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IMPROVING THE ASSESSMENT OF DISASTER RISKS TO STRENGTHEN FINANCIAL RESILIENCE

A Special Joint G20 Publication by the Government of Mexico and the World Bank

G2012 MÉXICO

THE WORLD BANK

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G2012 MÉXICO
ESTADOS UNIDOS MEXICANOS
THE WORLD BANK
GFDRR
Global Facility for Disaster Reduction and Recovery

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This publication is a product of the Government of Mexico and the World Bank Group with submissions by the Governments of Argentina, Australia, Brazil, Chile, China, Colombia, France, Germany, Italy, Japan, Republic of Korea, Mexico, Turkey, United Kingdom, and United States, as well as by the Organisation for Economic Co-operation and Development, in response to the 2012 G20 Disaster Risk Management initiative and the request from G20 Ministers of Finance and Central Bank Governors to the World Bank to prepare a compilation of country experiences.

Message from the G20 Presidency

Due to its geographical location, Mexico is highly prone to a wide range of natural disasters: earthquakes, hurricanes, tropical cyclones, droughts and floods that recurrently affect our population and economy. Also, the risk of a volcanic eruption is always latent in central and western Mexico. Although these hazards may materialize in different forms and in different regions of our country, some of them have the potential to cause significant damage to housing and vital infrastructure, and more importantly, to cause injuries and fatalities in the population. For instance, the 1985 Mexico City earthquake caused 6000 deaths and provoked damages estimated at 11.4 billion dollars.

Although we have not had another disaster of this magnitude, climate change-related events are becoming more frequent and intense. As a consequence, whilst the cumulative cost of disasters during the 70s was 1.2 billion dollars, they nearly reached 14 billion in the 80s and exceeded 15 billion dollars in the 90s. Between 2000 and 2010 the cumulative cost of disasters was more than 25 billion dollars, and the number of people directly affected was approximately 8 million.

As a result, Mexican scientists, civil society organizations and all levels of Government have formed strong links to prepare to respond to natural disasters. We have strengthened our technical knowledge on the dynamics of natural hazards, the location of the most vulnerable populations and infrastructure, and have created models to assess risks using top international standards. Furthermore, we have put in place financial instruments and opened up the reinsurance and capital markets to support our disaster management policy. We have improved our disaster management strategy and obtained great benefits from doing so.

Many other countries around the world face similar challenges, and their individual solutions provide a wealth of knowledge largely unexploited until now. As President of the G20, Mexico decided to take the invaluable opportunity of interacting with the world's leading economies to raise awareness of the benefits of effective Disaster Risk Management strategies, and facilitate the voluntary implementation of proven solutions in developed and non-developed countries alike.

This publication has been made possible thanks to the valuable contributions of many countries committed to tackling the negative impacts of disasters in a more effective way, not only in their own countries, but around the world. It includes a wealth of experiences that we are sure will set the foundation for new initiatives, ideas and approaches to Disaster Risk Management.

The benefits of sound Disaster Risk Management policies can be far reaching; they can improve disaster preparedness, prevention and response, ultimately saving lives and protecting the livelihoods of vulnerable people. These same policies can also set the basis for innovating around the way we pay for natural disasters. However sophisticated financial markets have become, they are yet to develop suitable solutions for Governments to be able to face natural disaster risk management.

Mexico would like to express its gratitude to all the countries and international organizations that contributed to this publication, and we sincerely appreciate the invaluable contribution of the World Bank to the discussions that you will find in these pages.

Felipe Calderón Hinojosa
President
United Mexican States

Message from the World Bank

Earthquakes in Chile, Haiti, Japan, and New Zealand. Major floods in Australia, Pakistan, and Thailand. The worst drought in sixty years in the Horn of Africa. 2011 was the worst year on record for disasters caused by natural hazards, resulting in an estimated $380 billion in economic losses. These devastating events affect millions of people around the world, destroying homes and livelihoods. They strike developing and developed countries alike. No country is immune.

As more people move to cities and climate patterns shift, we face increasing exposure to natural hazards with a greater risk of damage. This puts a greater economic strain on the poor who have less capacity to protect their property and themselves. Building disaster resilience in communities and nations is therefore essential, not only for reducing the risks and impacts from natural hazards, but for fighting poverty and meeting the Millennium Development Goals. Resilience is a combination of adequate prevention, preparedness, swift response, and predictable recovery. It is both a development imperative as well as a question of humanitarian response.

The good news is that many countries are making progress on building resilience to natural disasters. This publication highlights their experiences, with examples of steps governments are taking to protect people and assets. These include improving land use management; applying better building standards; using more thorough emergency response mechanisms; and developing insurance markets and social safety nets. These experiences demonstrate that it is possible to reduce risks to natural disasters, and that – if done right – prevention pays off.

One of the most important lessons emerging from this publication is that, globally, we need to better understand how and where we are vulnerable to disasters, and how best to manage the risks we face. Information is the foundation of any risk management strategy. Informed and knowledgeable citizens and public authorities, with the resources to back them up, are the key to successful disaster risk management planning and implementation.

This publication is a partnership between the Government of Mexico and the World Bank Group, with the strong support of G20 and guest countries, as well as the OECD. Mexico has made significant contributions to disaster prevention, particularly through innovative risk assessment and risk financing tools. Working with Mexico, the World Bank has learned important lessons that can now be shared with, and applied in, other countries. Today, we have an opportunity to make better decisions about how to lessen the impact of disasters, help safeguard property, protect development gains, and rebuild lives.

Robert B. Zoellick
President
The World Bank Group

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Executive Summary

Rising losses from adverse natural events are compelling leaders of countries to develop more proactive approaches to risk management. In 2011 the world witnessed record losses from disasters caused by natural hazards with estimated costs of up to US$380 billion. Events in both developed and developing countries have shown that this is not a threat facing just one part of the world. In this context, the Mexican G20 Presidency included this growing threat to sustainable development on the group's agenda, a decision which was welcomed by G20 finance ministers and central bank governors.

The economic costs of disasters complicate public financial management for many countries. Natural hazards are nondiscriminatory, potentially affecting all countries irrespective of economic status. The negative fiscal impacts of disasters can hamper longer-term growth and economic development. Moreover, in an increasingly interconnected world, disasters in any one place can have far-reaching impacts. The upward trend in losses is set to accelerate with a changing climate and rapid urbanization. More than ever, decisions about investment in development need to consider long-term resilience.

While lower income countries bear the brunt of the human impact from disasters, middle income countries experience the largest economic impact relative to GDP. The Government of Chile estimates the cost of the 2010 earthquake and tsunami at US$30 billion, around 18 percent of the country's GDP. With costs of over US$200 billion, the 2011 Great East Japan Earthquake and tsunami was the costliest natural disaster in history. Contingent liabilities from disasters impact national budget balance, restrict fiscal space, and hamper economic growth and long term economic development. While advanced economies face the highest absolute losses, comparatively, middle-income countries experience the largest direct losses in terms of average economic losses compared to their GDP and small economies sustain the largest capital stock losses as a proportion of GDP.

Responding to a G20 mandate, this publication brings together the experiences of G20 countries in protecting their populations and assets against natural hazards. It includes contributions by fifteen G20 members and invited countries *(Argentina, Australia, Brazil, Chile, China, Colombia, France, Germany, Italy, Japan, Republic of Korea, Mexico, Turkey, United Kingdom, and United States)*, as well as the OECD. A World Bank paper introduces the country experiences and sets out the challenges and opportunities to address rising disaster losses with more accurate risk data and better informed decision making. A G20 Country Steering Group provided strategic and policy guidance to the Disaster Risk Management initiative.

Prevention is better than cure; there is a need to raise awareness about disaster risks and their potential financial consequences. Increased resilience and sustainable development will require a more proactive approach to tackle risk at its roots. Preparedness measures to cope when disasters strike need to be combined with ex ante measures to avoid disasters in the first place. Effective prevention measures can, in the long run, save money by reducing spending on recovery and reconstruction. Increasing awareness at all levels of government and society is needed to allow for a better integration of risk in decision making. The use of new tools can help policy makers understand the risks from natural hazards, which, in turn, can inform decisions for resilient development and increased financial resilience. This process needs to be supported by the international community.

The need for better information on adverse natural events and associated economic, fiscal and social impacts emerges as a key message. Governments are increasingly able to access techniques for risk identification and modeling that result in better understanding and valuing of risk to identify the potential effects of hazards on infrastructure and assets. Utilizing these tools countries can assess the risks they face, and help policy makers and the public arrive at better informed decisions. New techniques have emerged that allow for detailed analysis of hazard, exposure and vulnerability on a territorial or sectorial basis and support objective decision-making on how to best address the root causes of disasters.

Countries can strengthen their financial resilience to disasters. While prevention and mitigation efforts are indispensable steps to build resilience, no country can fully insulate itself against losses from adverse natural events. Considering disaster risk in fiscal policy can provide efficient means for countries to financially protect themselves against events that cannot be prevented.

Integrated disaster risk financing strategies allow countries to increase their financial response capacity in the aftermath of disasters and reduce their economic and fiscal burden. Governments should develop integrated disaster risk financing strategies, as part of their overall risk management strategy. Such strategies would allow governments to reduce their budget volatility through a combination of self-retention (such as dedicated domestic reserve funds) and risk transfer instruments (such as insurance).

Governments should stimulate innovative financial solutions with and leverage the technical and financial capacity of the reinsurance and capital markets through public private partnerships. The private sector has an important role to play to innovate in order to meet the needs of governments around the world, and create new markets and financing tools that will allow for a more effective response to disasters.

Resilience to natural hazards should be a core element in the design of development programs. Given the path dependency of many development strategies leading to potentially irreversible development trajectories, it is important to incorporate risk management early in development planning. Governments and society at large should first try to stem the creation of new risk resulting from an uncontrolled development process while addressing existing risk in a targeted manner that makes best use of the limited resources available.

Every country and situation is different but much can be learnt from other countries' experience. Knowledge sharing and documentation of lessons learned around the world should help avoid errors of the past. Lessons from one country or one disaster should not be applied blindly but can help inform solutions fitted to the local context. Tailored solutions are needed in particular for developing countries that do not have the same level of resources available as advanced economies.

The G20, the World Bank and other international partners have an important role to play in collaborating with national and local authorities on the issues and challenges set out in this publication. No single country or institution has all the answers. There is a need to document lessons and stimulate innovation. Without significant effort, our collective capacity to prevent avoidable losses will not keep up with the rising threat of disasters. As a first step the Country Steering Group recommended that G20 countries and international organizations:

- *Document international experience to promote global exchange and knowledge transfer.* The experience in assessing and reducing disaster risks among G20 countries is significant. In order to tap into this experience, international cooperation is important to increase the availability and quality of technical expertise and collaboration accessible to disaster prone countries.

- *Promote global and regional efforts on risk assessment and risk financing.* Cooperation among countries, institutions, and regions is important to streamline global efforts on risk assessment and risk financing. In particular, G20 countries can contribute to the promotion of exchange of risk data and methodologies between governments and commercial financial institutions. Furthermore, the role of international organizations such as the World Bank in establishing platforms for sharing good practice and discussing lessons learned in risk modeling and risk assessment should grow, with the involvement of all relevant stakeholders including the private sector.

- *Support initiatives to tackle the increase of disaster losses in developing countries.* Developing countries are particularly exposed to disaster risk, yet, with limited resources, they are the least able to address the problem. A strong link exists between risk, vulnerability and poverty. G20 countries that provide humanitarian and development assistance to disaster-prone countries also have a responsibility to apply the principles of disaster risk management to aid.

The World Bank has been working with countries around the world to support the implementation of disaster risk management strategies to save lives and protect development gains. Over the last decade alone the World Bank supported almost a hundred countries with disaster related assistance worth a total of US$17.9 billion. Furthermore, the establishment of the Global Facility for Disaster Reduction and Recovery was a crucial step in enhancing partnerships and fostering stronger cooperation towards disaster resilience. Drawing on this experience, this chapter sets out the challenges from rising disaster losses, introduces the opportunities to reduce risks through better informed decision making, and highlights necessary steps in this direction. While every country faces unique challenges, much can be learnt from exchanging experiences and lessons learnt.

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Women involved in community meeting to discuss village reconstruction. Yogyakarta, Indonesia.

IMPROVING THE ASSESSMENT OF DISASTER RISKS TO STRENGTHEN FINANCIAL RESILIENCE

Experiences and Policy Lessons from the Work of the World Bank

Disaster Risk Management in a Changing Climate

Catastrophic Events—A Major Concern for Modern Societies

The large social and economic impacts of disasters demonstrate the vulnerability of modern societies to natural hazards. In recent years, many countries have been affected by events that have caused large human, economic, and financial losses.[1] With costs of more than US$200 billion, the 2011 Tohoku earthquake and accompanying tsunami was the costliest disaster in history (table 1). In the same year, floods cost Thailand over US$30 billion. Only six years earlier, Hurricane Katrina caused damages of more than US$160 billion in the United States. These costs do not even take into account the human loss resulting from these events. This vulnerability to natural hazards highlights the importance for countries not only to be prepared to respond to disasters, but also to implement adequate prevention measures, mitigate risks actively, and establish sound post-disaster financing mechanisms.

