Engaged in a multitude of international initiatives through the Federal Ministry for Economic Cooperation and Development and the Federal Foreign Office, the German government adopted a framework for action on Disaster Risk Management (DRM) in 2003. For German development cooperation, disaster risks have to be taken into account in all programs in countries regarded as particularly vulnerable and it aims to mainstream DRM as a standard process in high-risk countries. Further, climate risks have to be systematically examined in all affected projects, and—where necessary—DRM is to be integrated within the framework of climate adaptation strategies. This chapter outlines DRM within German development cooperation; the following sections illustrate how German development cooperation, within the framework of sustainability, contributes to more resilient societies in its partner countries.

CHAPTER 9: Experiences in Disaster Risk Management within the German Development Cooperation

This chapter is a submission of the Government of Germany

Disaster Risk Management within German Development Cooperation

Large-scale natural disasters are increasingly the cause of massive economic and ecological damages and losses, claiming human lives and inflicting suffering on survivors.[1] Because of the prevalence of global supply chains, local disasters have increasing negative economic and social impacts in other, more distant parts of the world. In addition, one disaster may trigger additional catastrophes through its negative impact on the environment or technical infrastructure. Disasters happen when an extreme weather event or natural phenomenon hits a vulnerable society. A society's vulnerability to natural events is determined by economic, social, physical, and environmental factors. Climate change, poverty, population growth, and urbanization make developing countries particularly prone to disasters. Disasters result from a multitude of underlying risks, which is why disaster risk management (DRM) requires the involvement of all relevant sectors and a variety of actors on equal footing, including civil society groups, the private sector, and academia. Good governance promotes successful DRM.

Engaged in a multitude of international initiatives through the Federal Ministry for Economic Cooperation and Development and the Federal Foreign Office, in 2003 the German government adopted the following framework for action on DRM:

- Applications-oriented implementation of the research results of academic institutions on DRM;
- Strengthening of national and international DRM committees;
- Development of intersectoral DRM networks;
- Support for training and education measures at schools, at universities, and in adult education;
- Establishment of international coordination agencies for early warning of flooding, fire, and so forth;
- Participation in shaping and formulating United Nations (UN) disaster risk management policy;

For German development cooperation, disaster risks have to be taken into account in all programs in countries regarded as particularly vulnerable. German development cooperation aims to mainstream DRM as a standard task in high-risk countries (box 9.1). Further, climate risks have to be systematically examined in all affected projects, and—where necessary—DRM is to be integrated within the framework of climate adaptation strategies. Overall, German development cooperation strives to ensure the following:

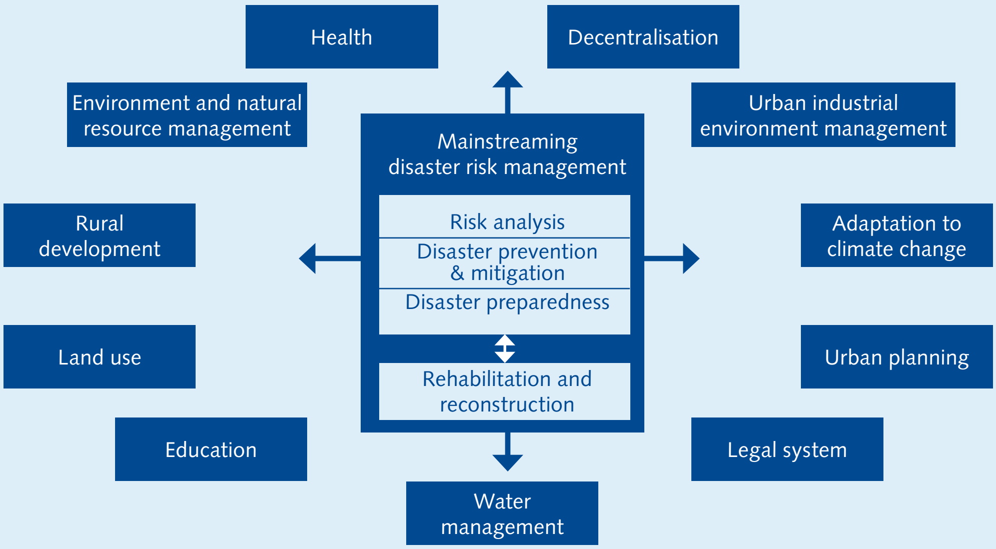
*Edited by: Florian Neutze (Federal Ministry for Economic Cooperation and Development); Wolfgang Lutz (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH)

- Programs reduce rather than amplify existing risks.
- Programs help limit the disaster impacts on people.
- Programs themselves are protected against natural events;
- Proactive steps are taken wherever possible to reduce the existing risk of disasters.

This approach offers an important interface with development cooperation's goal of reducing poverty and building capacity. The following sections illustrate how German development cooperation, within the framework of sustainability, contributes to more resilient societies in its partner countries.

Disaster risk management as a standard task in German development cooperation

Within German development cooperation, disaster risk management in disaster-prone countries is seen as a standard task that is incorporated into various sectors and programmes. Planning is undertaken in collaboration with local partners, and affected groups are involved in implementation. This means that local knowledge is effectively combined with technical know-how and used to maximum effect to reduce vulnerability and improve resilience.



Source: BMZ Information Brochure 3/2010e

Low-Technology Disaster Risk Management Approaches in Asia

Population growth and climate change, with associated sea-level rise and more violent weather patterns, have led to a widespread increase of floods and other hydrometeorological hazards. In Afghanistan and the Philippines, national and local authorities as well as organized townspeople developed and implemented capacity development measures, policy frameworks, and early warning systems (EWSs), together with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)—commissioned by the German government. These approaches do not rely on expensive technology but make use of community participation, freely accessible or easily collectible data, and already existing knowledge and focus on methods adapted to address knowledge, communication, and resource gaps.

Community Participation in Local Flood Early Warning Systems Based on Low-Technology Approaches in the Philippines

Olaf Neussner (GIZ, Philippines)

Weather services monitor levels of major rivers and are able to warn of impending floods, but such warnings are more difficult for minor rivers. However, smaller river basins cover areas of considerable size. Substantial numbers of people inhabit these areas, slowly accumulating assets and businesses. One solution is the establishment of EWSs that allow inhabitants of flood-prone areas to bring moveable items susceptible to water damage to secure places. Although weather forecasting abilities have greatly increased, aided by sophisticated space infrastructure and computer models, floods continue to affect largely unprepared communities. Floods caused by typhoons result from extreme rainfall amounts, but the magnitude of casualties and damages is also a consequence of poor urban planning, clogged drainage systems, lack of early warning, and poor disaster preparedness.

The flood situation in the Philippines

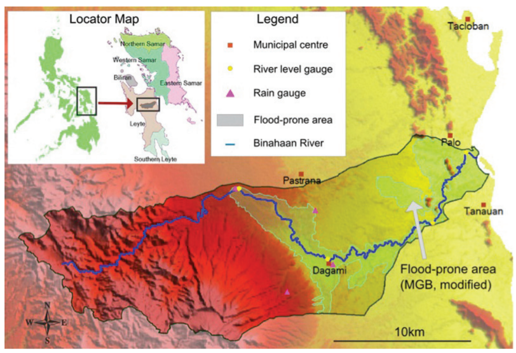
In the Philippines, sizable catchments quickly drain large amounts of rainwater in downstream areas. The country is affected annually by two monsoon seasons, and on average, nine typhoons make landfall. While typhoons can lead to exceptional rainfall, local flooding is also frequent during monsoon season.

The Philippine Atmospheric, Geophysical and Astronomical Service Administration (PAGASA) is responsible for weather and flood forecasts and does so with sophisticated and automated systems for major rivers. However, such approaches are neither practical nor affordable for smaller rivers, most of which are consequently not being monitored. For these areas, a geodata-based system may still be appropriate, although it must be low cost, robust, and sustainable and must rest on strong involvement of the local population. The following best practice example describes a system in which the local population is involved in both data collection and transmission, as well as in the early warning chain.

The Binahaan River Basin

The Binahaan River, located in the province of Leyte, with a relatively large flood-prone area (64 square kilometers) has a history of frequent flooding, with an average of more than one damage-causing flood per year (map 9.1). Often, the harvest is destroyed, and residential buildings and infrastructure are damaged. An increase in waterborne communicable diseases has been observed as well.

