Natural Disaster Reduction
Safer Sustainable Communities: Making Better Decisions about Risk

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10 April 2002

Executive Summary

Natural hazards -- earthquakes, volcanic eruptions, wildfires, tropical cyclones, floods, severe storms, storm surges, landslides, meteorite falls, and tsunamis -- pose a severe threat to many parts of the world. Severe events have set back economic development in some countries by many years. Yet, there are proven approaches that could, if broadly implemented, significantly reduce the impact of natural disasters. Such mitigation methods are based on scientific knowledge about the hazards and on technical means for countering their effects. But their implementation requires not only integration with the social sciences, but also effective partnerships with the many parties that have a stake in reducing losses. In the end, implementation of mitigation measures is typically carried out at the local level. Thus, scientists and engineers must join with social and behavioral scientists, economists, insurers, politicians and other decision-makers to make vulnerable communities more disaster resilient.

Specific knowledge areas that warrant increased attention include:

- Understanding the consequences of hazard impacts rather than just their causes, leading to a risk management approach.
- Improving knowledge of community vulnerability to promote awareness, hazard and risk assessment, and decision-making.
- Increasing access to, and improving the quality of, data bases on disaster impacts, including both direct and indirect losses.
- Improving and utilizing models for loss estimation.
- Upgrading the quality of spatial data bases and means for data handling.
- Integrating expertise among the physical and social sciences to provide more effective decision making for implementing loss-reduction measures.

As natural hazards occur infrequently, although with severe consequences, decision-makers usually devote limited resources to the most pressing current problems rather than to a problem that may not occur on their "watch". To do otherwise, a decision-maker must have a cost-effective justification. Providing that justification is our challenge.

1. Introduction

Modern natural disaster reduction principles and practices depend on a solid information base, best-practice information management, and robust methodologies and tools for analysing hazard and risk.. Science also must keep pace with the current natural disaster reduction trend towards a community-centred approach to the way that risk is managed. This means working *with* communities rather than *for* them. Furthermore, implementing the concept of working-with-communities will itself require research in order to develop new approaches to a more effective interaction between science and the community.

The aim of this paper is to identify key issues arising from the area of science, research, and information that can assist in the reduction of the consequences of sudden-impact natural hazards and their associated risks, and to emphasise the need for collaboration between the physical and social sciences.

2. Hazard Science to Risk Science

Government scientific agencies and universities have a history of involvement in research and monitoring of natural hazards identified – namely, earthquakes, volcanoes, bushfire, tropical cyclone, flood, storm (including hail), storm surge, landslides, meteorite, tornado, and tsunami. In many countries, the Meteorological Agency provides forecasts and warnings of dangerous weather and of the conditions leading to floods and bushfires. A Geoscience Agency operates the national network for volcanic and earthquake detection and reporting. Research tends to be directed at understanding the geophysical processes of specific natural hazards (including climate change). Most of this work can be referred to as 'hazards science'.

In addition there needs to be increased recognition of man-made hazards, particularly those that can be triggered by natural phenomena. For example,a significant hazard in many former areas of underground mining is subsidence and this is often triggered by meteorological events. Another example relates to emissions of explosive or asphyxiating gases, many of which can come from natural or man-made sources, but regardless of origin the precautions and responses that are needed are often essentially the same.

Important changes in approach have taken place during the last ten years, in large part through the inter-agency collaboration engendered by the successful International Decade for Natural Disaster Reduction (IDNDR). There is now increased emphasis on understanding the *consequences* of hazard impacts on communities rather than simply the geophysics of the hazards themselves. Thus, work in both the physical and social sciences needs to be brought together to give a more holistic understanding of these shocks to communities. Progress has also been made in the application of risk management at community level.

An important driver in the shift from hazard science to community and risk-based science has been the introduction of national Risk Management Standards. The first of these was the Australian Standard 4360 (1995, 1999). The standard provides a generic framework for the identification, assessment and treatment of risks. It also offers the possibility for greater collaboration between science agencies, research bodies and natural disaster management agencies by providing a common approach to risks. In practice, however, different disciplines use different frameworks to examine risk. The natural hazards community bases their analysis of risk on a frequency of event-vulnerability framework. Determining the common elements of risk frameworks so as to provide a common language of risk is an important research role for the international scientific community.