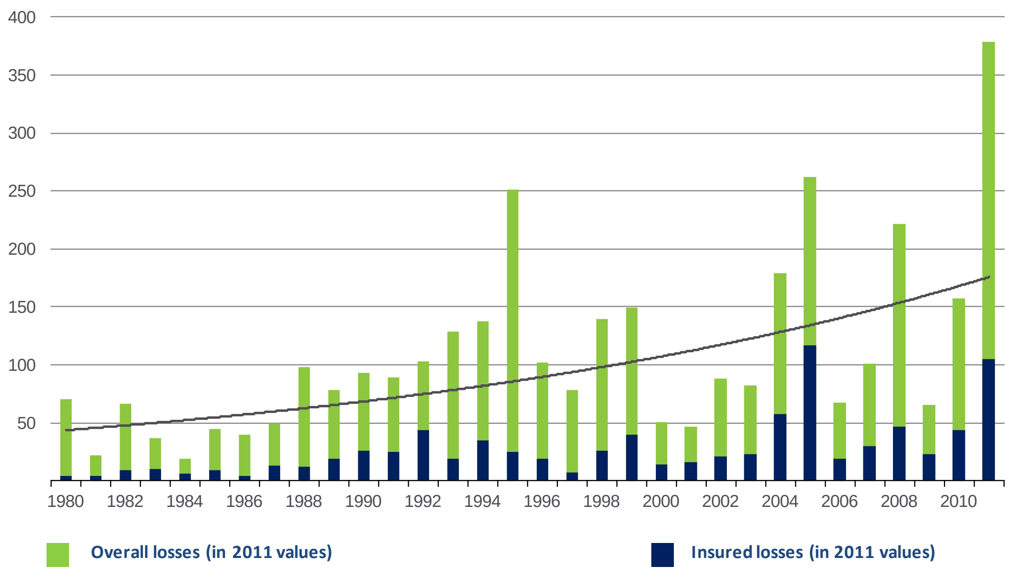
Table 1 Top 10 Natural Catastrophes in Economic Losses, 1970 to Present

Country	Year	Brief description	Number of Victims	Total loss (US$, inflated)	Insured loss (US$, inflated)	Total loss (% of GDP)
Japan	2011	Earthquake (Mw 9.0), tsunami	19,184	210,000	35,000	3.5
United States	2005	Hurricane Katrina	1,836	161,164	74,686	1.1
China	2008	Earthquake (Mw 7.9) in Sichuan	87,449	130,104	383	2.8
Japan	1995	Great Hanshin earthquake in Kobe (Mw 7.2)	6,425	121,596	3,648	1.6
China	2010	Floods	2,490	53,977	785	0.9
United States	1994	Northridge earthquake (Mw 6.6)	61	45,513	21,239	0.4
United States	1992	Hurricane Andrew	43	42,469	25,641	0.4
United States	2008	Hurricane Ike	136	41,774	21,141	0.3
China	1998	Flooding along Yangtze River	3,656	41,385	416	3.0
Japan	2004	Chuetsu earthquake (ML 6.9)	39	34,849	712	0.6

Note: GDP = gross domestic product; ML = local magnitude; Mw = moment magnitude;
Unit = US Dollar million at 2011 prices
Source: Swiss Re, Sigma Catastrophe (database), http://www.swissre.com/sigma/.

The frequency of disasters is increasing, and although mortality resulting from disasters seems to be decreasing around the world, economic costs are rising precipitously. (Figure 1) Mortality rates from natural hazards are decreasing, particularly in advanced economies, reflecting successful investments in prevention and reduction of people's vulnerability to natural hazards (UNISDR 2011; World Bank and United Nations 2010). In contrast, the estimated cost of US$380 billion from disasters in 2011[2] was the highest in any single year, mainly because of earthquakes in Japan and New Zealand and major floods in Thailand, Pakistan, and Australia, causing devastating effects. While many countries successfully decreased mortality risk, fatalities remain a major problem in countries with low gross domestic product (GDP) and low capacity to implement risk reduction and prevention strategies.

Figure 1 Overall and Insured Losses from Natural Catastrophes Worldwide, US$ Billions, 1980–2011



Source: Munich Re, NatCatSERVICE, http://www.munichre.com. As of January 2012.

Disasters are nondiscriminatory, potentially affecting all countries irrespective of economic status. Despite prevention and mitigation efforts, no country can fully insulate itself against losses from disasters. In absolute terms, the costliest disasters generally occur in developed countries, which have the highest concentration of valuable assets. Comparatively, middle-income countries experience the largest direct losses in terms of average annual losses compared to their GDP, and small economies sustain the largest capital stock losses as a proportion of GDP (Cummins and Mahul 2008).

The economic costs of disasters complicate public financial management for many countries. Effective disaster risk reduction strategies, including prevention, mitigation, and financing strategies, are rising as a global priority as the losses of disasters increase. Events such as the 2003 heat wave in Europe, Hurricane Katrina in 2005, the 2011 Tohoku earthquake and tsunami in Japan remind the world that disasters are a threat to both rich and poor countries. The rising economic impact of disasters is attributed to growing concentration of assets and population in zones at high risk of natural hazards. This is likely to continue given expectations of further rapid urbanization, environmental degradation, and an increase in the frequency and intensity of disruptions resulting from climate change.

Because they are harder to quantify, the indirect consequences of disasters are rarely considered, but can have important negative impacts on development achievements and poverty reduction efforts. Indirect economic impacts include job losses, economic slowdown, falls in tourism, and reduction in public revenue. The fiscal effects of budget reallocations from other priorities are difficult to assess. In addition, there are social impacts such as physical and mental health consequences or education, health, water, power, and other public services disruption. Even temporary malnourishment can permanently stunt growth and lower cognitive abilities among children younger than age three (World Bank and United Nations 2010). Natural disasters also affect school enrollment rates through the destruction of schools; loss of teachers; loss of income; and family preoccupation with securing the basic needs of shelter, water, and food. Being prepared can make a significant difference in reducing the costly disruptions of natural disasters.

In an increasingly interconnected world, disasters in any one place can have far-reaching impacts. Negative effects from disasters can rapidly cascade through increasingly interconnected and tightly coupled systems, making them as vulnerable as their most vulnerable parts. For example, global supply chains and "just in time" production, which maximize efficiency and minimize redundancy, can rapidly transmit business interruptions around the globe.

The rising frequency of disasters requires a more informed approach to decision making. A changing climate, increased exposure and vulnerability, requires robust decisions for resilient development.

Costs of Disasters—An Often Ignored Contingent Liability

The financial consequences of disasters are one of many types of fiscal risk that are faced by governments; because they are difficult to measure, they are often ignored. Like many other financial shocks, disasters present a liquidity challenge. Governments find themselves in need of immediate resources to pay for response, recovery, and reconstruction.[3] They need to manage the budget to meet these immediate needs along with maintaining basic public services and core development programs. They need to do this while maintaining macroeconomic stability to avoid inflation and keep public debt within sustainable limits. Nevertheless, governments usually do not plan on or budget for disasters. Few countries systematically assess their exposure to natural hazards and the potential financial and fiscal impact before an event. Governments may find it useful to explore how the avoidance of disruption of longer-term growth and development objectives can be firmly grounded in fiscal strategies that reduce the budget shock of natural disasters.

The negative fiscal impacts of disasters can hamper longer-term growth and economic development. A government's post-disaster response is rarely clearly defined in advance. The government is generally expected not only to fund recovery and reconstruction expenses for public assets in the aftermath of a disaster, but also to organize and fund post-disaster relief and recovery. Often governments provide funding for reconstruction of underinsured private dwellings to avoid homelessness. Explicit and implicit contingent liabilities arising from disasters create budget pressures for governments, potentially hampering long-term growth and economic development. Beyond the direct economic costs, disasters come with significant indirect costs, such as sustained business disruptions, lowering tax revenues and upsetting fiscal stability.

Effective risk management needs to be integrated in development and fiscal planning. Given the path dependency of many development strategies leading to potentially irreversible development trajectories with potentially regrettable impacts in the future, it is important to incorporate risk management early in development planning, especially within land use, urban planning, and construction standards. This approach also requires building capacity at multiple levels within a country to assess risk, prevent the creation of new risks, and mitigate existing risks.

See also chapter

"Experiences in Disaster Risk Management within the German Development Cooperation"

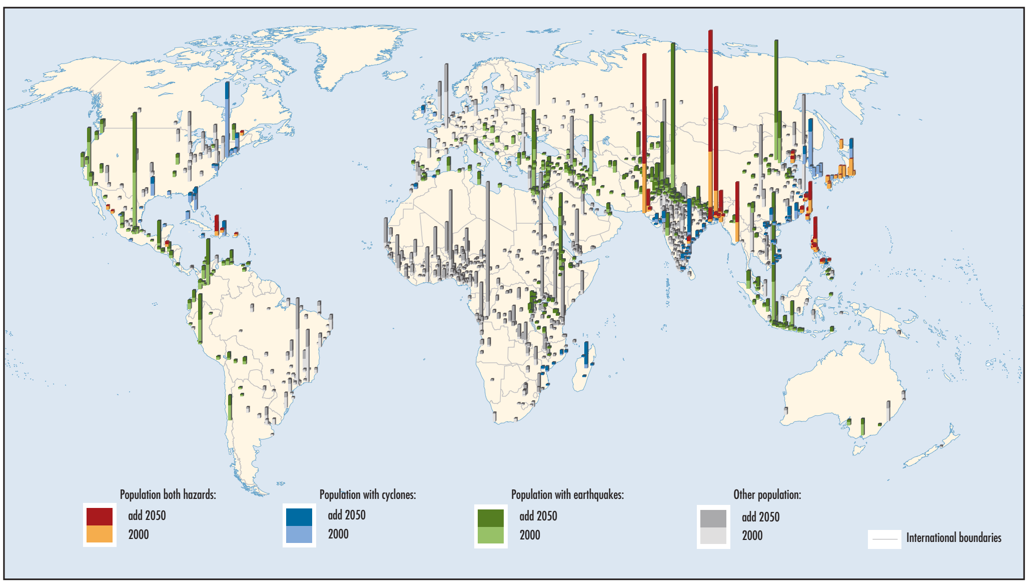
Emerging Trends: Increasing Hazards and Exposure, Rising Economic Costs

Growing population and assets exposed to adverse natural events are the main drivers of rising disaster losses. The increasing level of population living in hazard prone areas, combined with substandard building standards, is the main factor explaining the growing impact of adverse natural events around the world. New settlements along rivers and coastal areas mean that more population is exposed to flooding and cyclone.

The current rapid process of urbanization around the world presents a particular challenge. By 2050, the United Nations (UN) estimates that 70 percent of the world´s rising population will live in cities; as a result, economic assets and output will also be strongly concentrated in cities. Indeed, the population exposed to earthquakes and cyclones in large cities is expected to double by 2050 (map 1). This concentration of people and assets increases the risk that any single event can have a large impact on a country or potentially affect world trade.

If not addressed, the growing population, economic expansion, and urbanization will invariably lead to environmental degradation resulting in increased hazards and vulnerability. In Haiti, for example, deforestation and erosion increased susceptibility to landslides and reduced the flood control capacity of riverbeds because of sedimentation. As a consequence, disasters from tropical storms are more frequent and devastating than in neighboring Dominican Republic. Similarly, the 2010–12 floods in

Map 1 Rising Exposure to Cyclones and Hurricanes, 2000–50



IBRD 37875
AUGUST 2010

Exposure to cyclones and earthquakes in large cities rises from 680 million people in 2000 to 1.5 billion people by 2050
Source: World Bank and United Nations 2010.

Colombia were among the most severe in the country's history even though they were caused by rains with a return period of as little as 20 years. Sedimentation of riverbeds from upstream deforestation and desiccation of flood buffer swamps for agricultural purposes had reduced the capacity of the land to naturally cope with floods and will likely increase the frequency of such events in the future (Campos and others 2012).

A changing climate will lead to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events and can result in unprecedented extreme weather and climate events (IPCC 2012). According to the Intergovernmental Panel on Climate Change (IPCC) report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, changes in the intensity and frequency of some extreme weather events are already taking place and will accelerate in the future. Increases in global mean temperature frequency of heat waves, and the frequency of heavy precipitation are expected in many areas of the world. Rising sea levels are likely to result in more flash floods and losses from storm surge. By increasing the frequency of extreme events, climate change can turn what are exceptional disasters today into routine aspects of life in the future.

Moreover, climate change introduces deep uncertainty in risk management. Climate projections sometimes disagree on how future extremes will evolve (for example in West Africa, some models project an increase in drought frequency while others project the opposite). It means that risk policies and measures need to be designed in a way that accounts for this uncertainty and favors the most robust solutions; solutions that are successful irrespectively of how climate change will affect local hazards or that can be revised when new information is available in the future.

Managing Disaster Risks: A Complex Task Including Many Stakeholders

Changing Mindsets: Toward a Culture of Prevention. This is the starting point of the joint United Nations–World Bank, with support from the Global Facility for Disaster Reduction and Recovery (GFDRR), landmark report published in 2012 that illustrates that prevention pays, if done right. Aimed specifically at finance ministers, *Natural Hazards, UnNatural Disasters: the Economics of Effective Prevention* outlines what it takes to achieve effective prevention.