Map 9.1 The Binahaan Watershed in the Eastern Visayas: Overview of the Flood Monitoring System



Source: Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH.

Basic setup of the Local Flood Early Warning System

The Binahaan Local Flood Early Warning System (LFEWS) was developed in accordance with the principles of people-centered EWSs. The system consists of rain- and river-level gauges, an operations center (OC) where data are collected and analyzed and where the decision is made about a warning. A communication chain down to household level facilitates the transmission of the warning message (figure 9.1).

Figure 9.1 Schematic overview of the Binahaan LFEWS

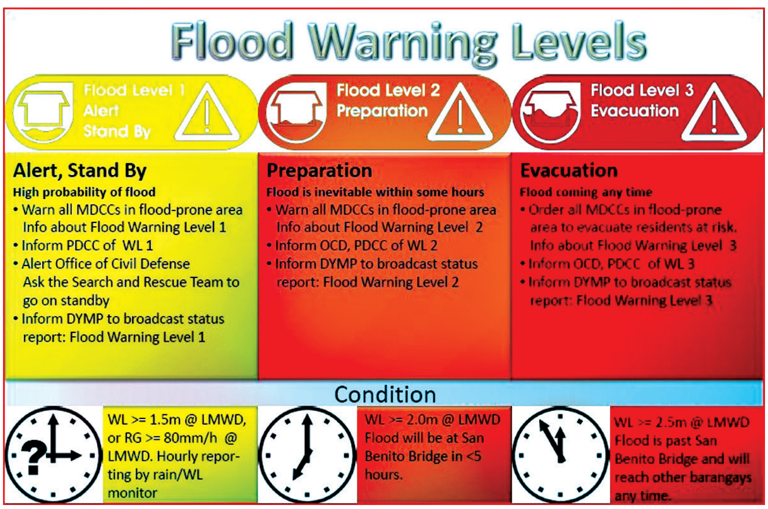
Source: Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH.
Note: LFEWS = Local Flood Early Warning System

German development cooperation paid for the initial investments for the LFEWS (€15,000). All running costs are covered by the provincial government. A cost-benefit analysis estimated that the investment costs will be recouped after 1 year.

The core of the LFEWS is the communication chain, starting with reading rainfall and river levels and transmitting data upstream to the OC. If a threshold is exceeded, the OC issues a warning that is sent to four municipalities. From there, villages are informed, and the message is passed on to households.

The LFEWS merges local engagement and modern technologies. Although most steps in the communication chain are covered by modern devices such as mobile phones or handheld radios, the final step in the chain is usually a bell made from a cut-down gas cylinder. Warnings have three stages: (a) alert and standby, (b) preparation, and (c) evacuation (figure 9.2). The flood warning comes in a color scheme with yellow, orange, and red, respectively, for the three stages and corresponding warning signals. One bang with a long break is level 1, two bangs with a long break afterward is level 2, and continuous banging is

Figure 9.2 Color-coded alerting scheme used in the LFEWS.



Source: design by GIZ, data from Binahaan Flood Early Warning system
Note: DYMP = call sign for local radio station; MDCC = Municipal Disaster Coordinating Council; OCD = Office of Civil Defense; PDCC = Proivincial Disaster Coordinating Council; WL = Water Level

level 3. Each stage has specific conditions to be fulfilled before the respective warning level is issued, and each stage requires a set of actions from different institutions.

The potential of low-cost geodata and tools in local flood early warning

In Binahaan, it has been difficult to analyze the watershed and the flood prone area with the use of only locally available data sources. The topographic map is 50 years old, and few statistical data are available on the socioeconomic situation in the region. Satellites can partly fill this gap. The elevation distribution, the current river bed, and the land cover and land use were identified using shuttle radar topography mission or Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM), and Satellite Pour l'Observation de la Terre (SPOT) or ASTER optical imagery. The project also used SPOT data obtained through a Planet Action project. The potential of 3-hourly data from the Tropical Rainfall Measurement Mission satellite was also used and assessed to estimate real-time rainfall amounts.

Although the local capacity to use geoinformatics for LFEWS is gradually growing, it is still limited to a few institutions, such as universities. Substantial training is needed to enable more institutions to make full use of remote-sensing and Geographic Information System (GIS) tools. Because costs remain a factor limiting the spreading of geoinformatics, the potential of free or low-cost tools and data is substantial. Free and open source GIS and remote-sensing programs cover a wide range of tasks.

Accomplishments, limitations, and the way ahead

The Binahaan River LFEWS has been operating since 2007 largely without flaws, not missing a single flooding event or issuing a false alarm. It was activated 21 times. The majority of the inhabitants of the flood-prone area is satisfied with the LFEWS and confirms that flood damage has been reduced. The data currently available, however, are not precise enough to run computer flood models. Furthermore, community volunteers at times only erratically gather data, which makes the system less reliable for certain periods.

The LFEWS is an effective tool to issue early warnings and thus increases community disaster preparedness and reduces damage. Geoinformatics has been shown to be highly useful for all natural hazard types. But a real effort is needed to set up and to maintain such EWSs, which includes building and retaining the required human and technical capacity. The Binahaan system demonstrates that ownership by the flood-prone communities and their local governments is the key to sustaining the LFEWS. Today, eight river basins in the province of Leyte are equipped with LFEWS. LFEWS are now promoted all over the Philippines by German development cooperation and joint international trainings with the Asian Disaster Preparedness Center in Bangkok will start in 2012.

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Strengthening Administration of Disaster Risk Management in Badakhshan, North Afghanistan

Sebastian Wigele and Walter Osenberg (GIZ, Afghanistan)

For decades, Afghanistan's rural areas have developed very little. In addition, nearly 30 years of fighting have destroyed people's livelihoods and some 80 percent of the population lives under very difficult conditions. In many places, state agencies and local self-government bodies are unable to deliver basic public services, such as schooling and medical care, or run only rudimentary services. Faced with this context, the DRM program in the province of Badakhshan confronts a multitude of challenges.

Photo 9.1 Typical landscape in northern Afghanistan: remote, isolated villages are often extremely vulnerable to natural hazards. Photo courtesy of Georg Petersen.

Challenges in northern Afghanistan

Located in the northeastern province of Afghanistan, Badakhshan covers an area of 47,403 square kilometers. Nearly nine-tenths of the province is mountainous or semi-mountainous terrain (photo 9.1). The province contains 1,851 villages with a population of 819,396 people.

Badakhshan is hit less by large-scale disasters than by frequent and widespread localized disasters. Each year a considerable number of houses and large areas of arable land are affected by landslides, avalanches, or seasonal flash floods. The situation is exacerbated by earthquakes. Broad-scale, "one size fits all" DRM approaches are difficult to apply. Self-help capacities at the community level are very limited, while external government aid frequently does not reach those in need on time—if at all.

The challenges noted can be divided into five main problem areas:

1. Coordination policies and procedures between community-, district-, and provincial-level authorities with regard to DRM are not clear. At the provincial level, the roles of the provincial government and the individual line departments are negotiated on an ad hoc basis. Responsibilities among Community Development Councils (CDCs), District Development Assemblies (DDAs), and the provincial government in case of disasters are not formalized. Prioritization of DRM activities at the provincial level also remains an ad hoc, arbitrary process, rather than an informed planning process.
2. The low technical and organizational capacities of the respective agencies are mainly focused on reactive disaster response rather than on preventive DRM, because of lack of awareness about the full disaster management cycle. Key personnel of responsible line departments and the Afghan Natural Disaster Management Authority (ANDMA) lack technical, information technology (IT) and, in many cases, language skills.
3. Communication structures and physical access between communities, district centers, and the provincial capital are poorly developed or dysfunctional. Only a quarter of roads are accessible by car throughout the year. An additional 18 percent are accessible during specific seasons. In 57 percent of the province, no roads exist at all. In case of an emergency, information often must be brought by foot or horseback to district level, where the provincial government can be informed by phone.
4. Resources needed for structural DRM, response, and reconstruction activities are scarce. Local communities often lack even basic materials, such as concrete, or search and rescue as well as first-aid equipment. Responsibilities for funding are not clarified, and emergency funding from state authorities often arrives too late or not at all.
5. Although general information on frequency and magnitude of hazards in Badakhshan is available, the disaster risk of individual communities has not yet been comprehensively assessed.

