Risk identification: a critical component of disaster risk management

By Maxx Dilley[1]

Introduction

The 21st century begins as the best of times and the worst of times in the history of contemporary disaster management. On the one hand, there are clear signs of a shift in thinking—away from over-reliance on post-disaster relief, recovery and reconstruction as the main means of managing disasters and towards a more proactive paradigm of managing the risk factors that create disasters. On the other hand, a continuing series of large-scale disasters—the Indian Ocean tsunami of 26 December 2004[2], the floods in New Orleans associated with Hurricane *Katrina* in August 2005[3], the South Asian earthquake of 8 October 2005[4], for example—adds to a growing trend in losses. Loss of life is proportionally higher and the economic impacts of disasters are proportionally greater in developing countries. In disaster-prone areas of the developing world, recurrent losses continually undermine development.

This article argues that evidence of risk factors and risk levels is key for both promoting and enabling a transition from emergency to risk management. Such evidence renders risk factors visible and allows them to be addressed through socio-economic development processes. We examine the process by which evidence on the causal factors of disasters can be created. The article concludes with some practical observations and recommendations relevant for high-risk countries concerning:

- The role of evidence in supporting risk-management decisions;
- The importance of hydrometeorological hazards and the need for high-quality hazard observations; and
- The technical expertise and close collaboration among different disciplines required for risk analysis.

Background

The case for risk management as an alternative to emergency management is made by mounting disaster losses. Losses could be stemmed if the causal factors that lead to disasters were more systematically identified and preventive actions taken.

Currently, the frequency of disasters associated with all types of major natural hazards is increasing, and disasters associated with hydrometeorological hazards (cyclones, droughts and floods) are increasing in frequency faster than disasters associated with geophysical hazards (Guha-Sapir *et al.*, 2004). Although the number of victims per 100 000 inhabitants has generally declined for upper and upper-middle income countries in recent decades, the numbers of victims in lower and lower-middle income countries have held steady or even increased (Guha-Sapir *et al.*, 2004). Moreover, economic losses—insured and uninsured—have continued to climb (Munich Re Group, 2004).

Despite these mixed (or even negative) results, recent publications by major organizations with global disaster and humanitarian assistance mandates document an encouraging trend in terms of how we think about the disaster problem, increasingly advocating a risk-management approach.

For example, in 2002, the International Federation of Red Cross and Red Crescent Societies' annual *World Disaster Report* focused on disaster risk reduction (IFRC, 2002). In 2004, the International Strategy for Disaster Reduction's *Living with Risk* report documented a large number of on-going actions to manage disaster risks globally (ISDR, 2004).

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3 TC-2005-000144-USA
4 EQ-2005-000174

In the past two years, three new reports have been published that provide evidence of global and regional disaster risks. In 2004, the United Nations Development Programme released *Reducing Disaster Risk, A Challenge for Development* (UNDP, 2004). This report contains a Disaster Risk Index (DRI), developed by the United Nations Environment Programme. The DRI measures relative vulnerability of countries exposed to cyclones, floods, drought and earthquakes. It demonstrates that some countries experience higher levels of mortality than others with similar degrees of hazard exposure and suggests some explanatory vulnerability factors that account for these differences.

Similarly, *Natural Disaster Hotspots: A Global Risk Analysis* (Dilley *et al.,* 2005), documents relative risks of disaster-related mortality and economic losses associated with six major hazards globally: cyclones, drought, floods, landslides, earthquakes and volcanoes. Risks of these two outcomes are calculated on a 5 x 5 km grid, based on the hazard exposure of population and GDP and historical loss rates stratified by region and country wealth. The Hotspots project was a collaboration between the World Bank and Columbia University with a number of international implementing partners under the umbrella of the ProVention Consortium.

The Inter-American Development Bank and the National University of Colombia in Manizales recently compiled a set of indicators for disaster-risk management in the Americas (Cardona, 2005; IDEA, 2005). These indicators reflect the extent to which 12 countries are financially prepared for the maximum probable loss in a major disaster, the degree of multi-hazard vulnerability, the spatial dispersion of disaster risks and risk-management capacity.

These reports not only exemplify a trend towards increased focus on risk management, they also provide scientifically grounded information on risk levels and risk factors. As such, they provide a foundation on which to build a process of using risk information more systematically to support risk-management decision-making.