Earthquakes, droughts, floods, and storms are natural hazards; disasters are the deaths and damages that result from human acts of omission and commission. Every disaster is unique, but each exposes actions—by individuals and governments at different levels—that, had they been different, would have resulted in fewer deaths and less damage. Damage reduction is possible, and the book referenced above examines how to do this cost-effectively. In the analysis conducted in the book, three common threads emerge: the role of information, incentives, and infrastructure (the three i's). Timely information, incentives that do not become distorted by public policy, and infrastructure that is reliable can all help ensure that natural hazards need not turn into human disasters. These need to be imbedded ultimately in institutions that are credible, effective, and responsive (World Bank and United Nations 2010).

Prevention pays; there are well-identified cost-effective steps governments can take to protect populations and assets. Preparedness measures to cope when disasters strike are important. However, by themselves they are insufficient; they need to be combined with ex ante measures to reduce the risk that a natural event becomes a disaster. Effective prevention measures can, in the long run, save money from reduced spending for recovery and reconstruction. Nevertheless, risk reduction measures are often weak, especially in developing countries. In too many countries, urban growth is often unplanned, resulting in the occupation of risky areas where public and private infrastructure is more vulnerable to hazards. Development strategies that ignore disaster risks hide a development trap: public and private investments and assets at risk of disasters will be frequently damaged, slowing down or even setting back development.

Mitigating the risks of natural hazards and preparing for disasters requires collective action among many stakeholders. Disaster risk management stretches across many different sectors, such as finance, economics, business, water, energy, and construction, and requires coordination among many actors, such as ministries and disaster management agencies. Moreover, many stakeholders are involved in addition to the state. From the local and municipal levels to the regional and global levels, actors such as nongovernmental organizations, those from the public and private sectors, and international organizations need to work together.

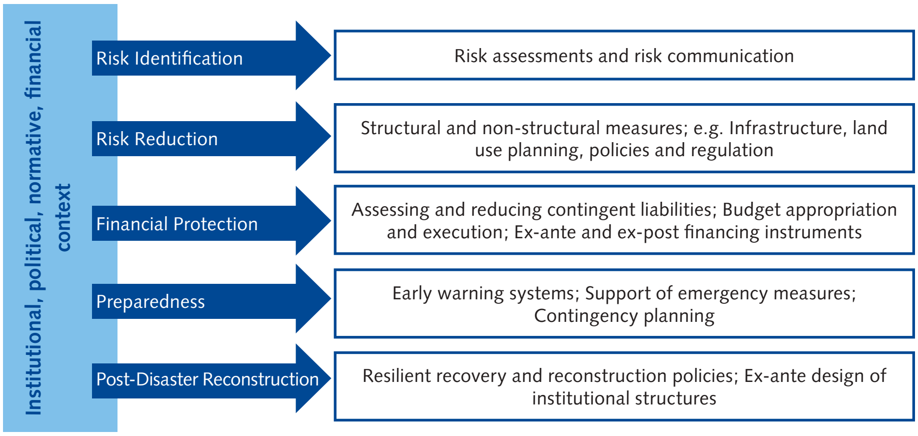
See also chapter

"From Business Continuity to Service Continuity: The Case of the Italian Financial System"

Effective risk management should be done in a comprehensive manner. Measures should be guided by the five priorities of the Hyogo Framework for Action (HFA), the internationally recognized blueprint for reducing disaster losses globally, adopted by 168 countries. The elements of a comprehensive strategy are (a) identification, assessment, and monitoring of risk; (b) reduction of risk through prevention and mitigation measures; (c) management of the financial impacts of natural disasters through disaster risk financing and insurance; (d) strengthening of preparedness for disasters; and (e) better post-disaster response, recovery, and reconstruction that reduces risk from future events (figure 2).

Many cost-effective risk management options can be applied immediately, based on available or easy-to-access knowledge, and do not require detailed risk assessment. For instance, solid waste management and maintenance of drainage infrastructure (including widening, deepening and evacuation of encroachers) would mitigate floods from heavy rainfall in many urban areas (see an example on floods in Mumbai in Ranger et al. 2011). Stricter building norms and higher quality buildings would reduce earthquake losses (Kunreuther and Michel-Kerjan 2012). Early warning systems have regularly been cited as highly cost-efficient (Subbiah, Bildan, and Narasimhan 2008; Hallegatte 2012).

Figure 2 Disaster Risk Management Framework, GFDRR and the World Bank



Source: World Bank and Global Facility for Disaster Reduction and Recovery (GFDRR)

Other risk management options require more precise data or assessment, especially when they are particularly expensive, difficult to enforce, or when they create irreversibility in exposure or vulnerability. This is particularly the case of large-scale hard protections (e.g. dikes) and land-use and urban planning, which influence the localization of population and assets over the very-long term and have consequences that are difficult or impossible to reverse (World Bank 2012).

Detailed risk assessments are a key element in any comprehensive risk management program. Detailed risk assessment should be used to guide decision making by governments, businesses, and citizens. New techniques have emerged that allow for detailed analysis of hazard, exposure, and vulnerability on a territorial or sectorial basis. These risk assessments are providing insight on the root causes of risks and provide increasingly useful information in the design of more resilient development processes and programs.

Risk information is also needed to develop effective financial protection strategies. Information on the potential fiscal impacts of disasters is a prerequisite to the establishment of effective financial protection strategies. Such strategies should aim at increasing the response capacity of the state while protecting its fiscal balance. Risk financing strategies should also aim at clarifying the responsibility of the state in order to limit implicit liabilities and, to the extent possible, to shift private liabilities away from public purse.

Moving Toward Informed Decision Making

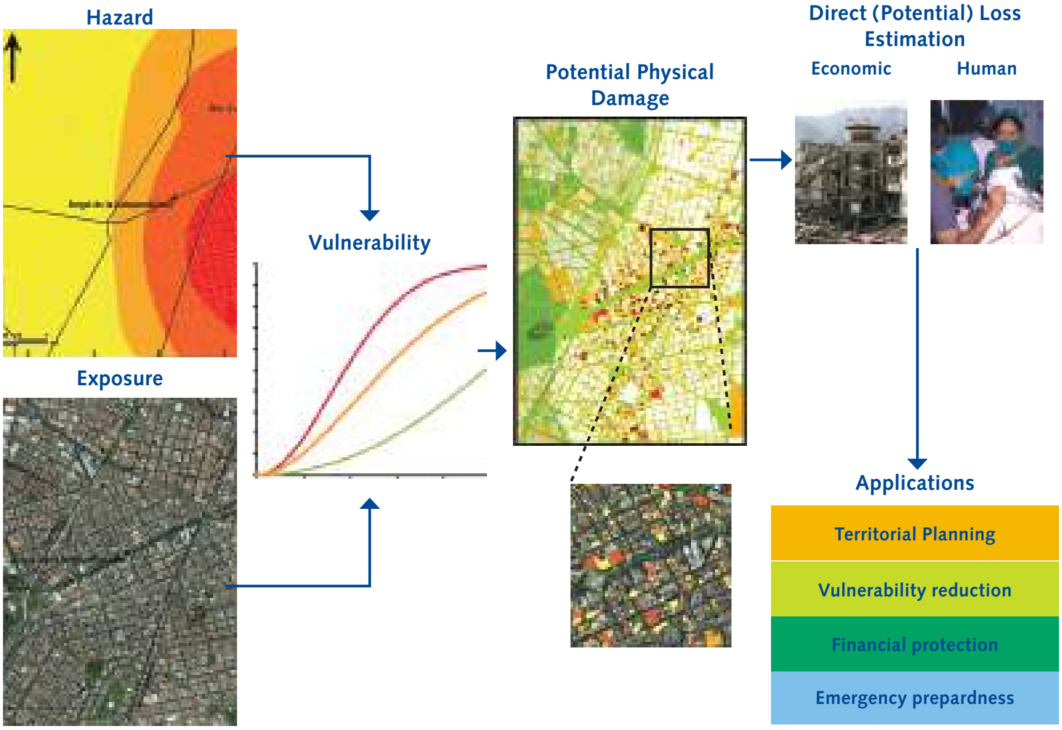
The Fundamentals of Risk Assessments

Risk modeling techniques are increasingly used by governments to assess their exposure to adverse natural events. These techniques provide a robust way to assess and compare risks from adverse natural events. They usually rely on three main inputs (see figure 3):

1. **Hazards:** threats from natural events that may affect all or part of a territory. There will always be large uncertainties about the occurrence of hazards. Existing knowledge at the local and global levels, including well-known databases and historical records, provide an idea of the expected intensity that may be experienced in a specific region.
2. **Exposure:** inventory of the physical assets and human occupation in harm's way, including specific geographical distribution and location, which will be affected by a hazard if it occurs. To characterize the exposure, one must identify particular components such as the location and geometric shape of the exposed elements together with their economic value and human occupation.
3. **Vulnerability:** the expected behavior (that is, potential structural damage) of the exposed elements related to the level of hazard (characterized by its intensity parameter, such as the level of shaking resulting from earthquakes).

Natural hazards can be characterized by their frequency and intensity. Hazard parameters can be determined through a combination of analyzing and understanding historical information and probabilistic risk modeling. Predictable, recurring events such as frequent, small-scale urban flooding or tornadoes can add up to significant damage or pose a serious development challenge. On the other end of the spectrum are low-probability, high-impact events such as catastrophic earthquakes or tsunamis. Hazard models take into account the nature, severity, and frequency of a hazard. However, they are limited by current knowledge of the environment. Lack of historical hydro-meteorological data and

Figure 3 Disaster Risk Assessment Model, Three Main Components: Hazard, Exposure, and Vulnerability



Source: Authors.

understanding of local geology often impairs the development of reliable models. Also, climate change will influence hazards over the long term (IPCC 2011) and there are significant uncertainties on (i) how much greenhouse gases will be emitted in the future and (ii) how the climate system will react to these gases. These uncertainties translate into deep uncertainty on future hazard characteristics, making risk management decision-making more complex.

Vulnerability of an asset to a given hazard can be measured as the effects of the hazard intensity on the given asset, allowing quantification of potential damage. Vulnerability assessments relate damage of each exposed component to hazard intensity. To be useful they should estimate the variability of damages associated with a given intensity value. Vulnerability assessments can use (a) analytical models; (b) laboratory tests on components, elements, or full structural models; or (c) observations of the behavior of components or structures during events for which the intensity is known or can be fairly estimated.

While climate change will affect hazard characteristics, socio-economic trends will affect population and asset exposure and vulnerability. Long-term risk assessment therefore requires the building and use of long-term socio-economic scenarios (e.g. World Bank 2011), taking into account drivers such as demographics, urbanization, economic growth, and changes in preferences and lifestyles.

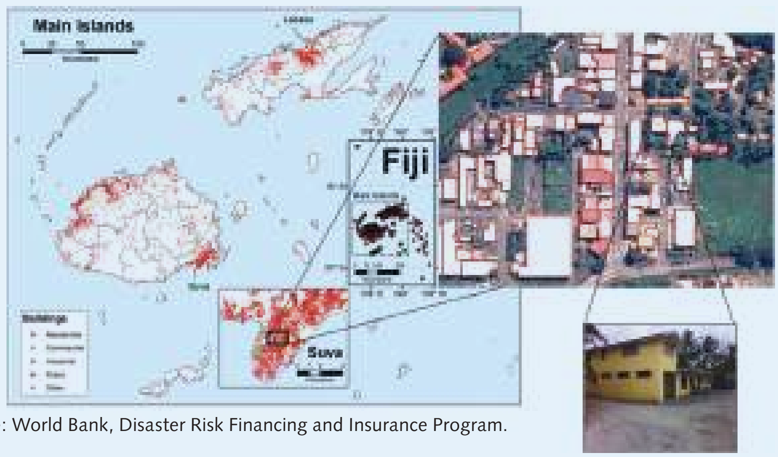
Box 1 Hazard, Exposure, and Risk Database: The Pacific Catastrophe Risk Assessment Initiative

The Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) created the largest collection of geospatial information on disaster risks available for Pacific Island Countries (PICs). The Pacific Risk Information System (PacRIS) platform includes detailed country-specific information on assets, population, hazards, and risks for the islands. Among other uses, these data inform the Pacific Disaster Risk Financing and Insurance Program.

A joint initiative between the Secretariat of the Pacific Community (SPC), Applied Geoscience Technology Division (SOPAC); the World Bank; and the Asian Development Bank, with financial support from the government of Japan and the Global Facility for Disaster Reduction and Recovery, it supports PICs in building resilience to natural disasters.

The first phase of the program conducted detailed risk assessments for 15 countries in the Pacific region, quantifying potential disaster losses from earthquakes, tsunamis, and tropical cyclones. This assessment includes the most comprehensive analysis of building, infrastructure, and cash crop exposure ever conducted for the region. Resulting exposure, hazard, and risk maps (see maps and photo below) and data are shared with policy makers and the public in the PacRIS platform, which forms the basis for three core areas of application:

- Macroeconomic planning and disaster risk financing
- Urban and infrastructure planning
- Rapid post disaster damage estimation



Source: World Bank, Disaster Risk Financing and Insurance Program.

New Techniques and Innovations for Risk Assessments

Probabilistic risk modeling techniques are rapidly becoming the norm when analyzing risk from adverse natural events. Probabilistic risk modeling helps manage uncertainty by providing decision makers with a robust measure of risk, allowing comparisons between sources of risk using coherent metrics. Originally developed by the insurance industry, these techniques acknowledge and incorporate much of the uncertainty inherent in risk assessments allowing for informed decision making on hypothetical scenarios.