Approach

In the described context, isolated, high-technology DRM approaches are likely to fail. Only a low-tech, multilevel strategy will address the problems outlined.

Provincial level

The program, commissioned by the German government, supports the Governor's Office, the provincial office of ANDMA, and the Provincial Disaster Management Committee (PDMC) responsible for disaster response and preparedness planning in Badakhshan. Together with the Asian Disaster Preparedness Centre (ADPC), GIZ developed recommendations to improve the governmental DRM coordination structure, tailored standard operating policies for each line department, and suggested improvements for the existing, though not operating, Provincial Disaster Management Plan (PDMP).

Trainings on DRM and scenario-based planning exercises for government decision makers were conducted to strengthen their technical and organizational capacities. To raise awareness on holistic DRM approaches members of PDMC, ANDMA, and district representatives made a study tour to geographically comparable regions in India the invitation of the Indian National Institute for Disaster Management (NIDM). They also traveled to Tajikistan, accompanied by Tajik DRM authorities. English and IT trainings were provided to improve cooperation with international organizations and to create the prerequisite for introducing basic GIS tools at the provincial level.

A technical working group has been established, and invited all international stakeholders involved in DRM activities in the province to participate. Formally chaired by the governor, the DRM working group now advises the Governor's Office, ANDMA, and the PDMC in technical and policy coordination. In addition, the group provides a regular forum for information exchange and donor coordination.

District level

Emphasis is put on linking provincial institutions with district authorities. To ensure readiness of individual district authorities in case of a disaster, District Disaster Management Committees (DDMCs) consisting of key decision makers were established and disaster preparedness trainings conducted. Because district governors participated in trainings and study tours, informal links with provincial authorities and cross-border cooperation at the district level have been established.

In 2012, community-support capacity of district authorities will be increased by establishing centralized emergency stockpiles. Equipped with basic search and rescue equipment, temporary shelter such as winterized tents, and basic food and water supplies, district authorities are more self-reliant and able to react quicker.

Community level

Limited access and thus limited ability for self-help remain a critical challenge at the community level. In close cooperation with the Norwegian-Afghanistan Committee, community-based DRM (CBDRM) activities in selected pilot villages were introduced and have proven to be successful. These activities, implemented in selected pilot villages, include (a) participatory risk assessments to increase awareness and establish basic village emergency plans; (b) training in light search and rescue and medical first aid (photo 9.2); and (c) capacity development in seismic-resistant construction skills with local materials.

Knowledge clusters, that is, clusters of villages able to support each other during emergencies and to share experiences, were established, and logistics, first aid, and search and rescue village groups were formed. The groups are certified and registered by the Afghan Red Crescent Society (ARCS). Group lists were submitted to district authorities, and joint disaster simulation events were organized, which ensures co-operation between local, district, and provincial

Photo 9.2 First Aid simulation in Robotak, Afghanistan. Photo courtesy of Sebastian Wigele.

authorities. In the CBDRM activities particular emphasis is put on including women: in every village where men's committees have been established, women's rescue committees have been established too.

Next steps

To address the knowledge gap, a remote-sensing study was conducted, including field surveys and use of freely available GIS (ASTER) data for geospatial assessments of avalanche, flood, and landslide risk in four pilot districts. The methodology used for the various assessments included GIS analysis for the avalanche and landslide risk as well as numerical modeling for the flood risk assessment. Avalanche risk was assessed on the basis of slope steepness and curvature considering snow depth. The approach was calibrated using field observations at specific locations and interviews with the local population. Landslide risk was assessed using a combination of slope data and spectral reflectance of different ground types. Flood risk was assessed using HEC-RAS, a one-dimensional river and flood analysis system based on flow hydrographs derived from hydrological records, which were based on resampled ASTER GDEM data, calibrated to match field survey data.

The benefit of this approach was reducing costs by using publicly available data, while the modeling reduced the need to visit every individual village. As a result, hazard probability and risk maps were developed. Provincial authorities will use these maps to assess the vulnerability of high-risk communities in Badakhshan. The results will serve to develop priorities for provincial preparedness planning, as well as to help in land-use and resettlement planning in case of landslides, avalanches, and floods.

Lessons learned and the way ahead

The outlined challenges must be considered to establish a sustainable DRM model in Badakhshan and beyond. The multilevel, low-tech strategy has proven to be the most suitable given the challenging context. Developing capacities and improving coordination at all administrative levels need to be the main focus. In addition, resources should be provided in a targeted manner, and existing knowledge gaps, if possible, closed through external support as follows:

- At the community level, a broad approach focusing on developing basic resilience skills and on empowering communities through local knowledge clusters—that are able to expand themselves and provide self-help horizontally—is needed. In addition, innovative, local solutions are required to improve communication speed with district authorities.
- Technical capacity and logistic disaster preparedness and response resources need to be available at the district level to respond to communities in need on a timely basis and to enable district authorities to communicate upward in a more effective manner.

- Relevant provincial authorities need to be trained, coordination structures improved and reliable hazard and vulnerability data provided to prioritize areas of intervention and to effectively communicate funding needs upward.

As a further challenge, reliable flows of resources before and immediate funding in case of disasters must be ensured. As a first step, funding lines and practical responsibilities for DRM on district and provincial levels must be further formalized and monitored. Second, ongoing national or international funding should guarantee that the system can function. In addition, public investments at the community level are needed to scale up the successful pilot approach.

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High-Tech Approaches in Risk Modeling and Early Warning

Steadily growing urbanization, complexly combined infrastructure, and progressive globalization of the worldwide economy cause that not only climate change but also other extreme hazards such as earthquakes and tsunamis pose an increasing risk for a global society. In many earthquake- or tsunami-prone regions, no risk models exist to provide such information, and where models exist, they are often inaccessible because of their proprietary nature or complex user interface. GeoForschungsZentrum Potsdam (German Research Centre for Geosciences, GFZ), together with a wide range of partners coming from science and politics as well as entrepreneurs and German development cooperation, is engaged in two initiatives to improve data collection, risk modeling, and warning systems for tsunamis and earthquakes. Technical aspects, legislative and organizational boundary conditions, cultural aspects, and community awareness and accountability, all decisive factors for successful risk reduction, are taken into account. At the core of both projects is the idea of creating a state-of-the-art model that could be used worldwide. Both models incorporate the latest technology and may serve many types of users in their needs to assess earthquake and tsunami risks.

German Indonesian Tsunami Early Warning System

Joern Lauterjung (GFZ)

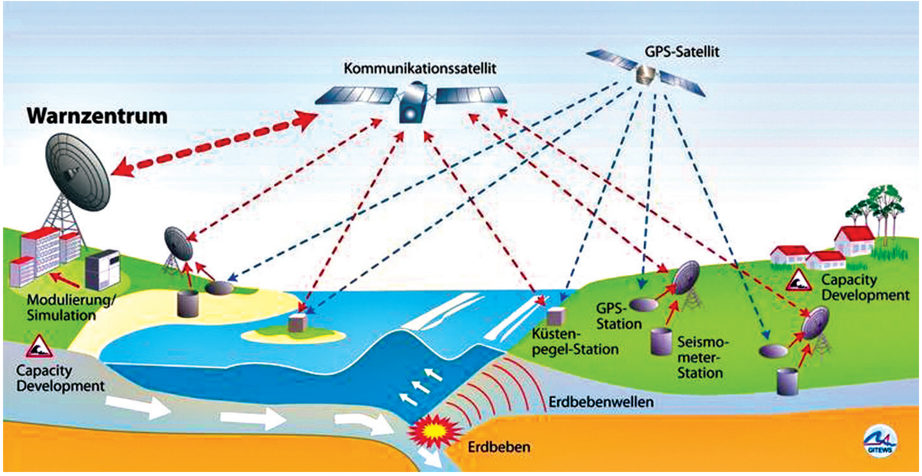
Indonesia is located along the most prominent active continental margin in the Indian Ocean, the Sunda Arc, and is one of the most threatened regions of the world in terms of natural hazards such as earthquakes, volcanoes, and tsunamis. On December 26, 2004, the third-largest earthquake ever instrumentally recorded (magnitude 9.3) occurred off shore of northern Sumatra and triggered a mega-tsunami affecting the whole Indian Ocean. This earthquake and subsequent tsunami caused a human disaster affecting countries of the Indian Ocean and Pacific region. More than 230,000 people lost their lives, 600,000 houses were destroyed, and about 1.8 million people remained homeless, because the region was not prepared in terms of an early warning or disaster response.