Evidence-based risk management

A simple schema for disaster-risk management is composed of three areas: risk identification, risk reduction and risk transfer (www.provention-consortium.org). Risk identification deals with the factors that cause disasters, namely: natural hazards; the exposure of people, infrastructure and economic activities to these hazards; and the vulnerabilities that the exposed elements may possess that cause them to be damaged or lost when a hazard strikes.

Risk identification was acknowledged as essential for reducing disaster losses at the January 2005 World Conference on Disaster Reduction (ISDR, 2005). Risk reduction comprises actions that decrease the likelihood or extent of losses. Risk transfer involves the use of financial mechanisms that allow risks to be shared and redistributed (Kreimer *et al.*, 1999).

The role of evidence in risk-management decision-making

Identification of disaster-risk levels and factors is crucial for preventing losses. In the pre-disaster phase, evidence of disaster risks and risk levels can support the incorporation of disaster risk reduction and transfer measures into development. After disasters, evidence on risks can be used to promote risk reduction and transfer as part of recovery and reconstruction. In both processes, risk identification provides the means of setting priorities, developing risk management plans and strategies, and evaluating the specific policies and measures needed to achieve an appropriate balance between risk minimization and other development priorities.

After a disaster, the risk factors that led to the losses—hazards, exposure patterns and vulnerabilities—become clear. The resulting losses can be dealt with through post-emergency management. Preventing such losses, however, requires that the latent causal factors that can lead to a disaster be identified before a disaster occurs, so that they can be reduced or transferred away from the affected population. One of the sad realities of disasters and risk management is that, very often, the main window of opportunity for risk management is in the aftermath of a disaster. At such times, the need for risk management is clear and attention at all levels of society is focused on the disaster problem.

This means that risk managers have two windows in which to act: before disasters, through prevention and preparedness; and after, during relief, recovery and reconstruction. The major difference is that, while the visibility of disasters is high post-disaster, the demands of the disaster response make longer-term risk management planning more difficult. Taking advantage of the window of opportunity for reducing risks in the aftermath of a disaster requires measures put in place ahead of time that can be implemented during recovery and reconstruction. Otherwise, the imperative to rapidly restore essential systems may lead to reconstruction of the same patterns of exposure and vulnerability that led to the disaster in the first place, or even worse.

Hurricane damage in Grenada in 2004: more than 90 per cent of the island's buildings were destroyed.

Damage and losses during disasters occur across all economic sectors. Social sectors include health, education and housing; productive sectors include agriculture, livestock and industry; infrastructure sectors include roads, railways, water and sanitation systems, telecommunications and electric power. Disaster losses in these sectors can be either direct (i.e. damages to assets) or indirect (i.e. downstream losses due to damaged or lost assets) (UNECLAC and the World Bank, 2003). Preventing losses requires assessing hazard exposure and vulnerabilities within these sectors—focusing on the geographic areas where hazard events are most likely to occur—and reducing the vulnerabilities that could lead to losses. In the wake of a disaster, pre-identification and preparation of vulnerability-reducing measures can promote adoption of these measures beginning from the very first stages of recovery.

What constitutes evidence?

In the wake of a disaster, the hazard, the vulnerabilities and the resulting risks become apparent. Unrealized risks associated with other hazards may not be so visible, however. Many disaster-prone areas are subject to multiple hazards; the next disaster will not always involve the same hazard as the one before. One challenge of post-disaster risk management is simultaneously to avoid reducing the risks of a recurrence of the last disaster, while incorporating measures to reduce the risks of the next.

In the pre-disaster phase, the even greater challenge is to make the latent risk factors associated with all hazards visible. This is often the more difficult task, in the absence of a disaster recent enough to capture the attention of the decision-makers.

In either case, the key to making the risk factors visible enough so that they can be acted upon is the creation of evidence that disaster-causing factors are both present and dangerous. Evidence to that effect helps disaster risks compete for attention with other pressing development priorities. Evidence-based policy requires information that is relevant, representative and reliable (Solesbury, 2001). Meeting those criteria requires a scientific theory of disaster causality on which rigorous methods can be based and relevant data identified.

The most obvious causal factor in a disaster is the hazard event itself. Hurricane *Katrina* brought pounding wind and water, for example, which breached a levee in New Orleans in August 2005. But the damage—first to the levee and then to the city itself—had two other intrinsic causes.