Box 2 R-FONDEN: The Financial Catastrophe Risk Model of the Ministry of Finance and Public Credit in Mexico

Since the creation of its National Fund for Natural Disasters (Fondo Nacional de Desastres Naturales, FONDEN) in 1996, Mexico has consistently implemented innovative improvements to its disaster risk financing and insurance strategy. Using this fund, Mexico has developed a comprehensive financial protection strategy relying on risk retention and transfer mechanisms, including reserve funds, indemnity-based reinsurance, parametric insurance, and catastrophe bonds. An in-depth understanding of the risks has allowed the Mexican government to successfully access international reinsurance and capital markets to transfer specific risks.

A fundamental feature of the program is the R-FONDEN, a probabilistic catastrophe risk assessment platform developed to estimate the government's financial exposure. R-FONDEN offers scenario-based, as well as probabilistic analysis at national, state, and sub-state levels for four major perils (earthquake, floods, tropical cyclones, and storm surge) for infrastructure in key sectors (education, health, roads, and low-income housing).

R-FONDEN takes as input a detailed exposure database (including details of buildings, roads, and other public assets) and produces as outputs risk metrics including Annual Expected Loss (AEL) and Probable Maximum Loss (PML). This model is currently used by the Ministry of Finance, in combination with actuarial analysis of historic loss data, to monitor the disaster risk exposure on FONDEN's portfolio and to design risk transfer strategies

Information provided by probabilistic risk models is increasingly used beyond the realm of finance and insurance. Probabilistic risk assessments are increasingly used to inform policy decisions in a variety of sectors. For example, probabilistic assessments of risk in urban areas are used to guide urban planning, ensuring that buildings, schools, hospitals and other assets are located in safe areas or meet building standards that ensure the safety of their occupants. More recently, probabilistic risk models and approaches have been coupled with climate change models to account for future changes in hazards, over the time horizons that are needed for decision-making in non-financial sectors such as urban planning (e.g., Ranger et al. 2011).

See also chapter

"Disaster Risk Modeling Techniques: A Common Methodology for Countries to Apply"

Innovations in mapping risk and visualization of hazard and damage scenarios helps policy makers and individuals better understand and internalize the risks they face. The outputs of probabilistic risk assessments have many policy applications (Box 3):

- Territorial planning to identify, for example, flood plains or geographic damage scenarios from earthquakes or tsunamis;
- Infrastructure risk assessment for an assessment of expected damage from specific hazard scenarios;
- Cost benefit analysis for mitigation measures;
- Preparedness measures for support of emergency and contingency planning for different crisis scenarios;
- Insurance premium calculations for provision of accurate information about annual expected loss and probable maximum loss for a specific area.

See also chapter

"Landslide Risk Reduction Measures by the Rio de Janeiro City Government"

Box 3 CAPRA: Probabilistic Risk Assessment Initiative

A free, modular, open-source, and multi-hazard tool for risk assessment, CAPRA provides a risk calculation platform integrating exposure databases, physical vulnerability functions and hazard assessments in a probabilistic methodology. CAPRA evaluates risk in terms of physical damage and direct economic and human losses in standard risk metrics (AAL, PML) to visualize hazards and risk on geographical information system (GIS).

Building on—and strengthening—existing initiatives, CAPRA was developed by Latin American experts with the support of the Central American Coordination Centre for Disaster Prevention (CEPREDENAC), the World Bank, the Inter-American Development Bank (IDB) and the International Strategy of United Nations for Disaster Reduction (UN-ISDR), in partnership with Central American governments

Risk assessment and visualization tools such as CAPRA can enable many applications

Deep uncertainty on future hazard characteristics is an important aspect of climate change adaptation and long-term risk management. While insurance contracts have a time horizon that does not extend beyond a few years, other risk management actions can have time horizons beyond a century. Over such timescales, climate change and socio-economic trends reduce confidence in hazard characteristics and in population and asset exposure and vulnerability, making it desirable to mobilize specific decision-making approaches that focus on the robustness of decisions.

Robust decision-making is based on an iterative approach, which aims to reduce vulnerability through the continued revision of strategies based on new lessons learned and on new scientific knowledge and new data.[4] It requires the building of long-term scenarios for the future of hazards and exposure that are relevant for the considered project and policy (Groves and Lempert 2007), and it favors solutions that are efficient in a broad range of possible futures, or that are flexible and can be revised over time at low costs (Hallegatte 2009). These new approaches have been applied in several instances, for example for water management in California (Groves et al. 2008), and are currently applied in a pilot study on flood risks in Ho Chi Minh City.

It is important to learn from the experience of other countries and institutions such as the G20, the World Bank, and the Organisation for Economic Co-operation and Development (OECD) which play a crucial role in facilitating knowledge exchange and transfer. Countries cannot afford to wait to learn from their own experience; their mistakes may only manifest themselves when it is too late.

Data is all around us, but countries need to collect and process that data effectively to harvest the full power of better decisions to unlock growth, promote economic development, and avert preventable human suffering.

Measures to Improve the Quality and Use of Risk Assessments

Small investments in the collection, management, and dissemination of hazard, asset, and vulnerability data would greatly help in better understanding and managing disaster risk. Accurate and reliable data is the fundamental requirement to assess, model, and understand the characteristics and potential impacts of natural disasters. Natural hazards are very complex phenomena, and understanding their characteristics and assessing the potential impacts of these hazards on exposed assets require extensive amounts of scientific and engineering effort, building on years of research and development.

See also chapter

"China's Natural Disaster Risk Management"

Recording and analysis of damage and loss data from previous disasters provide valuable insight to understanding physical, social, and economic vulnerability. Collecting accurate information in the aftermath of disasters can help build damage scenarios to inform planning processes, assess the physical and financial impact of events, and develop preparedness measures. DesInventar (Sistema de Inventario de Desastres, Disaster Inventory System) is one such initiative that aims to facilitate the systematic recording of low- and medium-impact disasters from a local scale to facilitate dialogue for risk management among private agents, institutions, sectors, and provincial and national governments.[5]

See also chapter

"Japan: Lessons Learned: Hazard Information and Damage Scenarios to Inform Effective Countermeasures to Extreme Events"

Improving national and regional monitoring systems (for example, seismic, weather, and meteorological systems) is important for generating accurate hazard data. These systems deliver outlooks, forecasts, and warnings for weather hazards and their impacts that serve as triggers or entry points in early warning systems. Major advances in observation, analysis, and prediction of high-impact weather and climate events have been achieved by some countries and are available to all. Seismic monitoring systems are a key tool for building historical information to improve hazard models and create better design and construction codes.

See also chapter

"Assessment of Disaster Risk Management Strategies in Argentina"

Collecting exposure data for risk assessments will help improve the accuracy of risk models. Databases covering infrastructure, buildings, and other assets exposed to hazards are fundamental requirements for risk assessments. Improving the quality of the input data and sharing these data along with detailed information describing the scales, resolution, and the way it was collected (metadata) directly decreases the uncertainty in the risk assessment. This approach also forms the basis for building and characterizing asset inventories (exposure and vulnerability databases) to integrate disaster risk information into development planning and include the contingent liability from disasters in fiscal risk management of a country.

See also chapter

"Policy Options for Disaster Risk Financing and Transfer and for Quantification of Disaster Losses and Exposures: An OECD Perspective"

Inter-institutional programs are needed to overcome significant constraints in building comprehensive asset inventories. Data are often fragmented across different government agencies and are not easily accessible to many actors. For instance, ministries of education and health often have very good building-by-building databases with information such as geo-coded location, construction material, occupancy, number of stories, and year of construction. It is also common that financial departments have cadastral databases of the city, which include much of the necessary information. The challenge is establishing commitments to share these data among ministries and with the public to ensure such data can be used effectively to assess risk and build resilience.

Working toward common standards for data and analysis will eventually help reduce costs and improve interoperability between modeling platforms. Difficulties comparing risk information from various models sometimes complicates interaction between actors working from different models. For example, in transactions between governments and private risk carriers, models are used by the

See also chapter

"The Republic of Korea: Strengthening Disaster Risk Assessments to Build Resilience to Natural Disasters"

insurance and reinsurance industry to design, structure, and place financial instruments in the capital and reinsurance market. Yet currently, few national governments have their own models to support the development of disaster risk financing and insurance strategies. To promote and expand the use of models to new areas, an effort should be made to define standards for data and to build open and public hazard, exposure, and vulnerability databases to allow the development and agreement on risk metrics that support comparability and interoperability of the models and their outputs. One such initiative toward developing a standardized model is the Global Earthquake Model.[6]

Common definitions are needed to allow for more coherent comparisons through time and across regions. No standard definitions exist to measure economic or human impacts. For example, measures of total economic cost of a disaster may include immediate expenses for emergency relief efforts and expenditures to rebuild public, private, industrial, and commercial property and infrastructure, but sometimes also crop and environmental damages are included. The definition could also extend to include indirect impacts such as reduced economic growth or decreased public revenues. Similarly, there is no standardized way to measure the human impacts, which could include mortalities and the injured, displaced and homeless, relocated, or otherwise affected population.

Empowering Institutions and Individuals through Data

See also chapter

"Building Resilience: Risk Models and Urban Planning: The Case of Chilean Coastal Cities' Reconstruction after the Earthquake and Tsunami of February 27, 2010"

Sharing data and creating open systems promote transparency and accountability and can ensure a wide range of actors are able to participate in the challenge of building resilience through better-informed decisions. Accurate and accessible risk information allows for better-informed citizens. It permits local governments to develop informed contingency planning. The data required for risk assessments reduce the impact of disasters by empowering decision makers with better information and the tools to support their decisions (box 4).

Box 4 Open Data Initiatives

Open data initiatives combined with bottom-up approaches such as citizen mapping initiatives can be an effective way to build large-exposure databases.

The Community Mapping for Resilience program in Indonesia is an example of a large-scale exposure data collection system. The program began in 2011 through a partnership led by the Australia-Indonesia Facility for Disaster Reduction (AIFDR), Indonesia's National Disaster Management Agency (Badan Nasional Penanggulangan Bencana, BNPB), and the Humanitarian OpenStreetMap Team (HOT), with support from the Global Facility for Disaster Reduction and Recovery and the World Bank.

The main goal is to use OpenStreetMap to collect building-level exposure data for risk assessment applications. OpenStreetMap offers several important features: open source tools for online or offline mapping, a platform for uploading and hosting data with free and open access, and an active global community of users.

In a little over a year, more than 160,000 individual buildings have been mapped and new partners, including five of Indonesia's largest universities, local government agencies, international development partners such Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), and civil society organizations, have been trained and are using the platform.

Disaster Risk Financing and Insurance Strategies

Financial protection strategies aim at improving the capacity of governments to respond in case of disasters while protecting their fiscal balance. A country's financial resilience to natural disasters relies on its ability to manage internal and external resources to finance post-disaster needs. That is, the government needs the ability to manage the internal (disaster reserve funds, budget reallocation, and internal credit) and external (external assistance, credit, and insurance or reinsurance payments) funds necessary to finance response, recovery, and reconstruction needs while protecting its fiscal balance and preventing harm caused by reallocations from other priorities.

See also chapter

"Building Disaster Risk Management: Improving the Understanding and Financing of Risk"

Disaster risk financing and insurance solutions can help improve financial resilience. Sovereign disaster risk strategies help countries manage the budget volatility associated with disasters. Three steps should guide a comprehensive approach to disaster risk financing: (a) assessing the contingent liabilities associated with disasters; (b) improving the post-disaster budget response capacity of the state; and (c) reducing long-term financial exposure of the state, including by setting up mechanisms to control the expansion of implicit liabilities and incentives to encourage proactive risk management. The development and regulation of insurance markets can play an important role in governments' effort to increase the resilience of private actors to reduce implicit liabilities.

Estimating and understanding a country's disaster risks are prerequisites for governments to adopt a proactive approach to disaster risk financing.

Assessing the Contingent Liabilities Associated with Disasters

Natural disasters are increasingly considered as a contingent liability. Governments are not only expected to fund recovery and reconstruction expenses for public assets in the aftermath of a disaster but are also held accountable by the public for post-disaster order, rescue, relief, and recovery of the most vulnerable groups. Governments are also regularly called upon to finance private losses, which can represent significant explicit and implicit liabilities, impose a significant fiscal burden, and, in some cases, complicate long-term growth and economic development objectives (box 5).

Box 5 Government Contingent Liability and Fiscal Instability

In accounting terms, a government's financial exposure to disasters can be considered a contingent liability—essentially, obligations that can be triggered by an uncertain event. Relative to government policies, the probability of occurrence of a contingency and the magnitude of the required public outlay are exogenous (such as a disaster) or endogenous (such as implications of market institutions and government programs for moral hazards in markets).

Explicit liabilities are specific government obligations defined by law or contract. The government is legally mandated to settle such obligations when they come due. Implicit liabilities represent a moral obligation or expected burden for the government not in the legal sense, but based on public expectations and political pressure (Polackova 1998).

Disasters can create major explicit or implicit liabilities for the government budget. Implicit contingent liabilities often pose the greatest fiscal risk to governments. The event triggering the liability is uncertain, the value at risk is difficult to evaluate, and the extent of the government involvement is difficult to predict.

Source: Cummins and Mahul 2008.