Recommendation 1: *That ICSU work with the IUGG GeoRisk Commission to support the development of a common risk framework*

The approaches, methodologies, and tool sets used in the scientific arena to assess hazards, vulnerability, risk, and uncertainty are not restricted to any one group, or groups, of hazards. Assessment and modelling of risk and uncertainty is a generic process that can be applied equally to, for example, tropical cyclones (sudden-impact natural hazard), dry-land salinity (slow-onset environmental hazard), or terrorist attacks (societal hazard), as long as there is an information base on which to undertake the analysis and define the uncertainty. Science directed towards the safety, security, sustainability, and stability of communities therefore provides the potential for communities and governments to take a truly all-hazards and holistic approach to risk.

3. Information, Knowledge, and Risk Assessment

3.1 Managing Community Knowledge

Disasters commonly lead to immediate responses but as time passes, the memory and need for preparedness fades leaving communities unprepared the next time around. To develop safer, sustainable communities it will be necessary for communities to become more knowledgeable about dealing with disasters, and storing their accumulated knowledge. Communities have always been a repository of knowledge. That is part of the definition of community. However, given the complexity of modern communities and the high-consequence risks being faced by them, the capture and sharing of knowledge needs to be undertaken in a more systematic and effective manner. An important role for scientists and natural disaster managers is to develop a culture of

knowledge management within communities that effectively contributes to risk management and sustainability. The goal should be to create communities that are aware of their need to be know and so they naturally generate and share knowledge about natural disaster risk management, not to develop a dependence where it is expected that an external or expert group will always undertake this role.

Knowledge is the body of understanding and skill that is mentally constructed by people from information they assimilate, that is, the understanding derived from experience. Knowledge management is the allocation and organization of resources to create and share knowledge, to benefit a particular activity or practice. Within the context of natural disaster reduction the benefit is improved decision making by individuals and groups within a community, behavioral changes to better manage risk and ultimately improved sustainability.

Recommendation 2: *That ICSU support the development of a knowledge management framework and standard for the natural disaster reduction community.*

3.2 Improved collection and management of data, information, and knowledge

A more integrated approach to database development is needed at the international level to support risk-assessment and natural disaster reduction. Most existing databases of relevance are not necessarily focused clearly on community needs.

In many areas there are significant amounts of data that can be collated as a first step. This need not necessarily be expensive, and it can help to set priorities for placing resources where primary investigations are needed. Often, such initiatives occur after disasters instead of before them. It would be useful to collect some data on how the costs of earlier investigation might have reduced losses in respect of specific examples to demonstrate that timely work is a good and appropriate investment.

Recommendation 3: *That ICSU assist in the creation, development and integration of databases relevant to natural disaster reduction.*

Collection and collation of data and information on the impact of individual natural disasters needs to be encouraged, coordinated, and systematised. Data must include observations of hazard (e.g., meteorological or geological data), physical damage, and cost of repair or replacement of buildings and other infrastructure. This type of

information is crucial for obtaining improved estimates of the *direct* costs of disasters. Much of this information is obtained readily by field teams visiting disaster areas soon after the events (such as with pre-formatted, palm-top computers) and collaborating with insurers, local officials, and engineers regarding damage and repair costs. The international community needs to collate the information that has been collected, and make it readily and easily accessible.

The fundamental datasets provided by government are a critical input to all spatial information activities. The spatial data collected and produced by Government agencies include geodetic control, topographic and thematic maps, satellite images and aerial photography, and digital information— such as cadastral infrastructures, administrative boundaries, topographic data and digital elevation models. There are currently significant issues relating to data access and data exchange being debated internationally through CODATA, yet these data are important for public-good, community-safety, risk-assessment requirements. In particular, the major research potential lies in the ability of Geographical Information Systems to provide the tools with which to provide spatially disaggregated data.

Recommendation 4: *That CODATA work with ICSU Committee on Disaster Reduction to improve access to the critical spatial data required for public-safety needs.*

3.3. On-line delivery of information

On-line delivery of spatial data and information relevant to natural disaster reduction is now a reality. Internet access and delivery are clearly the way of the future and inevitably they will become included in normal business practice for those involved in disaster-mitigation, relief, and response activities.

IUGG, through their Commission on Geophysical Risk and Sustainability (GeoRisk Commission) are presently developing a webcyclopedia of risk and sustainability. The webcyclopedia is envisaged as a web based encyclopedia. A traditional encyclopedia is ordered alphabetically. The webcyclopedia will be ordered in terms of i)communities, and ii) hazards and risks. The hazards to be considered are determined by the scientific skill base, as determined by the IUGG associations. The risks are determined by the sustainability issues such as infrastructure issues (building vulnerability, robustness of infrastructure), and health issues (air quality, water quality, contaminated land).