The first of these is exposure. New Orleans sits on the coast of the Gulf of Mexico at an elevation at or below sea-level. Its geographical position exposes the city to hurricanes. There are many highly populated locations around the world that are vulnerable to natural hazards owing to their geographical position. The second is vulnerability. The widespread flood damage that occurred was caused by the fact that the levees surrounding the

city were unable to withstand a Category 4 or 5 hurricane ("Why the levee broke", Will Bunch, 1 September 2005, http://www.alternet.org/story/24871).

A complete explanatory theory of disaster causality therefore includes both hazard exposure and vulnerability. Risks of losses are a product of these two sets of causes. Evidence on vulnerability is particularly crucial for planning purposes, because reducing exposure and/or vulnerability is generally the main means of reducing overall risks. Such evidence may not always be heeded but the consequences when the evidence is not heeded underscore its importance for decision-making.

The main task of risk identification is to assemble the necessary data on hazard exposure and vulnerability and integrate them with appropriate methods to arrive at a scientifically grounded explanation of the risks of potential consequent losses. As hydrometeorological hazards are involved in the lion's share of disasters globally, having good data on climatic hazards and associated vulnerabilities is particularly important.

Hydrometeorological hazards

Disasters involving hydrometeorological hazards are the most frequent and geographically extensive globally and account for the largest share of overall disaster losses (see table above). Relative risks of disaster-related mortality and economic losses associated with drought and flooding in particular are high across large areas of virtually every inhabited continent (Dilley *et al.*, 2005).

Climate changes associated with global warming have the potential to change regional hydrometeorological hazard patterns. Such changes would reveal new vulnerabilities and create new global, national and local patterns of risk. Given the pervasive nature of hydrometeorological hazards and current levels of vulnerability, keeping up with these changes will require continuing and renewed commitment to maintaining the basic data needed for identifying and managing climate-related risks.

*Global disaster frequency and losses 1900-2004**

Hazard type	*Frequency*	*Killed (millions)*	*Affected (millions)*	*Economic loss (US$ billion)*
Hydrometeorological	7 369	18	5 723	866
Geophysical	1 172	2	103	320

* EM-DAT: The OFDA/CRED International Disaster Database (www.em-dat.net), Université Catholique de Louvain, Brussels, Belgium

Hazard events are characterized by magnitude, duration, location and timing (Burton *et al.*, 1993). Calculating the probability of occurrence of hazard events in terms of these characteristics is the key task in fully documenting the hazard component of disaster causality. These defining characteristics provide a basis for extracting information on hazard frequency and severity from observational datasets.

The fundamental requirement is the availability of, and access to, high-quality historical meteorological and hydrological data. This requires:

- Ongoing, systematic and consistent observations of hazard-relevant hydrometeorological parameters;
- Quality assurance and proper archiving of the data into temporally and geographically referenced and consistently catalogued observational datasets; and
- Ensuring that the data can be located and retrieved by users.

Since its establishment in 1950, one of the core activities of WMO has been the consolidation of general requirements for global Earth observations and the coordination of consistent, systematic and continuous collection and archiving of hydrometeorological observations. Furthermore, through establishment of standards, guidelines and procedures for data collection, quality control, formatting, archiving and rescue, WMO has assisted countries, through their National Meteorological and Hydrological Services, to enhance their capacity in this area.

WMO continues to work towards ensuring consistent data quality and accessibility across national boundaries for the purpose of improving risk-management capabilities at the regional and subregional level. Through the WMO Global Observing System, operated by the National Meteorological Services, data are collected from 14 satellites, hundreds of ocean buoys, thousands of aircraft and ships and nearly 10 000 land-based stations. More than 50 000 weather reports and several thousand charts and digital products are disseminated daily through the WMO Global Telecommunication System, which interconnects all meteorological centres around the globe. The WMO Global Data-processing and Forecasting System ensures cooperation by world, regional and national centres to process data and routinely provide countries with analyses and meteorological forecasts—including of severe events—supporting early warning through National Meteorological Services.

WMO's coordinated Global Observing System and Global Data-processing and Forecasting System involves three World Meteorological Centres (WMCs) and 40 Regional Specialized Meteorological Centres (RSMCs). They are all operated by National Meteorological and Hydrological Services and have proved to be highly effective for operational early warning capabilities for a number of hazards.