See also chapter

"Contingent Liability Management in Colombia and the Financial Strategy Associated with Natural Disasters"

Only a handful of countries today measure their contingent liabilities to natural disasters. Many advanced economies and emerging markets have developed significant experience in the identification of sovereign fiscal risks and the corresponding risk management measures to safeguard public expenditure programs. However, the integration of risks from natural disasters in fiscal planning processes is still limited. Assessment of potential financial losses associated with disasters from natural events is not a common practice in the majority of countries (see box 6).

Box 6 Assessing the Contingent liability of Disasters Using Catastrophe Risk Models in Colombia

In 2010, the government of Colombia conducted for the first time a comprehensive review of its contingent liabilities. Disaster risks have been identified as a potential source of contingent liabilities. State-of-the-art catastrophe risk modeling techniques have been used to develop an earthquake catastrophe risk model for Colombia, allowing decision makers to assess the cost of reconstruction of public assets and private assets (including low-income housing).

In response to this review, the National Development Plan and Strategic Plan of the Ministry of Finance and Public Credit (Ministerio de Hacienda y Crédito Público) has outlined a strategy to reduce these impacts. This plan sets out the development of a financial strategy to mitigate fiscal volatility, managing risks arising from natural hazards as implicit contingent liabilities, to address the fiscal impact generated by catastrophic events in Colombia.

Source: Ministry of Finance and Public Credit, Colombia 2011.

Systematic analysis of contingent liabilities resulting from adverse natural events would help governments better manage their fiscal exposure to these events. Better integrating contingent liabilities in countries' fiscal risk management frameworks and establishing an efficient budget planning and execution system can help improve the fiscal resilience of countries. A broad set of constraints limits greater integration of disaster risk into fiscal risk assessments, including (a) the necessary legal and institutional frameworks to include risk management in general are lacking, (b) governments may not have funds available to invest in risk management, (c) decisions to invest in hedging are vulnerable to ex post criticism and associated political risks, and (d) technical capacity is often not sufficient.

Improving the Post-disaster Budget Response Capacity of the State

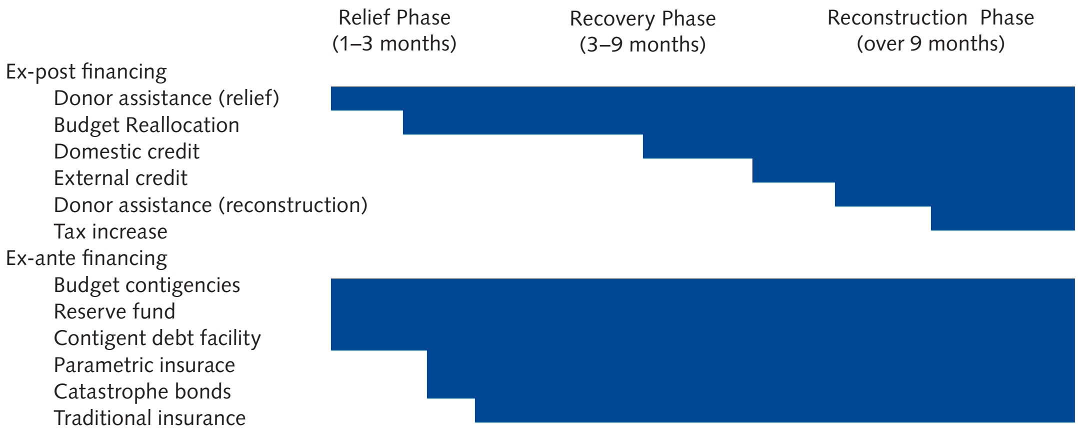
See also chapter

"Australia's Recent Experience with Natural Disaster Risk Management"

Effective financial protection strategies generally require a combination of multiple risk-financing instruments. Governments have access to various sources of financing following a disaster (see figure 5). These sources can be categorized as ex post and ex ante financing instruments. The speed at which resources can be mobilized and the cost of funds vary greatly from one source to another.

Ex post funding sources are used as a result of a disaster without previous financial arrangements or explicit allocation of resources. These funding sources include budget reallocation, domestic and external credit, tax increases, and donor assistance. Though some of these financial instruments can be relatively inexpensive, a major disadvantage is that these instruments can take a long time to negotiate (for example, emergency loans), can be highly variable and unpredictable (for example, donor's

Figure 5 Sources of Post-disaster Financing



Source: Ghesquiere and Mahul 2010.

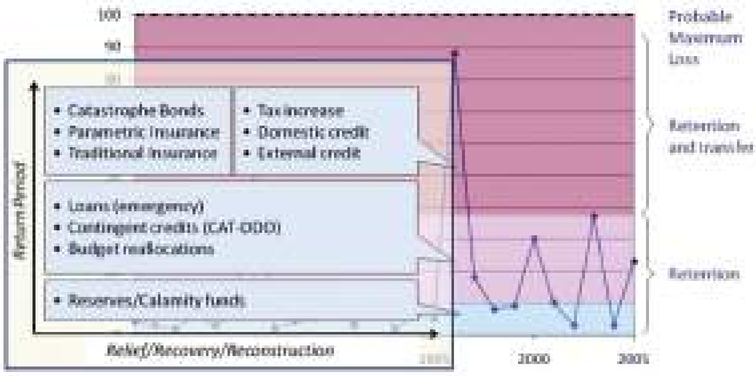
assistance), and can potentially endanger development programs that often take many years of preparation (for example, budget reallocation). The transactions, coordination, and compliance costs of donor facilities can become quite large and burdensome. Experience demonstrates that relying solely on post-disaster financing to manage sovereign disaster risks entails fiscal uncertainty. This is especially relevant for small economies with limited capacity for risk diversification and emergency borrowing, as well as for economies that are experiencing fiscal crises.

Ex ante risk financing instruments generally build upon understanding of a country's exposure to adverse natural events and signal a more pro-active stance toward potential crises. These instruments include reserves or calamity funds; budget contingencies; contingent debt facilities; and risk transfer mechanisms, such as traditional insurance and reinsurance, parametric insurance, catastrophe (CAT) bonds, and weather derivatives.

Effective financial protection strategies must consider the timing as well as the cost of the resources to be mobilized in case of a disaster. A government facing a disaster will not require funding for its entire recovery and reconstruction program immediately following the disaster. Although immediate resources will be needed to support relief operations, the bulk of the needed funds will be required only several months after a disaster when the actual reconstruction programs starts.

Governments use risk transfer instruments to manage budget volatility by ceding risks to international financial markets. A major advantage of risk transfer is that it allows for quick mobilization of resources without post-disaster impact on budget balances. At the same time, these instruments can be relatively costly. As a result, the optimal use of risk transfer instruments must consider the timing of needs after a disaster as well as the implicit trade-off between readily accessible resources after a disaster and the up-front costs to be paid to a third party willing to take on the risk. In many cases, governments have used risk transfer instruments to address expected liquidity shortage after a disaster, giving them enough breathing space to access other sources of funding that cannot be mobilized as quickly.

Figure 6 A Layered Approach to Financial Strategy against Disasters



Source: Ghesquiere, and Mahul 2010.
Note: CAT-DDO = Catastrophe Deferred Drawdown Option.

Developing Sovereign Disaster Risk Financing Strategies

Governments have successfully implemented sovereign disaster risk financing strategies based on a combination of ex ante and ex post financial instruments. The layered, bottom-up approach proposed by the World Bank uses a combination of retention instruments such as reserves and contingency budgets to finance lower layers consisting of recurrent losses; budget reallocation and contingent credit for the intermediate layers; and a combination of retention and risk transfer mechanisms to cede higher layers to reinsurance and capital markets (figure 6).

The majority of risk, including lower layers, is best financed through risk retention instruments such as reserves and annual budget allocations. Small recurrent losses from high-frequency, low-impact disasters such as localized floods, storms, or landslides are often best retained by the government. As the base layer of a bottom-up strategy, risk retention instruments should be put in place first to enable effective response to high-probability events. Budget allocations have relatively low upfront costs and can be disbursed rapidly following a disaster. For example, Mexico retains up to the first US$1 billion of losses through an annual budget allocation of US$800 million to its National Fund for Natural Disasters (Fondo Nacional de Desastres Naturales, FONDEN), and if required a US$200 million exceptional federal budget allocation.

The intermediate layers of risk can be addressed through lines of contingent credit or budget reallocation. Contingent credit lines provide governments with immediate access to funds in the aftermath of natural disasters to enable a more rapid and more efficient response (see IMF and World Bank 2011). Multiple countries, such as Colombia, Costa Rica, and the Philippines, have benefited from World Bank Development Policy Loans (DPL) with a Catastrophe Deferred Drawdown Option (Cat-DDO). The DPL with Cat-DDO is a line of credit designed to enhance the capacity of governments to manage the impacts of natural disasters. Many countries, however, have limited access to contingent credit arrangements due to income-level and/or borrowing constraints.

Box 7 The Caribbean Catastrophe Risk Insurance Facility

The experience of Caribbean countries illustrates the importance of better risk information systems to facilitate access to market-based risk transfer instruments.

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) makes innovative use of parametric instruments through a joint reserve facility that offers liquidity coverage to 16 Caribbean countries exposed to earthquakes and hurricanes. The estimated impact of insured events is derived from a probabilistic catastrophe model, which was specifically developed for the facility. CCRIF's transparent pricing formula and risk assessment model allowed it to efficiently transfer specific layers of risk from small island states to the international financial markets.

To reduce basis risks for its clients and to better negotiate reinsurance premiums, CCRIF is permanently improving its own risk model. This includes improving the hazard and model estimation framework by using exposure data. Over the past two years, CCRIF has also moved from a purely parametric index-based insurance approach to a modeled losses approach.[7]

Risk transfer mechanisms can be used to cede part of the higher risk layers to capital and insurance markets. To date, instruments for transferring sovereign disaster risk to international insurance markets are rare, and they are used in specialized circumstances only. In Mexico, a US$400 million risk layer in excess of the US$1 billion retained in the budget is covered through an indemnity-based reinsurance policy. Through the World Bank–sponsored MultiCat program, FONDEN also has a multiperil, multiyear catastrophe bond (MultiCat Mexico) in place to provide immediate liquidity should a major earthquake or hurricane occur in predefined areas of the country.

See also chapter

"Mexico: Experience in Disaster Risk Management"

Box 8 Parametric Risk Transfer Solutions

Parametric risk transfer solutions can be effective ex ante risk financing tools. Unlike traditional insurance that requires the assessment of individual losses on the ground, parametric insurance contracts are index based and make payouts based on the location and intensity of an adverse natural event (for example, wind speed, rainfall levels, and ground acceleration). Use of a particular index can be tailored to the availability of data (for example, using a parametric index when only hazard data are available, but using a modeled loss index when exposure data are available). The use of parametric coverage demands improved accuracy of hazard risk data collection systems because of their heavy reliance on objective measurement of weather and hazard parameters.

Although parametric insurance offers several advantages in relation to traditional insurance, such as lower administrative costs and reduced moral hazard and adverse selection, "basis risk" poses a major challenge. Basis risk, implicit in index insurance, is the risk that the index measurement will not match individual losses (that is, the possibility that an individual insured unit experiences losses that are not captured by the parametric trigger, or a payout is triggered without any losses incurred). Improved accuracy of hazard data collection systems, increased openness and centralization of historical data, and resulting quality-enhanced risk assessments would reduce basis risks and thereby grant a more efficient and effective use of parametric insurance.

Reducing Financial Exposure of the State

See also chapter

"The French Experience on Disaster Management"

In the medium to long term, governments should aim to reduce their risk exposure through mitigation measures. Improved territorial planning, applications of adequate building standards, retrofitting of infrastructure, and preparedness measures can promote sustainable risk reduction to help mitigate the financial and fiscal impacts of natural disasters.

The implementation of a clear framework clarifying the responsibility of the state and society at large can play an important role in reducing the government's contingent liability. By defining how far it is willing to go to support its constituents in case of disaster, a government can provide clear signals on the part of the risk that will not be covered, encouraging those bearing that risk to take precautionary measures. A clear policy framework will also limit compensation inflation, which can be observed from one disaster to another, in which the level of compensation in one disaster becomes the minimum expected by the affected population when the next disaster occurs.

Promoting the use of insurance in both the public and the private sectors can help reduce the contingent liability of governments and help increase the resilience of society as a whole. Insuring public assets such as schools, hospitals, and bridges can be an effective way to reduce explicit contingent liabilities of the government. It would also reduce moral hazard issues by introducing a financial stake of the insurer to undertake diligence in reducing exposure and vulnerability of the public assets covered by insurance. By encouraging competitive property insurance markets, governments can help shift the burden of post-disaster recovery to insurance companies and contribute to increasing the resilience of their economy, thereby reducing both explicit and implicit contingent liabilities. By increasing access to insurance for the middle class through the development of sound catastrophe risk insurance markets, governments can reduce implicit liabilities to focus post-disaster spending on the most vulnerable segments of society (box 9).

Box 9 Promotion of Basic Infrastructure for Catastrophe Risk Insurance Markets

Basic risk market infrastructure should be in place to support the development of catastrophe risk insurance. This includes product development, risk assessment and pricing methodologies, underwriting and loss adjustment procedures, and distribution channels.

The World Bank works with low- and middle-income countries to develop property catastrophe insurance programs, usually relying on public-private partnerships to assist countries with the development of their catastrophe risk insurance markets.