To provide, in the future, a fast and reliable warning procedure for the population, Germany offered, during the UN World Conference on Disaster Reduction in Kobe, Japan, in January 2005, technical support for the development and installation of a tsunami EWS for the Indian Ocean in addition to assistance in capacity building for local communities. This offer was accepted not only by Indonesia but also by other countries such as Sri Lanka, the Maldives, and some East African countries.

The project

The international community commissioned the Intergovernmental Oceanic Commission of the UN Educational, Scientific, and Cultural Organization (UNESCO) to coordinate the establishment of a tsunami EWS for the entire Indian Ocean. Germany and Indonesia decided

Figure 9.3 Concept of GITEWS



Source: Source: GITEWS website "Conception" (last access: 2nd May 2012) http://www.gitews.org/index.php?id=22&L=1
Note: GITEWS = German Indonesian Early Warning System; GPS = global positioning system.

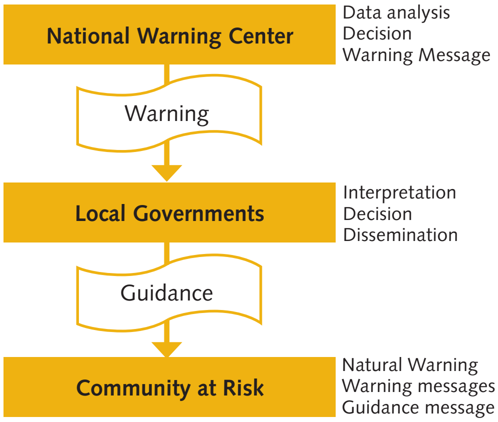
in January 2005 to make a substantial contribution to this extensive EWS through the German Indonesian Tsunami Early Warning System (GITEWS), based on the long cooperation between the German Federal Ministry of Education and Research (BMBF) and the government of Indonesia (see figure 9.3).

GITEWS was accomplished by a consortium of nine leading institutions in Germany with GFZ as consortium leader and counterpart institutions in Indonesia. GITEWS integrated terrestrial observation networks with marine measuring processes and the rapid distribution of warning messages. For complete documentation of the project, see Rudloff, Lauterjung, and Münch (2009).

The upstream part

Most tsunamis observed worldwide are generated by large submarine earthquakes. Thus, earthquake parameters such as location and magnitude are commonly used as input parameters for tsunami simulation or selection of precalculated scenarios from scenario databases. In the case of Indonesia, one is generally faced with tsunamis generated near the coast, so the technical design of the system was oriented to high speed, accepting initial input parameters with high uncertainties. Seismological observations can provide only the main earthquake parameters, such as location, depth, and magnitude within 2–4 minutes. The epicenter and magnitude are poorly defined immediately after the earthquake. Hence, a judgment of tsunami potential and—if positive—propagation models must be made on the basis of parameters with high uncertainties, and a reliable local early warning still largely depends on additional information on the rupture characterization. A completely new approach in tackling the problem of rupture characterization, especially the slip distribution of an earthquake, is the monitoring of coseismic crustal deformation by real-time or near real-time global positioning system (GPS) deformation monitoring. This information is available 5–10 minutes after the event and can be used immediately to determine the rupture direction. Therefore, GPS is a striking and cost-effective tool for the characterization of an earthquake's source geometry. In Indonesia, a GPS network consisting of a nationwide reference network and GPS stations along the Indian Ocean coastline (combined with tide gauges following Global Sea Level Observation System [GLOSS] standards) was established within the

Figure 9.4 GITEWS Warning Chain



Source: see Harald Spahn et al. 2008. http://www.gitews.org/fileadmin/documents/content/wp6000/GTZ-IS_GITEWS_Newsletter_01-08_english.pdf
Note: GITEWS = German Indonesian Early Warning System.

project. Near real-time processing (solutions for the network every 2 minutes) is performed at the early warning center (see Lauterjung et al. 2010).

GITEWS consists of terrestrial networks such as seismological and geodetic stations as well as oceanographic instruments. The application of different sensor technology is extremely important to avoid false alarms and to ensure redundancy. All data are transmitted by satellite to the Warning Centre at BMKG (Badan Meteorologi, Klimatologi dan Geofisika) in Jakarta and are evaluated immediately (figure 9.4).

The core of the EWS is a network of seismic broadband stations (150 stations: 105 from Indonesia, 20 from Germany, 15 from Japan, and 10 from China) because it gives the first important information on a possible tsunamogenic event. The warning center has access to about 300 seismic stations, includes data from seismic stations around the Indian Ocean, and is successfully in operation for rapid earthquake information in the Association of Southeast Asian Nations (ASEAN) region. Tide gauges installed along the Indonesian coastline as well as on islands off the Indonesian mainland are able to monitor the instantaneous sea-level changes in near real time. For GITEWS, an integrated concept was developed that comprises three different tide gauge sensors and a GPS receiver for vertical movement control (and as part of the GPS network for coseismic deformation monitoring) at each site.

Tsunami simulations are of particular importance, because based on a handful of measured information—in spite of a dense sensor network—an overall picture of the situation must be calculated. Oceanwide tsunami simulations are precalculated for a dense net of earthquake locations along the Sunda Trench and for a wide variety of magnitudes (7.5–9.0). These precalculated simulations are stored in a database and can be selected on the basis of available sensor data. Because time plays an important role in the warning procedure, the selection process is fully automated. To include all available sensor information in this automated process, a special approach has been developed. In a first step, earthquake parameters (location and magnitude) are used to preselect a number of scenarios with almost the same probability. All other sensors are treated as individual and nonrelated sources of information (GPS stations and tide gauges). For each of these sensors, theoretical response functions are calculated for every simulation (theoretical displacement vectors in the case of GPS and theoretical tsunami arrival times and wave height for tide gauges). These data can be directly compared to the respective measured values and are used to reduce the list of best-fitting scenarios. The inclusion of GPS displacement vectors reflects, in particular, the slip distribution of a larger earthquake and supports the decision of earthquake rupture direction, which is of special importance for near-field tsunami forecasting. Some seconds after the first earthquake evaluation, the best-fitting scenario resulting from the selection process gives a first situation picture including wave heights, arrival times, and inundation areas along the coast.

In a Decision Support System, the different information is aggregated to draw a fast and detailed picture of the actual situation. Settlement structure in affected coastal areas, combined with additional static geo-information, that is, hazard or vulnerability maps, result in valuable material for the decision-making process and for authorities as well as for the population. In this way, the responsible staff members in the warning center have a clear picture of the situation and can disseminate an adequate warning.

The downstream part

Most important are strategies and measures to educate the population in coastal areas to respond correctly to warning information, particularly because of the extremely short time span (20–40 minutes) between the earthquake and the tsunami impact. Standard operating procedures and evacuation plans have been customized for this specific precondition. Thus, not only academic and technical training in the operation and maintenance of the system were of importance, but also efforts to strengthen the awareness and preparedness of the people at risk as well as to support institutional capacity building.

The experiences from several years of local capacity development for tsunami and earthquake warning (TEW) and preparedness in Indonesia reveal that implementing an end-to-end and people-centered EWS is a complex task (see Spahn et al. 2010). Implementation requires a common understanding of the overall system on the part of all actors involved, political leadership, the will to cooperate, and committed and skilled individuals. Various experiences with recent earthquake and tsunami warnings highlight the major effort that is required to close the "gap" between the system's technical achievements and its ability to actually benefit the people at risk and motivate them to take action. This effort requires a holistic and systemic view, focusing on technical processes as well as local response capability in equal measure.

To make the system effective, the development of local response capability must be addressed with the same level of commitment and investment provided to the development of the technological components. Human capacity need to be developed at all levels to increase the institutional response capability at the local level. To build a common understanding of the system and to encourage all actors to accept and play their respective roles, the provision of sufficient funding, adequate capacity development, and instructive guidelines is essential. Developing these guidelines is a multistakeholder task. Only a joint learning process can lead to a tailor-made warning chain and public outreach strategies that really address the needs of the community at risk. Public education needs to explain clearly, openly, and continuously how the system can help save lives, indicating its strengths but not understating its limitations. Going public, explaining the system, and building relations with the end users of the system—the communities at risk—are essential to building the trust in and credibility of the system that is required to achieve its ultimate goal: saving lives.