One example is the WMO Global Tropical Cyclone Early Warning System. It comprises a coordinated observing network for collecting and sharing data, six RSMCs dedicated to providing tropical cyclone analysis, forecasts and alerts in support of National Meteorological Services' operational warning systems and five regional committees which ensure ongoing improvements in the tropical cyclone forecasting and warning systems. This has enabled the availability of tropical cyclone warning capacities in all countries at risk. Although significant progress has been made in some countries, and long historical records exist in some cases, data in others are scarce and variations in data quality are significant. Furthermore, there remain inconsistencies in the historical records across national boundaries and over time.

At the national level, many challenges remain, including:

- The need for hydrometeorological instrumentation;
- Data-collection and management systems;
- Technical capacity and resources for maintaining observational networks;
- Data rescue to translate massive amounts of paper-based records into digital form;
- Ongoing quality control to ensure consistency and completeness of the records;
- The capacity to archive large databases; and
- Ensuring that the data are available to all users.

Development of these capacities should be considered as an investment towards enhanced risk management and socio-economic development in disaster-prone countries.

Increasingly at the political level, countries are recognizing the importance of investing in hydrometeorological data as a national resource, and are consequently directing more resources to their National Meteorological Services. Furthermore, the international and regional development community—including the World Bank and regional development banks—recognizes the critical contribution of National Meteorological and Hydrological Services and is increasingly investing in strengthening their capacities to be able to meet these critical needs.

Currently, renewed efforts are underway to address limitations with respect to data quality and consistency, as well as availability and accessibility of relevant data for critical applications such as risk assessment on regional and subregional scales. The goal of the international Group on Earth Observations (GEO)[5] is to ensure comprehensive and sustained Earth observations. This initiative builds on, and adds value to, existing Earth observation systems by coordinating their efforts, addressing critical gaps, supporting interoperability, sharing information, reaching a common understanding of user requirements and improving delivery of information to users.

This international initiative aims to establish a Global Earth Observation System of Systems (GEOSS) over the next decade. GEOSS is intended to achieve comprehensive, coordinated and sustained observations of the Earth system in order to improve monitoring of the state of the Earth, increase understanding of its

5 In July 2003, 33 nations and the European Commission adopted a Declaration that signifies political commitment to developing a comprehensive, coordinated, and sustained Earth Observation System(s). To further this goal, the Summit participants launched the intergovernmental ad hoc Group on Earth Observations (GEO) to develop a 10-Year Implementation Plan

processes, and enhance prediction of its behaviour. GEOSS seeks to meet the need for timely, quality, long-term global information as a basis for sound decision-making, and to enhance delivery of benefits to society for nine high-priority societal areas—of which one is reducing loss of life and property from natural and human-induced disasters.

Governments that recognize the importance of risk assessment can commit themselves to addressing the above-mentioned challenges by contributing to GEOSS. Actions include appropriate data-access policies and legislation and measures to enhance the institutional capacity and operational services of their technical agencies such as the National Meteorological and Hydrological Services. Furthermore, through close national, regional and international collaboration and exchange of relevant data, all countries can benefit from enhanced understanding of the hazards and their impacts, contributing to hazard mapping and risk assessment around the globe. In this way, organizations dealing with hydrometeorological data can further contribute to risk identification, risk management and, ultimately, the reduction of losses.

Expertise and collaboration requirements

To arrive at disaster risks, data on hazards are used to estimate the likely exposure of people, infrastructure and economic activities (Coburn *et al.*, 1994). Once the exposed elements have been identified, a more detailed exploration of their vulnerabilities to the specific hazards to which they are exposed can be undertaken.

Risk identification, therefore, involves a range of physical and socio-economic data and expertise. Obtaining and integrating the required data and achieving the required collaboration among stakeholders can be pursued through a three-step process:

- Identifying and reviewing existing disaster risk and loss information products;
- Locating or developing the capacity to generate and improve upon such products;
- Understanding the status of risk-management decision-making within the relevant domain and the entry points for risk identification input.

Key or illustrative elements within each area, as well as key information resources, are summarized below.

Existing risk and loss information products

Valuable information on risks can be obtained from data on historical losses. Internationally, the most comprehensive, publicly accessible database on global disaster losses is EM-DAT (www.em-dat.net). EM-DAT contains one entry per disaster, with data on the date, location, type of hazard, numbers of people killed and affected and the information source.