For example, the Southeast Europe and Caucasus Catastrophe Risk Insurance Facility (SEEC CRIF) developed a new platform to provide low-cost insurance service infrastructure, including access to web-based insurance production and claims settlement technologies that support sales of complex catastrophe and weather risk insurance products. The facility will develop new, standardized weather risk insurance and reinsurance products; automate insurance underwriting, pricing, and claims settlement processes for such products; and increase public awareness of weather risk in participating countries.

Making risk information available and easier to understand for private agents can help stimulate the demand side of private catastrophe insurance markets. Creating incentive for individuals and businesses to buy insurance is important to stimulate the demand for and use of insurance products by individuals and the private sector. Visualizing and communicating hazards is an important step toward internalizing risk and promoting risk mitigation measures to reduce both explicit and implicit liabilities by the state.

Increasing transparency and promoting more accurate risk information are important for the development of insurance markets. The promotion of best practices for developing disaster risk data collection systems and harmonized risk assessment methodologies will increase transparency in insurance markets and foster the development of sustainable private catastrophe risk insurance programs. Reliable and transparent information, such as annual expected losses or maximum probable losses, is indispensable for the functioning of insurance markets by enabling, for example, sound pricing and control of adverse selection.

Box 10 Risk Modeling in the Insurance Industry

The use of risk modeling techniques has helped significantly increase the resilience of the insurance industry.

The insurance industry was among the first to use catastrophic models to build financial resilience to adverse natural events. The emerging convention that insurers should be able to tolerate a 1-in-200 year probable maximum loss has inspired the use of modeling within the insurance industry. As a result, the insurance market was able to endure 2011, the worst year on record for catastrophes, relatively unaffected. This was further reinforced by regulators and credit rating agencies grading the financial strength of insurers for investors and policy holders.

Risk information and risk models are also used to support regulatory frameworks to supervise catastrophe risk insurance markets. In most countries, insurance regulators establish minimum technical reserves and equity capital requirements to guarantee solvency of insurance companies and safeguard the interests of insured individuals and businesses. In establishing mandatory requirements, regulators need to have a clear understanding of the underwriting risks that insurance companies take on their portfolios. More and more, risk models are used to establish minimum technical reserves and monitor the solvency of insurance companies.

Public-private partnerships can help tackle information problems hampering the development of catastrophe risk insurance markets. Government intervention is often required to foster the creation of public goods required for the emergence of efficiently run private catastrophe insurance markets. The French Natural Disaster Compensation scheme and, more recently, the Turkish Catastrophe Insurance Pool are pertinent examples.

See also chapter

"Disaster Risk Management in Turkey"

The Way Forward

The rising frequency and costs caused by natural hazards call for more action to reduce disaster risk. The inexorable increase in disaster loss over the past 50 years underscores the fact that ad hoc action may no longer be adequate. A more proactive approach is urgent, starting with a better understanding of the sources of risk, the systematic consideration of risks in development planning, and the development of financial protection mechanisms.

Disasters are the result of the interaction between hazards, assets, and vulnerability. Adverse natural events affect population and infrastructure that are vulnerable to these hazards. Analyses show that the increasing population living in hazard prone areas combined with substandard building construction is the main factors behind the growing impact of disasters around the world. In turn, if not addressed, growing population, economic expansion, and urbanization will lead to environmental degradation that results in increased hazards and vulnerability.

Changes in climate patterns will exacerbate these trends. According to the IPCC (2012) report, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, changes in the intensity and frequency of some extreme weather events are already taking place and will accelerate in the future. Increases in global mean temperature and the frequency of heat waves and heavy precipitation are expected in many areas of the world. Flash flooding and storm surges are likely to become more common. By contributing to an increase in the frequency of extreme events, climate change could turn what are exceptional disasters today into regular occurrences in the future.

The growing impact of disasters is an increasing fiscal burden for governments. This is a trend that will rapidly become unsustainable for many countries. Given the path dependency of many development strategies, action is needed now to limit growing financial exposure. To do so, experience shows that disaster risk analysis must be integrated into development planning. In the longer term, effort is also needed to increase accountability and clarify responsibilities of the state in order to incentivize risk mitigation and, to the extent possible, to shift private risk away from the public purse. Governments can also increase their financial resilience by adopting financial strategies to improve their response capacity while protecting their fiscal balance. Finally, they can increase the resilience of their economies by encouraging the development of private insurance markets.

In an increasingly interconnected world, disasters can have far-reaching impacts. The concentration of people and assets in cities increases the risk that a single event can have an exaggerated impact. The negative effects of disasters can rapidly cascade through increasingly interconnected and tightly coupled systems. For example, a disaster in one location can disrupt global supply chains and quickly transmit an impact on business and commerce around the globe.

There is an urgent need to act. Drawing from the experiences of Mexico, G20 and other countries, this publication shows that better risk management is possible. It argues that many immediate actions are available to reduce disaster risks, based on current knowledge and technologies. Moreover, recent advances in risk assessments provide governments increasingly efficient tools to assess sources of risk, support the design of more resilient development processes, and prepare for the inevitable. Some of the main lessons drawn from countries' contributions on how risk information can improve risk management are summarized below.

Countries can identify and assess risks

A number of risk assessment methods are rapidly emerging that allow governments to better understand the risks resulting from adverse natural events. Probabilistic risk modeling in particular is rapidly emerging as a useful technique for providing decision makers with coherent and robust measures of risks. Initially developed by the insurance industry, probabilistic risk models are increasingly used beyond the realm of finance and insurance to inform public policy in general, including territorial planning, cost-benefit analysis of risk reduction programs, scenario analysis and contingency planning, and financial protection. Risk assessments, and probabilistic risk models in particular, build on historical as well as prospective information. The recovery of historical data, analysis of events, strengthening of monitoring systems and development of geospatial databases all support the development of better risk models. Experience shows that even small investments in the development and dissemination of national databases on hazards, assets, and vulnerability can yield significant results in improved understanding of risks.

Better risk information can help countries reduce risks

Risk reduction calls for comprehensive programs encompassing all sectors. Governments can significantly reduce disaster loss over time by (a) acting to stem the ever-increasing process of risk creation resulting from uncontrolled development processes and (b) investing in risk reduction to address existing risks. Risk analysis and the integration of risk information in land use and territorial development, urban planning, and design of public infrastructure, as well as the adoption and monitoring of better building standards, are effective ways to reduce risk over time, especially if combined with appropriate decision-making approaches that account for deep uncertainty in future hazard characteristics and future population and asset exposure and vulnerability. Risk analysis can also be used to identify existing sources of risks and to prioritize and design interventions to address these risks.

Better risk information can help countries be better prepared

Preparing for disaster response is central to any comprehensive risk management strategy. A better understanding of the potential impact of natural hazards can be used in contingency planning. Prepositioning of emergency assets, identification and training of first responders, and development of response and evacuation procedures are just some of the responsibilities of national and local authorities that benefit from improved risk assessment. Early warning has proven to be one of the most effective ways to save lives. Risk models are increasingly being used to move beyond warnings based on hazards to warnings based on analysis of the potential impact.

Risk information can help countries increase their financial resilience

Integration of disaster risk information in national fiscal risk management frameworks can help improve the fiscal resilience of countries. The systematic analysis of contingent liabilities resulting from adverse natural events can help governments better understand their fiscal exposure to these events. The development of financial exposure profiles can be used to support the design of financial protection strategies by allowing for rational layering of risks to be covered by specific financial instruments from reserve funds to contingent lines of credit, insurance, and other alternate risk transfer instruments. Detailed risk information is also needed to support the placement of insurance or other risk transfer instruments. The provision of risk information can also help support the implementation of a policy framework clarifying the responsibility of the state and society at large, hence aligning incentives and reducing moral hazards.

Finally, governments can encourage the development of competitive property insurance markets by increasing access to information about hazards, assets, and vulnerability.

Next Steps for the International Community

Document international experience; promote global exchange and knowledge transfer

No single country or institution has all the answers. Multilateral institutions such the World Bank, the OECD, and others play a crucial role in facilitating knowledge exchange and transfer. The experience in assessing disaster risks among G20 countries is significant. In order to tap into this experience, international cooperation is important to increase the availability and quality of technical expertise and collaboration accessible to disaster prone countries. In particular, academic institutions and technical bodies possess important skills and research perspectives in how to best address disaster risk, and the G20 group has an opportunity to cultivate this knowledge exchange and transfer.

Promote global and regional efforts on risk assessment and risk financing

Cooperation among countries, institutions, and regions is important on many levels. Today, tools exist to better assess and quantify risks and support objective decision making for risk reduction. The international community must apply these tools to its own practice and cultivate their use in support offered to others. For this approach, it is important to streamline data for global modeling of risk and asset inventories. This cannot be the domain of any single organization. Data sets are rarely in standardized formats, creating significant challenges for data management and analysis. Drawing from experience, countries using common standards for data and analysis will reduce costs and improve interoperability between modeling platforms. In particular, the G20 countries can help contribute to the promotion of exchange of risk assessment data and methodologies between governments and commercial financial institutions. Furthermore, international scientific research collaboration must be strengthened, and the role of multilateral organizations in establishing platforms for sharing good practice and discussing lessons learned in risk modeling and risk assessment should grow.

Support initiatives to tackle the increase of disaster losses in developing countries

Developing countries are particularly exposed to disaster risk, as they experience the fastest demographic expansion, economic growth, and urbanization. Yet, with limited resources, they are the least able to address the problem. Demand for guidance to assist in the task of integrating risk information in macroeconomic and public investment planning across sectors is growing in emerging and advanced economies alike. The realization of the role of private insurance markets in national resilience is also accompanied by an upsurge in the demand for analytical and advisory services in this area.

G20 countries that provide humanitarian and development assistance to disaster-prone countries also have a responsibility to apply the principles of disaster risk management to aid. Too often, the default reaction for donors and at-risk countries alike is to wait for the disaster to strike before mobilizing financial and technical support. Targeted financial investment in risk modeling and assessment capacity, alongside risk sensitive policy making, should be a staple of development assistance to redress the balance between what is spent on mitigation versus what is spent on humanitarian relief. Mechanisms to deliver this financing must be strengthened and scaled up. Ultimately, demonstrating good practice in understanding risk in G20 countries, and investing in the financial protection of assets and public goods, must underpin any assistance offered.

Notes

1. All figures in this paragraph are drawn from Munich Re, NatCatSERVICE database, http://www.munichre.com/en/reinsurance/business/non-life/georisks/natcatservice/default.aspx.
2. See Munich Re, NatCatSERVICE database, http://www.munichre.com/en/reinsurance/business/non-life/georisks/natcatservice/default.aspx.
3. Response refers to the provision of emergency services and public assistance during or immediately after a disaster to save lives, reduce health impacts, ensure public safety, and meet the basic subsistence needs of the people affected. Recovery and reconstruction refer to the restoration, and improvement where appropriate, of facilities, livelihoods, and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors. For definitions, see United Nations International Strategy for Disaster Reduction, "Terminology," http://www.unisdr.org/we/inform/terminology.
4. For further information on sustainable development and robust decision making in an uncertain environment see also World Bank, 2012, Inclusive Green Growth: The Pathway to Sustainable Development.
5. See DesInventar, http://www.desinventar.org/.
6. See GEM Foundation, Global Earthquake Model, http://www.globalquakemodel.org/.
7. Insurance instruments with a "modeled loss" trigger involve the construction of an exposure portfolio and a probabilistic catastrophe model to estimate losses when a large catastrophic event occurs. The event's parameters are run against the exposure database in the Cat model, and the resulting modeled losses are compared with the trigger loss. If the modeled loss exceeds the trigger, an indemnity is paid out.

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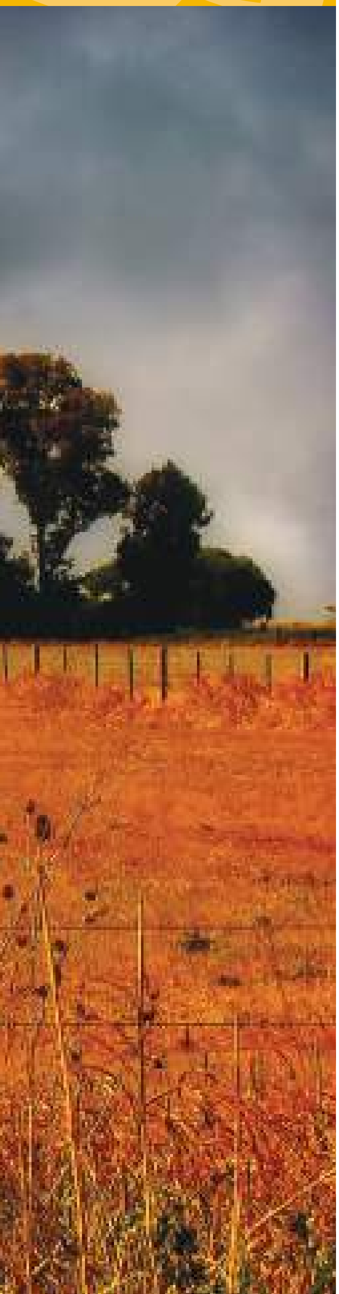
Argentina is a country exposed to many natural disasters such as earthquakes, severe storms, volcanic eruptions, and it is vulnerable to climatic changes.

This chapter outlines the most common risks in Argentina and the way they are being managed. In particular the chapter discusses how the national strategy for risk management operates; what outcomes are expected in the near term; agricultural risk management; government interventions in this area, and agricultural insurance. A new program to foster agricultural insurance in Argentina, being prepared by several national ministries and the World Bank, is also outlined. The chapter concludes by describing the difficulties still encountered and what reinforcement is required.