Recommendation 5: *That ICSU endorses development of the IUGG GeoRisk Commission Webcyclopedia of Risk and Sustainability.*

3.4. Loss Estimation Strategies and Decision-Making Tools

There is also a need for assessing the long-term economic impact and social costs of disasters. In particular, data and information are needed on indirect and intangible costs of disasters, such as the health costs and the costs of psychological effects. These are more difficult to identify and quantify, and require the coordination of a wide range of stakeholders in the community as well as guidelines for interpretation. The combination of direct and indirect cost information provides the basis for tracking the costs of past disasters and is vital for improving loss-estimation models. The major scientific challenge in relation to risk and sustainability lies in finding robust ways to determine whether the apparently greater present-day vulnerability is due to the increase in the frequency of natural disasters, or due to the growth of population into more vulnerable areas.

Recommendation 6: *That ICSU and IUGG examines ways to quantify and analyse the changes in vulnerability and in natural disaster occurrence.*

Loss-estimation models generally capture the risk in a rather limited context, commonly in terms of the direct damage or cost of a disaster. Research is needed to extend these estimates to include *indirect* effects (e.g. loss of income, quality of life) as well as other social, political, and other economic factors that invariably play a role in decisions about risk treatment. Advances in risk modelling also can be used to develop disaster scenarios for natural disaster response and urban planning, to educate the community, and to evaluate risk acceptance thresholds for a wide range of stakeholders

Recommendation 7: *That ICSU supports the development of a systematic approach to loss estimation as a part of a program to capture the full costs of past disasters and to estimate the costs of future ones through risk modelling approaches currently under development.*

4. Understanding and Working With Communities

A community-centred approach to natural disaster reduction should produce better management of risks. Thus, effective risk reduction and mitigation requires the active contribution of community members. Natural disaster management agencies cannot achieve these results by themselves because the causes of risks are commonly in areas beyond the scope of practice of agencies. In many cases, community members can be far more effective in addressing the causes of risks through their everyday practices.

The shift to a community-centred approach requires a better understanding of community profiles, cultures, expectations, decision-making processes and needs. This is a difficult issue because communities are complex. No two communities are the same. Social science research can assist here.

Some of the UN organizations, such as the WHO, conduct very valuable in disseminating awareness of the causes of illness and disease and simple precautions that can be taken to reduce occurrences and exposure. Once simple approaches are developed, these need to be harmonised with the prevailing legislative and regulatory systems and, therefore, to engage with national, regional and local governments, as well as communities at risk.

Importantly, there are also great differences within communities in terms of the susceptibility of community members to different hazards and their ability to cope with extreme events. Community engagement with risk management therefore becomes an important issue. Risk communication research identifies that provision of information is not enough: people need to have a vested interest in the issue to take it on board, and agencies therefore must develop processes that engage and maintain people's interest in issues about risk.

Strategies for understanding and engaging the community have become central to many areas of public policy. Research and practice from other disciplines and policy areas will contribute to successful community-centred natural disaster reduction. The wide range of ways being used to understand and engage communities in other areas need to be identified, tested, and reviewed to ensure they are appropriate for effectively managing risk.

An understanding of communities is critical in guiding the research priorities of hazard and risk science. Effective adoption of the results of hazard science by community members relies on research being carefully developed to address community priorities.

The challenges facing the natural disaster reduction sector will benefit from input from research in both the physical and social sciences. Building, enhancing, and maintaining an appropriate research capability is essential in order to achieve the required outcome of safer sustainable communities.

A number of key areas can be identified:

- understanding communities; and importantly the decision-making foci and processes within them
- natural disaster reduction capability;
- mitigation – definition, values and marketing;
- information management and modern information technology;
- voluntarism;
- value of the emergency services – development of performance indicators;
- economic and social costs of disasters – an improved framework is needed.

Of this list, the highest-priority is a greater understanding of the nature of communities. This will require:

- describing and understanding communities' perceptions, values and expectations within an natural disaster reduction context
- developing the practical concepts of risk communication, sustainability, vulnerability, resilience, security, coping capacity, and community safety to enhance natural disaster reduction activities
- linking with relevant research in other fields, including social capital, community well-being, and sustainable and healthy communities.
- identifying better methods for and handling uncertainty in communicating with stakeholders.

Recommendation 8: *That ICSU support research that will assist in the implementation of a "community centered" approach to natural disaster reduction in vulnerable areas.*

5. Conclusions

The recommendations provided in the foregoing, address solutions to current issues in the application of science, research, and information management to risk assessment and natural disaster reduction. Scientific research and information management in the natural disaster reduction arena have developed significantly in recent years and are poised to have an even greater impact on risk-management, given the current international focus on community vulnerability and needs.