At the regional level, a similar methodology, called DesInventar, has been used to develop national-level databases in Latin America and the Caribbean (www.desinventar.org). Pilot work applying DesInventar is also under way in Asia.

In the process of inventorying information resources on historical disaster losses for use in identifying risks, it is important to identify any data on losses that may be maintained at the national or state/province level. In high-risk areas, if such data are not being systematically collected and maintained, a system for doing so should be established as a priority. Identifying the appropriate institutional home for such a system is crucial. Considerations include database sustainability, institutional mandates and credibility, capacity for rigorous data verification and maintenance and open data access. Databases on disaster losses should conform, as much as possible, to international standards such as those set by EM-DAT and DesInventar.

Another important international standard is the GLobal disaster IDEntifier (GLIDE) developed by the Asian Disaster Reduction Center and partners (www.glidenumber.net). GLIDE numbers provide a unique identifier for each disaster (see footnotes 3-5 above). Use of GLIDEs allows disaster events to be unambiguously identified and data about specific disasters to be verified across datasets. GLIDE numbers are routinely assigned to all disasters tracked on Reliefweb (www.reliefweb.int) by the United Nations Office for the Coordination of Humanitarian Affairs. GLIDE numbers can also be assigned for disasters at the national or subnational level.

An important consideration in the establishment of national or local disaster data inventories is that loss data must be routinely and consistently obtained, disaster after disaster. This requires consistent application of rigorous and comprehensive loss-assessment methodologies. One such method, for assessing economic losses, was developed by the UN Economic Commission for Latin America and the Caribbean (UNECLAC, cited above). DesInventar can be used to inventory

damage in real-time following disaster events, and also permits that information to be archived in a geo-referenced, historical database.

Information on past losses provides valuable information about the potential for future losses. In the case of infrequently occurring hazards, such as earthquakes, volcanic eruptions or tsunamis, however, the recent past may not be a good guide to the near future. Furthermore, the 50-year flood will ultimately be followed by the 100-year flood, etc. Therefore, it is important to complement historical loss information with analyses of risk, based on hazardousness, exposure and vulnerability as described above.

The global and regional risk analyses cited earlier provide limited risk information about all countries. In high-risk areas, additional, higher-resolution risk assessment information may be available on national or local scales. It is important to locate these larger-scale studies if they exist and verify whether they meet the criteria for evidence described above.

Risk and loss estimation and documentation capacity

The quality and quantity of available risk-identification products on national and local scales is an indicator of risk-assessment capacity. Creating and updating these products require input from a wide range of experts, to the extent that risk-assessment products can seldom be generated by a single institution. Required inputs to a multi-hazard risk assessment, for example, include expertise on each hazard, the elements at risk and the vulnerabilities of those elements to each hazard. Inputs include physical hazard data and subnational, geo-referenced socio-economic and demographic data.

Barges swept up and left stranded on levees when Katrina made landfall on the US Gulf coast on 29 August 2005. (Photo: NOAA)

Undertaking to create or improve existing risk assessments therefore involves clarifying institutional roles, responsibilities and comparative advantages in producing and processing the required information on risk factors. Where critical capacity is lacking, it may be necessary to draw on international expertise to support and enhance it.

Entry points and capacity for risk reduction and transfer decision-making

The relatively recent trend towards risk management as an alternative to disaster management has advanced at different rates from one country or context to the next. In many instances, disasters may still be thought of as an issue primarily of civil defence. Yet, reducing and transferring disaster risks through a risk-management approach involves a range of decisions across virtually all economic sectors. Within a total risk-management strategy, preparedness—an important civil defence function—is complemented by preparedness within affected sectors, as well as by long-term measures to prevent losses through appropriate development policies and sector-specific risk reduction measures.

When undertaking risk identification, therefore, it is important to understand and involve the specific actors whose decisions the evidence generated through the analysis is intended to support. These stakeholders are not simply "users", they are full partners in the risk-identification exercise and the decision options that they identify dictate the specifications of the products developed. Although the capacity of these decision-makers to effectively apply risk information is an issue that goes beyond the scope of risk identification itself, the ultimate utility of the investment in risk identification depends totally on the extent to which it is effectively used for risk management.

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