CHAPTER 2: Assessment of Disaster Risk Management Strategies in Argentina

This chapter is a submission of the Government of Argentina

Introduction

Disasters not only affect lives, but also produce negative effects on the environment, economic infrastructure, and essential services. These negative effects directly impact economic development, and their magnitudes are amplified when economic processes are affected.

Disasters have a much more disruptive impact on the economies of developing countries. These countries are particularly vulnerable to adverse natural events in their territories. However, in absolute terms, the costliest disasters mainly occur in developed countries where the concentration of assets, and thus potential losses, is the highest. Nevertheless, in such economies, the damage as a proportion of gross domestic product (GDP) is limited to a few percentage points. In contrast, disasters have a particularly disruptive effect on the fiscal balances of developing countries because their governments often lack the appropriate mechanisms to effectively mobilize resources in response to an emergency (Ghesquiere and Mahul 2010).

Argentina is a federal republic occupying a territory of 2,780,400 square kilometers, with large prairies and fluvial systems in the east and a mountainous relief that begins in the center of the country, reaching its summit in the Cordillera de los Andes.

In recent years, extreme climatic and ecosystemic events have been observed more frequently and intensely in Argentina. Among other events, one finds droughts, frosts, floods, severe storms, hailstorms, and volcanic ash falls. Not only do adverse climatic events have a significant impact on different sectors of the economy and erode natural capital with long-term effects, but they also produce tax revenue losses and require public spending increases to address the emergency. This fiscal and social exposure to catastrophic climatic risks is what drives Argentina´s interest in the use of financial instruments for risk sharing.

The Argentine risk management system is organized in three distinct levels, each one with a greater degree of responsibility: local, provincial (states), and national. Because of Argentina's political organization, the degree of development of the risk management system varies from one place to another in the country. Therefore, disparity in the quality of the risk management system exposes society to heavy direct and indirect economic losses.

This chapter outlines in the first section the most common risks in Argentina and the way they are being managed. The second section outlines how the national strategy for risk management is operating and what outcomes are expected in the near term. The third section focuses on agricultural risk management, government interventions in this area, and agricultural insurance. In the fourth section, a new program to foster agricultural insurance in Argentina, being prepared by several national ministries and the World Bank, is outlined. The final section recalls the difficulties still encountered and what outlines the required reinforcements.

Most Common Natural Risks in Argentina

Because of its geographical characteristics, the country is exposed to natural disasters such as earthquakes, severe storms, volcanic eruptions, and climatic changes.

Earthquakes have affected Argentina several times. In the past 150 years, three big quakes and several minor ones have produced casualties and material losses. The first struck in March 1861 in Mendoza city (capital of the province of Mendoza), the most important city in the west of the country, 1,100 kilometers west of Buenos Aires. This quake destroyed the city completely, killing more than 10,000 of 16,000 inhabitants. The losses were aggravated by the long time that elapsed between the event and the arrival of relief. The city was rebuilt in a new location, near the original city. The new design improved the city's capacity to endure new earthquakes. However, the city grew much larger than it was in 19th century, now occupying the site of the destroyed city.

The second great quake was in January 1944, affecting San Juan, provincial capital of San Juan province, 1,200 kilometers west of Buenos Aires, the second most important city in the west of the country. The quake completely destroyed the city and killed more than 10,000 people. It was rebuilt in the same place, using the most advanced seismic-resistant building techniques of the moment. Moreover, that event originated one of the most important nationwide organizations to study earthquakes, their genesis, and their consequences on buildings and infrastructure: the National Seismic Prevention Institute (Instituto Nacional de Prevención Símica, INPRES). The institute is responsible for enacting the National Seismic-Resistant Building Code (named INPRES CIRSOC [Centro de Investigación de los Reglamentos Nacionales de Seguridad para las Obras Civiles, or Research Center of National Regulations Security for Civil Works]) and overseeing its application on San Juan city, San Juan province, and national buildings. Years after the code was enacted, many provinces adopted it, adapted to their own needs.

The third earthquake was in Caucete, in San Juan province, in November 1977, killing fewer than 100 people, but inflicting heavy material losses on productive facilities. None of these events limited its action to epicentral areas. Material damages were reported several kilometers away from epicenters in the aftermath of the 1861, 1944, and 1977 earthquakes. Many provinces delayed the adoption of the INPRES CIRSOC code until the 1980s. For that reason, thousands of houses built before the eighties are not seismic resistant at all and could be damaged because of nearby epicenters or because of elastic wave propagation originating in relatively distant epicenters.

The Plata Basin is the second-most important fluvial system in South America and one of the most important in the world. Its most important rivers are the Paraná, with a flow module of 16,000 cubic meters per second (m^3/s), and the Uruguay, with a flow module of 4,000 m^3/s. Paraná River is the fourth-longest river in the world.

More than 80 percent of the Argentine population lives along the Plata Basin, and most of the nation's GDP is produced in the so-called riverfront, a strip 400 kilometers long between Rosario City (on the Paraná River in the north) and La Plata (on the Río de la Plata in the south), where the most important industries are established.

The most fertile agricultural lands and stockbreeding prairies are drained by the Plata Basin. A great part of Argentine prosperity relies on the climatic stability of the basin. However, the basin climate is strongly influenced by El Niño/Southern Oscillation (ENSO), with both El Niño and La Niña episodes. ENSO El Niño episodes produce higher rainfall along the basin, and with rain comes flooding. The greatest floods in the 20th century were in 1905, 1982/83, 1992, and 1997/98, affecting thousands of people who were evacuated to safer areas during several months and producing a very serious negative impact on regional and national economies. The main rivers involved were the Paraná, the Paraguay, and the Uruguay, so the most significant damages were located along their valleys. Roads and transport infrastructure were especially destroyed. In spite of the duration and size of the floods, very few casualties resulted from them.

In March and April 2003, severe storms struck the Northern Salado River Basin, north of Santa Fe province; in a single day, precipitation totaled more than 400 millimeters, the amount of rainfall the region usually registers in 6 months. In the last days of April and the beginning of May, the flood reached Santa Fe city, the provincial capital of Santa Fe. The southern and eastern limits of the city were protected by dams against overflows of the Paraná River; the northwest limits were unprotected. The Northern Salado River entered the city through the unprotected zone, flooding the city completely and killing more than 20 people. In the southeastern district of the city, the water, retained by dams, reached a level of 7 meters (21 feet). The return to normal took several months and cost many millions of dollars.

La Niña provoked drought in the basin during the last months of 2011, which affected the farming of soy and corn, producing a loss of US$2.5 billion.

Severe storms cause direct and indirect monetary losses as well. Heavy rain, hail, and strong winds impact on large cities more and more often. Specifically, Buenos Aires and its suburbs undergo severe storm impacts several times each year. Severe storms damage cars and houses; public services such as power, gas, and water; and public transport. Collection and disposal of urban solid waste is affected too. Climatic change aggravates the problem, making severe storms more frequent and more dangerous as well.

Another region that is potentially affected is the Cordillera de los Andes, which forms the boundary between Argentina and its western neighbor, Chile. In the Andes there are 117 active volcanoes, most of which are in Chilean territory. Although some volcanoes (the most active) are under surveillance, a large number are not. Many volcanic eruptions have occurred in the Andes, the most damaging on Argentine territory being the eruptions of Quizapu-Descabezado, 1932; Villarrica, 1988; Hudson, 1991; Laskar, 1993; Llaima, 2008; and Chaitén, 2008; as well as Puyehue-Cordón Caulle volcanic complex, which is ongoing. The bigger part of eruptive material is composed of tephra. Tephra, transported by west wind (west winds blow more than 300 days per year), easily reaches Argentine territory, where ash fall occurs. The region of the country most often affected by eruptions is Patagonia, where the environment is very fragile, and this fragility multiplies the negative effects of volcanic ash fall. The tourist industry, petroleum exploitation, and sheep farming are the most affected activities, suffering heavy economic losses.

An eruption of Puyehue-Cordón Caulle volcanic complex began in June 2011. This eruption is still ongoing. During the 2011 winter season, heavy ash fall blanketed Bariloche and Villa La Angostura, the most important winter sports and tourist centers in the country, located in the Cordilleran foothills in Río Negro and Neuquén provinces, respectively. Moreover, thick ash fall deposits affected several towns located in the so-called Southern Line in the plateau region of Río Negro province. These towns are especially affected because of mobilization of ash fall deposits by the strong winds of the Patagonian plateau. Mobilization has especially affected the town of Ingeniero Jacobacci, Río Negro province, a sheep farming and mining community.

To conclude, the Argentine territory is exposed to natural disasters of different origins. Strategies for disaster risk financing should be implemented to reduce the losses to the national economy.

National Risk Management Strategy

To improve national risk management, with the goal of reducing material losses and developing financial resilience, the Chief Cabinet of the Ministry of Internal Affairs of Argentina is running a number of initiatives aimed at creating and sustaining networks to identify, gather, generate, and exchange data, information, and knowledge of such a quality that can be used by different authorities to achieve the enunciated proposal.

This section describes the way that those activities are being developed, setting out their objectives and describing participant organizations, challenges found, and the way they were overcome.

The strategy will be applied to the following disasters:

- Volcanic risk
- Climatic change
- Earthquakes
- Severe weather

The development of risk transfer instruments suitable to the country's needs must be based on detailed knowledge. In addition, to reduce the cost of insurance and other financial instruments, government organizations have to establish modern disaster management procedures, including early warning networks, which should be easily available to decision makers and technical personnel.

Volcanic Risks

A network is under organization, involving the National Geologic Service (Servicio Geológico Nacional, SEGEMAR), the National Scientific and Technical Research Council (Consejo Nacional de Investigaciones Científicas y Técnicas, CONICET), the National Weather Service (Servicio Meteorológico Nacional, SMN), the Institute of Scientific and Technological Research for the Civil Defense (Instituto de Investigaciones para la Defensa, CITEDEF), and the National Parks Administration (Administración de Parques Nacionales, APN).

The goals of this network are to assess volcanic risk and develop skills to model ash cloud dispersion, ash removal from recent deposits, and lahar hazard. These goals will be complemented with a volcanic alert network covering the western part of Río Negro and Neuquén provinces. The network will develop volcanic monitoring, data collection, data interpretation, risk assessment and hazard identification, weather forecasting, and a seismic and volcanic early warning system. The federal government is responsible for coordination of these actions, having the authority to employ technical and scientific resources to obtain better results, working together with local and provincial governments.

Data will be gathered, processed, and analyzed to produce information that will be shared using an informatics platform available to all participants. SEGEMAR will prepare a geological risk chart for the region with the assistance of CONICET and volcanologists. This chart will focus on risks related to volcanic eruptions such as ash fall deposits and lahars. An early warning system will be developed too. An air monitoring system will be implemented to identify solid particles from volcanic eruptions, especially PM 2.5 (particles less than 2.5 micrometers in diameter) and PM 10 (particles less than 10 micrometers in diameter). A water-quality monitoring system will also be set in operation. These instruments are essential to assess volcanic-related health hazards. Numerical models will be used to forecast volcanic plume direction, ash fall zones, concentration at different heights, and thickness of ash fall deposits. Weather monitoring instruments will be set up to achieve these goals. Aerospace information will be used when necessary to detect, identify, chart, georeference, prepare, and produce information for risk management.

The information produced by the network will be used in volcanic risk assessment to finally prepare specific risk transfer instruments to cover all damage derived from volcanic eruptions, mainly ash falls and lahars. These systems should be operative by fall 2012.

Climate Change

Climatic change is a real concern for Argentina because of its economic dependence on farming. Since the beginning of the 20th century, natural events such as floods or droughts affecting farming triggered palliative measures involving tax reductions, low-interest-rate loans, and the like. Recently, in August 2009, the National Congress passed Act No. 26,509, creating the National System of Prevention and Mitigation of Farming Emergencies and Disasters (more detailed information on this act is provided in the next section of this chapter).

The act creates a National Committee on Farming Emergencies and Disasters. The committee's main mission is management of economic compensation to farmers affected by climate, weather, seismic, volcanic, or biological events. Besides farming emergencies, climatic change increases the likelihood of natural disasters.

To respond to and manage that incremental situation, the National Civil Protection Direction (Dirección Nacional de Protección Civil, DNPC), jointly with the National Climate Change Direction (Dirección Nacional de Cambio Climático) and the National Territory Planning Direction (Dirección Nacional de Ordenamiento Territorial), has written and published a handbook aimed at facilitating the job of local governments, risk management organizations, and land use regulation organizations. The handbook, *Vulnerability and Adaptation to Climatic Change for Local Management and Planning*, was published in 2011. Among other topics it discusses how to gather, organize, and interpret climatic and geographic data to improve resilience in facing new risks and challenges derived from climatic change. With sponsorship of the United Nations Development Programme (UNPD) a field test is being carried out, applying the handbook's recommendations to a town located on the Atlantic coast, to verify its usefulness.

The next step, in coordination with local governments, is to apply the handbook method in gathering and processing information as the basis for designing suitable risk transfer instruments to cover damages on properties caused by climatic change.

Earthquakes

Seismic risk is of special concern to Argentina. As previously mentioned, earthquakes have been commonplace in the country's history.