For the system to be sustainable, it needs to be institutionalized at all levels. Clarifying institutional arrangements and developing strong institutions at national and local levels need to go hand in hand with the technical advancement of the system. The provision of sufficient long-term funding is part of this process, as well as the integration of TEW as a component into long-term national and local DRM and development plans. This requires a great deal of advocacy at both national and local levels to convince the relevant actors to embrace the concept of risk reduction.

Conclusion

GITEWS was handed over to the Indonesian government on March 29, 2011. It is a multisensor system applicable not only to tsunamis but also to almost all natural hazards, because of innovative and generic developments in sensor fusion and decision support. The developed response strategies, concepts, and solutions are valid for almost all hazards.

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Natural Hazards: Meeting the Challenges of Risk Dynamics and Globalization

Jochen Zschau and Kevin Fleming (GFZ)

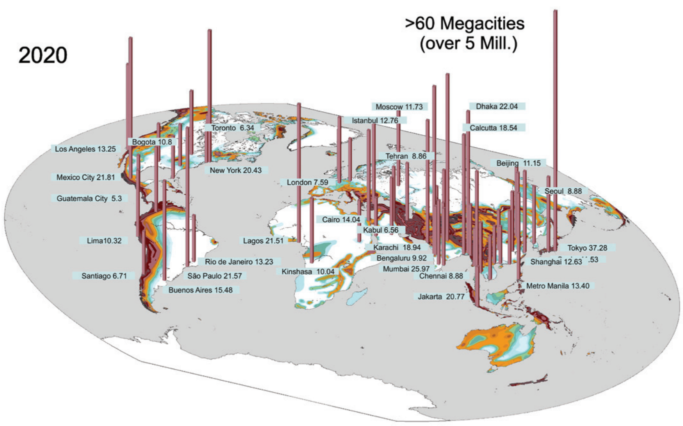
A major issue in the quantification of the risk associated with the full spectrum of natural hazards is the highly dynamic, dramatically increasing, and globally interdependent nature of the phenomenon. However, such characteristics are not yet accounted for in conventional risk models, where researchers, policy makers, and disaster risk experts generally consider each hazard individually and temporally invariant over local scales. In addition, they rarely consider the often considerable spatial and temporal relationships between natural hazards and their resulting risk. This section addresses the problem by reviewing the main drivers behind the changing nature of hazards and risks, identifying shortcomings in existing models, and calling for efforts to develop multitype risk assessment schemes and scenarios for the mapping and monitoring of disaster risk on a global scale that are also capable of predicting future risk. To meet such demands, the Global Earthquake Model (GEM), a global initiative dealing with global earthquake risk, may serve as a suitable template.

Risk dynamics and globalization

Among many drivers of risk, the current urban explosion, with more than 50 percent of today's world population residing in urban zones and more than 60 percent expected for 2030, is one of the most important. For example, whereas in 1950 only 7 megacities existed (cities with a population greater than 5 million inhabitants), in 2020 more than 60 will exist, most of them in developing countries (see figure 9.5).

Many of the fastest-growing cities have doubled their populations every 15 years. However, what is more alarming is that in the same cities, informal settlements have often doubled in less than half the time. According to the United Nations Human Settlements Programme (UN-HABITAT), every week about 5 million people move to cities, of which 90 percent find themselves living in informal settlements. This means that 40–60 percent of fast-growing cities are typically made up of informal settlements, which leads to a dramatic increase in the vulnerability of urban conglomerates because infrastructure development cannot keep pace. In more industrialized countries, the rise of vulnerability partly results from increasing interdependency of critical infrastructures, lifelines,

Figure 9.5 Distribution of Megacities for 2020



Sources: Stefano Parolai and Regina Milkereit, German Research Centre for Geosciences Potsdam, personal communication; population values from City Mayors, http://www.citymayors.com.

economies, and communication and transport systems. To a certain extent, these same factors are responsible for the increasingly globalized character of disaster risks, where today's communities are not only affected by extreme events in their own countries but are also more vulnerable to those occurring outside their national territories.

Multitype hazards and risks—interactions over time and space

A given location, regardless of its spatial extent (local community, regional, national, and international), is rarely under threat from a single hazard. It is usually confronted by a number of different natural phenomena that may potentially cause disasters of varying degrees of severity for different aspects of society. In addition, many of these natural processes involve frequent and complex interactions. These so-called *cascade* or *domino* effects not only potentially increase the total risk, but also sometimes cause a secondary event more devastating than the original trigger, such as the 2004 Indian Ocean tsunami or the 2011 earthquake and Tsunami in Japan. There is a need to consider not only the risk of an area associated with possible hazardous natural events, but also the interaction between these events and their influence on the different facets of vulnerability within the human-made system, which itself displays significant interdependencies and temporal variability.

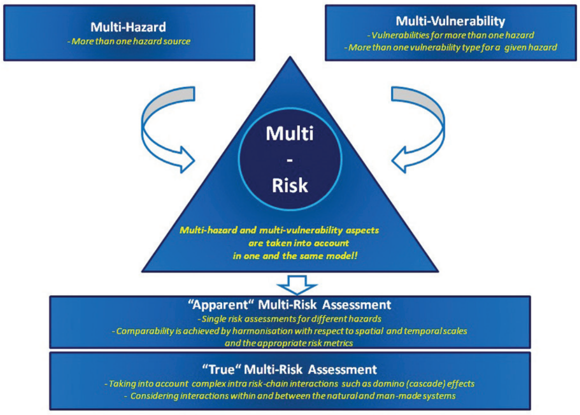
Current risk models and their limitations

Unfortunately, current conventional disaster risk models are not able to capture the dynamic nature of risk or the interactions between hazards and risks as previously described. These models generally focus on local rather than international or global scales, while assuming risk to be constant over time. Not considering, for example, cascade events ignores the consequences of disastrous events as they propagate through the human-made system, frequently causing highly interrelated technological, economic, and financial disruptions, as well as social and political upheavals on all spatial scales. A major disaster may negatively affect the global supply chain, potentially disrupting economies worldwide. If treated at all by risk models, such complex interactions are addressed only by simple and coarse semi-quantitative disaster indexes, which include a high degree of subjective expert opinion. Moreover, they are usually applied separately to each hazard type, although they are similar or even the same across many different natural hazards. In addition, single-hazard approaches are often not harmonized with respect to the different spatial and temporal scales and risk metrics considered, leading to the incomparability of the various estimated risks.

Confronting global and multitype risks

A number of studies have analyzed multiple types of hazards and risks, for example the Cities Project in Australia, which took into account numerous natural hazards for a number of urban and regional communities (for example, Granger 1999); the DFNK (German Research Network Natural Disasters) project, which undertook a multirisk assessment for the city of Cologne, Germany (e.g., Grünthal et al. 2006); and a Joint Research Centre and civil protection project for the Piedmont Region, Italy (Carpignano et al. 2009). However, when risks associated with each hazard type were combined, it was only through weighted summations (Carpignano et al. 2009). None of these projects considered cascade effects. Current research projects examining multiple hazards, risks, and their interactions—such as the NaRaS (Natural Risk Assessment) project (Marzocchi et al. 2012), the MATRIX (New Multi-Hazard and Multi-Risk Assessment Methods for Europe) project[2] and the Multi-Hazards Demonstration Project[3] —however, deal only with urban and regional scales, revealing a major gap in efforts to define methodologies appropriate for a global context.

Figure 9.6 Different Aspects of Multitype Hazard and Risk Assessment



Source: Jochen Zschau, GFZ

Research activities need to expand to confront hazard and risk assessments in a multidimensional and global manner, considering multiple types of hazards, the physical processes involved, the circumstances under which interaction arises between hazard and risk types, the way vulnerability varies over time, and the way the dynamics of human society affect the evolution of risk, and in some cases, the hazard itself (figure 9.6).

Research in this field should, therefore, focus on new solutions for risk modeling that include the following:

- Developing methods for treating different hazards together in a uniform probabilistic multirisk framework;
- Developing and implementing international standards and harmonized methodologies, terminology, and coherent data collection procedures that allow various relevant disciplines to effectively interact with each other;
- Ensuring comparability of risks arising from different hazards;
- Accounting for complex risk chain interactions in natural, as well as human-made, systems;
- Treating hazards and vulnerabilities as time-dependent quantities.

