-datnet.UCL - Brussels, Belgium
[5] www.munichre.com/
[6] The WCDR News, published by the Secretariat of the Hyogo Cooperative Committee for the World Conference on Disaster Reduction, No. 4, 21 January 2005.
[7] McBean, G.A., 2005: The worst is yet to come: hurricanes and global warming. Policy Options, December 2005-January 2006, pp 21-26. (www.irpp.org)
[8] Mutter, J.C., 2005: The Earth Sciences, Human Well-Being, and the Reduction of Global Poverty, EOS, 86, 16, 157, 164-165
[9] Handmer, J., 2003: Adaptive capacity: what does it mean in the context of natural hazards. In Climate Change, Adaptive Capacity and Development, J.B. Smith, R.J.T. Klein and S. Huq (Editors), Imperial College Press, 51-70.
[10] Handmer, J., 2003: Adaptive capacity: what does it mean in the context of natural hazards. In Climate Change, Adaptive Capacity and Development, J.B. Smith, R.J.T. Klein and S. Huq (Editors), Imperial College Press, 51-70.
[11] World Commission on Environment and Development, 1987: Our Common Future. Oxford University Press, 400 pp.
[12] Mirza, M.M.Q. 2003: Climate change and extreme weather events: can developing countries adapt? Climate Policy 3, 233–248
[13] Beg, N., J. Corfee Morlot, O. Davidson, Y. Afrane-Okesse, L. Tyani, F. Denton, Y. Sokona, J. P. Thomas, E. Lèbre La Rovere, J. K. Parikh, K. Parikh, A. Atiq Rahman, 2002: Linkages between climate change and sustainable development. Climate Policy 2, 129–144
[14] IPCC, Climate Change 2001 – Synthesis Report, p. 211 – Also in WG1 Technical Summary
[15] IPCC, Climate Change 2001 – Synthesis Report, p. 225 – Also in WG2 Summary for Policy Makers, section 2.5
[16] Report of the World Summit for Sustainable Development, Johannesburg, South Africa, 26 August- 4 September 2002 (A/CONF.199/20*, www.un.org)
[17] World Conference on Disaster Reduction 18-22 January 2005, Kobe, Hyogo, Japan. Hyogo Declaration Extract from the final report of the World Conference on Disaster Reduction, (A/CONF.206/6), International Strategy for Disaster Reduction www.unisdr.org/wcdr
[18] Godschalk, David R. 1991: "Disaster Mitigation and Hazard Management," in Emergency Management: Principles and Practice for Local Government, T. E. Drabek and G. J. Hoetmer (Ed.). Washington, D.C.: International City Management Association: pp. 131-159.