These requirements are essential for successfully mapping and monitoring disaster risk on a global scale and predicting its future development. These goals can be achieved only with an interdisciplinary approach in which natural, social, and economic sciences are brought together. A possible starting point or template is the GEM, a global public-private partnership that aims to establish an independent standard for calculating, monitoring, and communicating earthquake risk worldwide. GEM is made up of numerous organizations (insurance companies, universities and research institutes, and various government agencies) working together to develop uniform global databases, methodologies, tools, and open source software. Such a global, interdisciplinary, and intersectoral scheme offers a breadth of expertise and researcher–practitioner–end user interaction that may serve as an appropriate model for a global multitype dynamic risk assessment and mitigation initiative.

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Risk Assessment and Contingency Planning in China

Christof Johnen, Li Xin, and Zhang Liwen (GIZ, China)

China is exposed to many natural and industrial hazards and threats to public health. Having vast experience in disaster response, China is attributing more and more importance to disaster mitigation and preparedness measures.[4] Complementing the ongoing efforts of the Chinese government, the GIZ, commissioned by the German government, cooperates with the National Institute of Emergency Management at the Chinese Academy of Governance (CAG/NIEM) and the Emergency Management Offices (EMOs) at provincial and municipal levels in China. The main objective is a more coherent DRM system with an integrated, cross-sectoral approach. Taking into account existing laws and regulations, a risk assessment framework is developed that provides the basis for disaster prevention and mitigation measures as well as for optimizing contingency plans.

The Approach

A risk assessment is the core element of DRM. It enables the relevant authorities to evaluate risks that derive from potential hazards and the population's vulnerability. On the basis of assessment results, disaster-sensitive planning that helps mitigate the detrimental effects of hazards is possible.

A pragmatic methodology for risk assessment developed in Germany provided the starting point[5]. Based on international standards for DRM—*ISO 31000, Risk management: Principles and guidelines*—the developed methodology is a result of joint efforts and combined national and international expertise. The main objective was to create a workable and practical tool.

The impact of a hazard on the economy, critical infrastructure, environment, and society as a whole also needs to be included in the assessment. However, the damage and losses a population suffers greatly depend on the type of hazard; therefore, various scenarios need to be carefully analyzed. These different scenarios can then be compared and used to identify an intolerable level of risks. The respective authorities are now put in a position to prioritize, to plan mitigation and preparedness measures, and to allocate resources accordingly. In this process, various administrative entities and sectors must participate to ensure that holistic and functioning contingency plans are being developed. Ultimately, the methodology was introduced to Chinese professionals and adopted for the Chinese context. In agreement with CAG/NIEM, Guangdong Province and Chongqing Municipality were selected as pilot areas for risk assessments and contingency planning.

Photo 9.3 Risk assessment seminar in Chongqing: exemplary application of the risk assessment methodology. Photo courtesy of DRM Project

As part of the cooperation, specific focus was put on capacity development. More than 400 local EMOs and government officials as well as Schools of Administration academics from selected provinces—Chongqing, Guangdong, Hebei, Jiangsu, Shaanxi, and Tianjin—participated in several seminars, workshops, discussion forums, and advisory groups (photo 9.3). Experts and officials from the pilot cities of Shenzhen and Heyuan in Guangdong Province and Jiulongpo District of Chongqing

Municipality drafted adapted guidelines for risk assessment, shared their findings, discussed the documents, and planned a common approach for the way ahead.

A structured and detailed risk assessment was carried out in the pilot areas, applying a standardized analytical process that led to transparent, comprehensible and, comparable results. In Jiulongpo, District of Chongqing, the risks of three hazards—a gas explosion, a landslide, and a high flood—were assessed in different scenarios. In Heyuan in Guangdong Province, a dam break was used as an example. In Shenzhen, the impact of a food poisoning incident was analyzed among other examples. The respective risk assessment results were documented and annexed to the guidelines for practical reference[6].

In addition, already-existing emergency plans are being revised in accordance with the results of the assessments. By identifying vulnerabilities and possible gaps, risk assessments provide valuable information to optimize emergency planning. As a last step, the adapted emergency plans are tested in practical simulations for coherence and proper functioning.

The main responsibility for the assessment process as outlined lies with the provincial EMOs, which have a coordinating role. Both Chongqing and Guangdong EMOs involved all relevant bodies, ensured cross-sectoral cooperation, shared data, and made joint use of results. The Chinese central-government level (CAG/NIEM) closely accompanied the process in the selected pilot areas. NIEM allocated additional human resources who participated in the field activities. The valuable experiences and results on the local level could pioneer standard operating procedures for the national DRM system.

Risk identification, analysis, and evaluation are the backbone of a standardized DRM procedure and can be applied anywhere in the country. Thus, the subsequent optimization of contingency plans will build on results derived from good professional practice and mirror the actual risk situation in a given location. The entire process, if seen as successful by the central-level decision makers, could serve as a national guideline in the future.

Practical Considerations

Given the limited time and resources and in view of the complex Chinese administrative structure, developing a process that can be implemented quickly but at the same time be easily adapted and continuously improved through revision and addition of more data was critical. Key elements of the chosen process are hazard and risk registration, risk analysis through scenario building, definition of damage parameters, and aggregation and consolidation of different scenarios in a risk matrix.

As a first step, a geographical reference area was defined and relevant data for the area were collected. The data included geographical information, population figures, economic and social figures, and environmental and infrastructural information. Because the required data are usually held by different authorities, compiling the data in a structured way was already a first step toward an integrated approach.

Second, potential hazards were identified. The identification of hazards and their risk potential was based on existing regulations or resulted from discussions with relevant authorities and experts. For the pilot areas in Chongqing and Guangdong, the hazards were identified by the respective EMOs, using previous experience and situation analyses.

For the various scenarios, references to similar events can be useful. The more detailed a scenario is described, the better the expected detriment from the hazard and the occurrence probability can be defined. Working with scenarios is considered a major advantage because it promotes and allows locally adapted results.

The extent of damages and losses determine one dimension of the risk matrix, whereas the occurrence probability determines the other. The pilot regions applied a five-stage structure with qualitative and quantitative indicators from 1 ("very unlikely") to 5 ("very likely") to define occurrence probability . For the extent of damages and losses, a range from 1 ("negligible") to 5 ("disastrous") was applied.

The selection of damage and loss parameters and corresponding threshold values was a challenge. They should allow for comprehensive yet manageable and realistic analyses while at the same time reflect existing regulations and criteria. Five categories—people, economy, infrastructure, ecology, and society—were chosen. Each of the categories was broken down into three or four key parameters. For each of the finally selected 18 parameters, the threshold values for all five stages—1 ("negligible") to 5 ("disastrous")—were developed by relevant authorities and experts, factoring in the local situation, capacities, and resources. These 18 parameters with staged threshold values were then applied to the respective scenarios, resulting in a damage indicator (1 to 5) for each parameter in every scenario. The overall sum of the indicators divided by the total number of parameters (18) provided the overall damage and loss indicator that was complemented by the occurrence probability for an unambiguous position in the risk matrix. The selection of damage and loss parameters and the respective threshold values showed the likely trade-off between easily comparable fixed values for all entities at one administrative level and adapted, more meaningful values providing more relevant information for the respective entity.

The final risk matrix provides relevant and easily accessible information for decision makers and facilitates political priority setting and resource allocation (figure 9.7). Also, the detailed damage and loss indicators in each scenario helped identify specific vulnerabilities and risks. Addressing these in the optimization of contingency plans is an effective and efficient way to reduce risk.

The chosen methodology allows aggregation and disaggregation of risks for different purposes. In addition, a comprehensible and transparent process not only builds trust but also provides the basis for the necessary continuous refinement and improvement of DRM measures. Finally, the cross-sectoral and multihazard approach provided the starting point for integrated and comprehensive DRM, reflecting the complexity of a fast-developing society.

Using a situation-based yet standardized approach to risk assessment and contingency planning that can be easily developed and adapted proved to be preferential for the challenges ahead.

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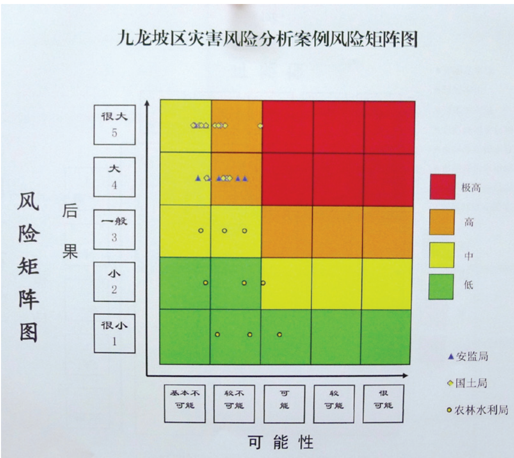
Figure 9.7 Risk Assessment Matrix, Jiulongpo District, Chongqing Municipality



Visualization of risks for various scenarios and different hazards

Source: Chongqing Municipality Government, Jiulongpo District Government. 2012. "Cases of Risk Analysis in Jiulongpo District, Chongqing Municipality"
Note: The matrix provides visualization of risks for various scenarios and different hazards.

Financial Instruments for Disaste Risk Management

Although receiving increasingly more attention at the international level, DRM is only bit by bit being embedded within society. DRM is the responsibility of local authorities and the national government, of every citizen and entrepreneur. Special attention is needed to ensure necessary financing for DRM measures.

Disasters interrupt and delay the development processes of societies, cause dramatic decreases in production output, and negatively affect the environment. At the same time, political, economic, and social decisions of the public or private sector might increase disaster risks. Public policies can play a vital role in a country's efforts to avoid new risks and mitigate existing ones. For example, in Peru, the Ministry of Economy and Finance started to integrate criteria for DRM and adaptation to climate change into its national public investment system.

Regarding citizens' responsibility, solutions related to weather risk insurance for low-income groups have the potential to provide swift and unbureaucratic recovery aid. However, in developing countries, these approaches have proven to be difficult in reaching out to a larger vulnerable population. The Caribbean is particularly hard hit by the impact of climate change and natural hazards. Therefore, German development cooperation jointly with the UN University Institute for Environment and Human Security of Bonn conducted a market-demand survey to develop weather risk insurance products for low-income groups in the Caribbean.

Making Public Investment Work for Disaster Risk Management

Alberto Aquino, Andrea Staudhammer, and Verena Bruer (GIZ, Peru); Julio García (UNISDR, Panama)

This section provides guidance for considering DRM in public policy, in particular, public investment planning and management. Emphasis is put on tools to assess the profitability of investments in economic, social, and environmental terms, including risk reduction measures. The section gives recommendations on how to institutionalize the DRM perspective in public investment decision-making systems, including project planning and implementation. The present practices build on the experience of the Ministry of Economy and Finance (MEF) in Peru and its longstanding cooperation with the executing agency, GIZ, in strategic alliance with the secretariat of the UN International Strategy for Disaster Reduction (UNISDR).

If public infrastructure is not sensitively planned in risk-prone areas, the efficient provision of intended services is likely to be disrupted when a natural hazard hits. However, if public investment projects are selected, rated, and designed in accordance with DRM criteria, risks of service disruptions will be reduced even without high additional costs.

When evaluating a public investment project, policy makers should take three steps: risk analysis, identification of DRM measures, and evaluation of the profitability of DRM measures (figure 9.8).

Figure 9.8 Steps to Incorporate DRM Considerations into Public Investment Projects

Risk analysis:
a) Analysis of natural hazards
b) Analysis of stakeholders, affected population and their vulnerability
c) Analysis of vulnerability of the project

Identification of risk reduction measures:
Factors: Exposure, fragility and resilience

Evaluation of the profitability of risk reduction measures:
Cost-benefit analysis or cost-effectiveness analysis

Source: authors, based on Alberto Aquino, Verena Bruer, Julio García, 2010

Risk analysis is crucial to identify and evaluate probable damages and losses caused by natural hazards. It includes three steps. First, an analysis is conducted of the possible natural hazards that a project might face. This implies detailed knowledge about the project implementation area and its area of influence. On the basis of these findings, the nature, frequency, and intensity of current and future natural hazards are defined. In a second step, relevant stakeholders and their vulnerabilities are identified. For example, social conflicts or lack of economic resources might limit a group's ability to efficiently cope with hazards. The third step involves analyzing vulnerability factors of the project throughout its lifespan. With this information, probable grades of damages and losses for the project, caused by natural hazards, can be estimated. For example, with regard to the project's objectives, these might include service interruptions, health care costs in cases of emergency, rehabilitation and reconstruction costs, or lower return rates, as well as direct and indirect project benefits not being achieved.

The risk analysis is followed by an identification of adequate risk reduction measures. Those measures focus either on reducing vulnerabilities or on limiting hazard exposure. Measures include modifying the project area, infrastructural features, the implementation timetable, and the technology needed for its operation.

Finally, to assess the profitability of the identified DRM measures, the costs and benefits of their inclusion in the project are quantified. Each option is assessed through a cost-benefit analysis or a cost-effectiveness methodology to come up with the most profitable or the least costly measure.

In a context of private investment evaluation, the main decision criterion for any cost-benefit analysis is the net present value (NPV): an investment is only profitable if the present value of its income flow exceeds its cost flows, which are updated using an appropriate interest rate. In other words, if NPV is equal to or greater than 0, the benefits of the project are equal to or outweigh its costs:

$$NPV = -II + \sum_{t} \frac{B_t - C}{(1+i)^t}$$

where *II* = initial investment (in phase zero of the project), *B/C* = benefits/costs of the project, *t* = time, and *i* = variable that represents the interest rate relevant for discounting the project.

However, this formula does not take into account the probability of natural hazard occurrence. A social evaluation,[7] however, includes DRM considerations (figure 9.9).

To include that information, the NPV formula has been modified as follows:

$$NPV\ (social) = -II + \sum_{t} \frac{B_t - C}{(1+i)^t} \left[\Delta II + \sum_{t} \frac{\Delta(O\&M)_t}{(1+i)^t} \right] + p\ \ [not\ generated\ damage]$$

where NPV = net present value, *II* = initial investment (in phase zero of the project), *B/C* = benefits/costs of the project, *t* = time, *i* = variable that represents the interest rate relevant for discounting the project, *O&M* = operation and maintenance, and *p* = probability of occurrence of a hazard. Note that the "not generated damage" applies to the total costs of reconstruction and services that

Figure 9.9 Steps of a Social Evaluation to Reduce Disaster Risks

Analysis of project costs without measures of risk reduction:
Investment, operation and maintenance (see formula above)

↓

Additional social costs in case of disasters:

a) Health-care in emergencies, rehabilitation and refurbishment
b) Reduction of project benefits for users during the period of emergency, rehabilitation and refurbishment

↓

Analysis of project costs with measures of risk reduction:
Inclusion of "avoided costs" (= costs which are not generated in case of disasters, thanks to risk reduction measures)

Source: authors, based on Alberto Aquino, Verena Bruer, Julio García, 2010 were not interrupted (avoided costs). These costs become benefits to measure social NPV. The incremental costs in investment *(ΔII)* and operation and maintenance *(Δ (O&M))* refer to the inclusion of measures of disaster risk reduction.

In Peru, the MEF has been gaining experience in the insertion of DRM criteria into the National Public Investment System (Sistema Nacional de Inversión Publica, SNIP, in its Spanish acronym) since 2004. A risk analysis according to figure 9.10 is mandatory during the planning phase of a public investment project. In November 2011, a similar process was initiated for integrating climate change adaptation (CCA) considerations into the Peruvian SNIP, building on the accumulated DRM experience. The experience from Peru suggests that six steps are necessary for incorporating both DRM and CCA into SNIPs in other Latin American countries. Institutionalizing this process may take approximately four years. Truly institutionalizing DRM and CCA considerations is the great asset of this approach. By integrating DRM and CCA into existing planning systems, systematic and multisectoral risk reduction architecture can be established. DRM and the quality and sustainability of public spending—usually in an environment of scarce resources—are improved.

Figure 9.10 Incorporation of DRM and CCA criteria into SNIPs

Precondition: Existence of a SNIP

Raising awareness of stakeholders
Ministries: Economy and Finance, Environment, Agriculture; regional governments; international cooperation

Building a national consensus

Preparing conceptual and methodological tools
Initially, their consideration in the formulation and evaluation of new public investment projects is on a voluntary basis

Dissemination and capacity building
Capacity building courses with technical staff at national and regional level

Formalizing regulations and methodologies
Improved versions are formalized and made obligatory

Monitoring, evaluation and feedback
Regular monitoring and adjustments to changed circumstances

Source: Authors based on Galarza and von Hesse 2011.
Note: CCA = climate change adaptation; DRM = disaster risk management; SNIP = National Public Investment System (Sistema Nacional de Inversión Publica).

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Microenterprise Demand for Weather-Related Insurance and Risk Management Approaches in the Caribbean

Koko Warner (UN University, Bonn); Christoph Feldkoetter (GIZ, Germany)

Developing countries located in disaster-prone regions such as the Caribbean are particularly hard hit by the consequences of global climate change, causing even more difficulty for vulnerable people to adapt to the increasing risk. Parametric weather risk insurance for low-income groups can play a role in providing swift and unbureaucratic assistance following weather events and thus safeguard livelihoods and build resilience. However, these approaches have experienced difficulties in reaching out to a larger proportion of the vulnerable population because of a shortage of information on local weather risks, insufficient risk management and risk transfer experience on the part of the initiators, and lack of a viable reinsurance concept.

This section draws on the results of a demand study[8] within the low-income segment, intended to support the development of financial risk management strategies and data in the Caribbean.

Weather hazards in the Caribbean

The countries of the Caribbean are vulnerable to a number of increasing weather-related hazards, including drought, floods, and hurricanes. For Belize, Grenada, Jamaica, and St. Lucia, data from the Collaborating Centre for Research on the Epidemiology of Disasters (CRED) of the World Health Organization, indicates that over the past 30 years, flood and tropical storm damage affected 1.5 million people directly and caused over US$5 billion in damage. Bueno and colleagues (2008) estimate the costs of climate change for the Caribbean at nearly US$6 billion per year by 2050, as well as the decline of coastal tourism by 16 percent by 2080 as a result of shrinking beaches. In addition, Crowards (2005) notes that in the year of a disaster, tourist arrivals drop by 2.8 percent, with a reduction of approximately 13 percent in the growth rate. On average, growth rates do not return to predisaster levels for 3 years. Rasmussen (2004), looking specifically at the Organisation of Eastern Caribbean States (OECS), estimates that damage from hurricanes, which hit approximately every 2.5 years, costs approximately 2 percent of the affected country's gross domestic product (GDP).

Low-income people from all sectors face weather-related risks

For the survey of low-income persons in agriculture and tourism in these four countries, a sample target of 275 persons per country was set with a target of 1,100 overall. The average household was operating at 113 percent of the poverty line (that is, they were 13 percent above the poverty line and would therefore be considered vulnerable). Overall, 49 percent of respondents indicated that they had a high or very high dependence on agriculture, 41 percent indicated that they had a high or very high dependence on tourism to their country, and 14 percent were highly dependent on both sectors. Nearly 70 percent of respondents had some form of self-employment while, as an indicator of the level of informality, 61 percent of businesses were not registered.

Extreme weather, coping mechanisms, and implicit demand

Low-income people face high risks from weather: 42 percent of the sample had experienced some loss because of extreme weather since 2000, with some respondents experiencing multiple losses. In addition, 26 percent experienced house damage from flooding or high winds, and 38 percent experienced loss of customers or employment.

The main coping mechanisms of respondents following a disaster were the use of savings (36 percent), followed by borrowing (12 percent) and government assistance (9 percent) (table 9.1). Of greatest concern from these results were respondents not "repairing or replacing," not knowing what to do, or "waiting." The level of these "do nothing" responses suggests an implicit demand for insurance.

Table 9.1 Coping Mechanisms of Low-Income Population, Selected Countries

Coping mechanism	Grenada (%)	St. Lucia (%)	Jamaica (%)	Belize (%)	Stressor level
Received insurance payout	4.8	1.5	2.9	8.6	Low
Used savings	45.7	96.2	65.4	34.5	Medium
Used remittances	3.8	3.1	9.6	1.7	Medium*
Found another job	10.5	6.1	0.0	12.1	Medium
Sold possessions	1.9	1.5	0.0	13.8	High
Received government assistance	34.3	8.4	1.9	25.9	Medium*
Borrowed (informal)	7.6	10.7	16.3	13.8	Medium
Borrowed (formal)	7.6	10.7	0.0	36.2	Medium
Did not repair or replace	22.9	59.5	48.1	24.1	High*
Other (includes "waiting")	9.5	0.8	51.9	6.9	High*
Total	148.6	198.5	196.1	177.6	n.a.

Source: Stressor levels from Sebstad et al. 2006.
Note: n.a. = not applicable. Totals do not sum to 100 percent because multiple responses were allowed.
* Not included in Sebstad et al. 2006.

Table 9.2 Demand for Weather-Related Microinsurance, the Caribbean *percent*

Demand level	Grenada	St. Lucia	Jamaica	Belize	Average
None	16.2	16.3	27.3	18.5	19.6
Very low	11.0	8.8	12.9	12.4	11.3
Low	15.8	15.0	8.3	11.2	12.6
Moderate	38.6	31.3	22.3	40.6	33.2
High	14.3	24.6	16.3	14.9	17.4
Very high	4.0	4.2	12.9	2.4	6.0

Source: Munich Climate Insurance Initiative (MCII) and GIZ. 2011

These coping strategies have the longer-term effect of depleting financial reserves, increasing indebtedness, and interfering with family life. Governmental support exacerbates a dependence culture among those affected. The inclination to not repair or replace reduces productive capacity, leading to loss of income sources, further depletion of assets, loss of access to finance, untreated health problems, and social isolation.

Respondents also conducted a self-assessment as to their risk exposure from a number of scenarios. The most prominent risk was loss of customers or of job, noted as being a high or very high risk by 33 percent and 30 percent of respondents, respectively. The other issue of concern was that 28 percent perceived themselves at a moderate to very high risk of house damage from high winds. These results suggest an implicit need for weather-related microinsurance in the region.

The demand for weather-related microinsurance in the Caribbean

A high level of implicit demand exists for weather-related microinsurance, and moderate explicit demand is demonstrated by the study (table 9.2). Overall, 23 percent of respondents exhibited a high or very high demand for the product, while 33 percent indicated a moderate level of demand.

Summary

The results of the study are now being used to implement two insurance policies for low-income people in cooperation with the governments of Jamaica, Belize, St. Lucia, and Grenada, by the partnership between MCII, CCRIF, MicroEnsure, and MunichRe. A number of product design issues need to be considered: simplicity for clients, rapidness and ease of claims, products that fit the needs of a broad group of low-income people, and EWSs and information to encourage reduction of loss and damage.

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Notes

1. This abstract draws largely from BMZ (2010).
2. See MATRIX, http://matrix.gpi.kit.edu/.
3. See U.S. Geological Survey, http://urbanearth.usgs.gov/.
4. see: Information Office of the State Council of the People's Republic of China. 2009.
5. see: BBK (The German Federal Office of Civil Protection and Disaster Assistance). 2010.
6. see: Chongqing Municipal Government & Jiulongpo District Government. 2011.
   Chongqing Municipal Government & Jiulongpo District Government. 2012a,b.
   Instruction and Coordination Group Office of Guangdong Provincial Government for the Pilot Project of Disaster and Risk Governance and Contingency Plan Optimization. 2011.
   Shenzhen Taskforce for the Sino-German Disaster Risk Management Project in the Bao'an District Emergency Management Office. 2011.
7. As distinguished from a purely commercial assessment, the social evaluation takes into consideration the costs and benefits of a project for the whole country and not only for the investor. Therefore, the NPV is calculated with social prices and takes into account the costs and benefits of external and indirect effects.
8. A demand study was commissioned by the German government, executed by the GIZ through the UN University, Bonn, and the Munich Climate Insurance Initiative (MCII). The key objective of the project was to develop and implement a market-demand survey for the creation of weather risk insurance products for low-income groups in the Caribbean. One of the main features in product design is the involvement of the MCII, the Caribbean Catastrophe Risk Insurance Facility (CCRIF), MicroEnsure, and MunichRe, organizations with experience in the areas of CCA, risk management, microinsurance, and reinsurance.

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