INPRES, located in San Juan city, provincial capital of San Juan province is, as already mentioned, an important government organization that studies earthquakes, their origins, and their effects on buildings and infrastructure. INPRES enacts the National Seismic Resistant Building Code (INPRES CIRSOC code) and oversees its application in San Juan city, San Juan province, and national buildings. Years after the code was enacted, many provinces adopted it, suiting it to their own needs.

Argentina has had 20 destructive earthquakes in the 19th and 20th centuries. Each one is known by the name of the location where the epicenter was located, or the nearest location to the epicenter. For each destructive earthquake, damages have been plotted, using the Modified Mercalli Intensity scale to determine strips with equal intensity throughout the country.

Intensity can be defined as a measure of damage produced during an earthquake. The project related to earthquakes involves the following steps:

- Using historical earthquake data published by INPRES (with the support of CERESIS [Centro Regional de Sismología para América del Sur], a South American–based network formed by the continent's Institutes of Seismic Research), strips of equal intensity for each historical earthquake will be determined;
- Strips of Intensity VI MM and higher are selected;
- Year of adoption of the INPRES CIRSOC code in each province will be determined;
- Dwellings built before those years will be considered non-seismic-resistant;
- Dwellings built after those years will be classified using the CALMAT classification (classifying buildings - or homes - by the quality and type of materials used for its construction). Dwellings included in CALMAT categories I and II will be considered unsafe and prone to suffer damages in a quake.

The project involves provincial and national government organizations, such as INPRES, the DNPC, the Dirección Nacional de Ordenamiento Territorial, and Provincial Directions of Civil Defense (Direcciones Provinciales de Defensa/Protección Civil), and so on.

The product to be obtained is the number of dwellings and other structures that will probably be damaged in a future earthquake, outside the most probable epicenter locations. This product will be used as a basis to design appropriate risk transfer instruments to cover damages on properties caused by earthquakes.

Severe Weather

The goal is to improve current warning and data collecting systems, including prediction models, by means of a network involving national organizations. The network, under design, involves coordinated efforts of the DNPC, the SMN, and the National Water Resources Institute (Instituto Nacional de Agua, INA). Other participants will be the Subsecretary of Water Resources, the Dam Safety Regulatory Organization (Organismo Regulador de Seguridad de Presas, ORSEP), and provincial and local governments.

The project, currently being designed, involves weather data systematization on informatics programs and severe weather modeling to determine actual exposure of dwellings and infrastructure to severe weather episodes and to develop an early warning system to increase protection of assets and people.

Agricultural Risk Management

As mentioned earlier, agricultural risk is the most common natural risk Argentina suffers, and a national strategy is needed to overcome or at least diminish its impact. This section of the chapter focuses mainly on agricultural risks generated by climate change.

Argentina is a country where the agricultural sector plays an important role in the economy, with part of the population working in this sector. For this reason, development of policies for managing climatic risk is especially significant. Working to encourage the development of financial instruments to mitigate and manage agricultural risks generated by climatic change and trying to minimize the economic impact principally on the small and medium producers is of vital importance. Argentina is seeking to incorporate risk management, through mitigation and adaptation measures, into the process of planning public policies.

Strengthening research and development of policies for the prevention of disaster risks and adaptation to climate change is therefore important. In Argentina, institutions such as the Agricultural Risk Bureau (Oficina de Riesgo Agropecuario, ORA) and the National Institute of Agricultural Technology (Instituto Nacional de Tecnología Agropecuaria, INTA), the SMN, and the INA coordinate and collect relevant information related to this sector.

Farming risk management strategies, risk mitigation, and risk transfer in this sector are outlined below.

Farming Risk Management Strategies

Farming production depends on the precautions taken considering "normal" behavior of climate variables that are not controlled by the producer. Without adequate coverage, those risks may produce damages that could impact the economy. Therefore, it is vital for producers to improve their knowledge of risk management and be able to adopt mitigation and coverage strategies to protect farming production.

Although risks cannot be totally extinguished, they can be reduced and managed. The approach to these kinds of risks has financial consequences, and producers have based their strategies on two overall categories: risk mitigation and transfer. These alternatives can be complementary and must be considered at the most appropriate moment within the decision-making process to reach the most efficient and intelligent management of farming risk.

Risk Mitigation or Reduction

Basically, these strategies are developed by the producer, without the intervention of other institutions, and they mainly tend to reduce vulnerability of production to climate factors.
A typical example of these instruments is active crop protection by using the spraying method to reduce frost impact on fruit trees, the placement of hail protection nets on vine crops, or supplementary spraying to reduce the impact of water deficit. Another tool that a producer may use to compensate for possible losses is temporal (harvests at different seasons) and spatial (crops on different zones) diversification of his or her production. However, these strategies may be limited by climate and ecologic conditions of the production zone or by lack of financial resources.

Producers from the La Pampa zone choose seeding dates, varieties, or hybrids that better adapt to water stress periods. Whereas fertilizers may improve water use efficiency, allowing more stable results in drought conditions, as regards livestock, suggested practices to reduce drought impact include rational grazing, avoidance of animal overload, and use of grains during critical stages.

Risk Transfer: Farming Insurance

Farming insurance is a financial instrument that allows balancing of producers' incomes, avoiding undesirable outcomes with their crops. These are contracts through which the insurer binds itself to compensate for damages if a covered event occurs, and for which the insured pays a premium.

To make their calculations, insurance companies must consider all possible situations and mainly those that may cause higher damages so as to evaluate whether they can assume the risk. Then, if as a result of such analysis the company is able to offer that coverage, it will calculate the price that should be paid by the insured. As a consequence of such considerations, it could be said that this analysis must be supported by good base information (weather, soils, production categories, and applied technologies) and calculation procedures (statistics of event occurrence). Insurance coverage and the price of premiums are the result of combining such information.

Farming Insurance in Argentina

According to information provided by the census survey of farming insurance that is informed by the Argentine Superintendence of Insurance (Superintendencia Seguros de la Nación, SSN), the state of the insurance industry to June 2010 reveals that 28 insurance companies cover agricultural insurance operations, but only 3 cover livestock insurance.

For the 2009–10 campaign, the figures that explain the market are as follows:

- Premiums: Arg$811.9 million
- Insured hectares: 18.9 million
- Insured capital: Arg$25.192 million
- Policies issued: 156,190

According to the above data, the insured land area reaches 50 percent of the planted land area. With respect to crops covered, 95 percent represents annual crops (cereals and oilseeds). As for the risks covered, the bulk corresponds to hail insurance and the remainder to multirisk coverage. Consequently, some productive activities of great importance to regional economies, such as cotton, horticulture, or livestock, appear to have a low level of insurance coverage.

The agricultural insurance industry was the most highly developed in the past decade in Argentina. It moved from 10 percent of the insured seeded land area in 2000 to 60 percent in 2010. This increase was influenced by two factors. The first was the increase in production, and the second was the organization of even small farmers as a company. As such, part of these risks was transferred to the companies.

Claim frequency rate for seeded land is 17 percent per every 100 policies. It represents a high percentage of claims compared with property insurance (excluding life), which is around 8.5 percent. To date, no official figures are available for the 2010–11 campaign, however, numbers are expected to be lower because of drought. Earlier this year, INTA believed that the water emergency would affect between 12 and 14 percent of crops.

Government Involvement

As previously outlined, one of the main features of farming activity is that productive processes are deeply related to climate behaviors. Thus, farming production is exposed to natural disaster risks beyond the control of producers.

Acknowledging this fact and that agricultural production remains one of the main productive sectors of the country, and given the risk events mentioned in the first section of this chapter, in 2009 the Argentine government sanctioned the Agricultural Emergency Act (Ley de Emergencia Agropecuaria, Act No. 26,509, August 2009), which creates the National System for Prevention and Mitigation of Agricultural Emergencies and Disasters. Its objective is to prevent and mitigate the damages caused by climate factors that significantly affect agricultural production, putting at risk exploitation continuity and affecting directly or indirectly rural communities. This act includes measures for the possibility of credit refinancing, tax schedule postponement, and subsidy grants to producers under various circumstances.

The act creates a regulatory framework for post-agricultural disaster financing. It defines agricultural emergencies and identifies the responsibilities of the central and local governments as well as the functions and duties of the national and regional disaster management agencies. The regulation outlines the disaster risk financing framework, which is a shared responsibility between the central and local governments, stipulating the three phases of a disaster as emergency, recovery, and reconstruction.

According to Law No. 26,509, the government is responsible for (a) the postdisaster financing of emergency and relief operations; (b) the postdisaster reconstitution of productive capacity; (c) controlling and monitoring that the assigned resources are used for the ends proposed by the law; (d) assistance for agricultural producers to reduce their losses during the emergency or the agricultural disaster; and to reduce the vulnerability to future events; and (e) coordination with the provinces, municipalities, and financial agents of the assistance to the agricultural producer affected by the adverse phenomena and diminishment of the vulnerability of the agricultural producers and the rural populations.

In regard to the prevention and mitigation of emergencies and agricultural disasters, once the status of emergency or agricultural disaster is declared, the Secretariat of Agriculture, Livestock and Fishing will have to (a) assign and/or reassign human and financial resources; (b) manage with the chief of cabinet the budgetary supplementary resources; and (c) assist the producers technologically and financially to restore financial, productive, and economic capacity.

The law provides for the creation of a national fund as a vehicle for the rapid financing of public postdisaster reconstruction operations—the National Fund for the Mitigation of Emergencies and Agricultural Disasters (Fondo Nacional para la Mitigacion de Emergencias y Desastres Agropecuarios, FONEDA). Its aim is to finance the execution of the National System for Prevention and Mitigation of Agricultural Emergencies and Disasters.

Policies to Subsidize Agricultural Insurance

As mentioned in the previous section, the government has made important commitments to protect agriculture, but it did not just restrict itself to the sanctioning of the aforementioned act. Among the actions that the public sector (at different government levels) has taken to manage risk and promote agricultural insurance, one can highlight the following:

- Undertake technical studies and data collection on the incidence of adverse phenomena;
- Grant subsidies for insurance as an instrument of social policy in rural areas (avoid rural-urban migration, strengthen the financial sector, and reduce producers' vulnerabilities by protecting physical assets);
- Grant tax exemptions for agricultural insurance to reduce costs;
- Grant reinsurance;
- Assume catastrophic risks by allocating funds or insurance for extraordinary losses.

Currently, Argentina does not have legislation at the national level to subsidize insurance programs. Nonetheless, diverse policies to subsidize agricultural insurance at local levels have been implemented.

Government Involvement in Risk Management and Promotion of Farming Insurance

Several local-level governments have started different programs of public-private measures, some of which are still ongoing, to encourage risk transfer to the private sector. The idea is to help bridge the gap between insurance companies and producers. Here, some of the activities that local provincial governments are undertaking to meet this objective are highlighted.

In Mendoza, the government is undertaking the Comprehensive Program for Agricultural Risk Management, which is subsidized by the provincial government. The objective is to obtain hail and frost insurance on fruit trees and vines. Currently, the program benefits 18,000 farmers with 300,000 covered hectares. The provincial government is undertaking the total cost of this insurance, so producers can have a risk transfer tool.

In Río Negro, the government is implementing hail insurance programs on fruit trees. The Ministry of Agriculture, Livestock and Fishery (Ministerio de Agricultura, Ganadería y Pesca, MAGyP) granted this insurance premium for producers with less than 50 hectares. 800 farmers benefited during the 2010/11 campaign with 6,000 hectares covered.

In Chubut, the government is implementing hail and frost insurance for fine fruit through a 100 percent allowance.

In Chaco, multirisk insurance for the cotton crop and financing of operating costs were subsidized by funds recognized under Law No. 26,060. About 800 small farmers benefited from this policy.

Livestock Climate Risk Management

Weather contingencies in recent years also caused serious losses to livestock production. Therefore, the MAGyP, under the Agricultural Risk and Insurance Project implemented by the ORA, initiated the development of coverage to mitigate damage to livestock.

The project involves developing an "insurance index of forage production" based on information provided by satellite remote sensing that allows accurate and objective measurement of pasture decline in production areas and the damages that the situation may create in production trends. A vegetation index database was developed.

The work includes the preparation of a monthly or fortnightly "Green Index," based on analysis of satellite images that are available from 1981 to the present. This type of insurance is low cost because the damage assessment does not require an individual expert for each place. The Green Index is related to the average forage production volumes of each region; thus, the fall of the established indicator below the level considered critical operates as a trigger for the payment of the amount stipulated insurance may cover, for example, the cost of supplementation needed to offset the loss. The information generated also serves as a monitoring and early warning of the state of vegetation to reduce the impact of extreme climate events on livestock.

Assessing and implementing all these governmental programs requires collecting, gathering, and analyzing data as a step in the process. An outline of information available in Argentina is gathered below.

Collecting and Managing Data: Information Integrity

A high heterogeneity in the quantity and quality of available information at the institutional level has been observed in Argentina. Furthermore, this information is presented in different formats and scales, and gaps have been found in risk processes. Fragmentation and heterogeneity of information is a critical issue regarding risks and emergencies. Information integrity allows the identification of the critical regions that require intervention, a prioritization of regions or areas to define strategies to generate maps and databases that outline vulnerabilities and risk areas, and the possibility of undertaking an assessment of information needs that are currently missing. In line with this, making the information available online is a top priority, so it can be readily available for decision makers in regard to risk and agricultural emergencies.

In the framework of the MAGyP, geospatial information that is currently available in different organisms is integrated to assess vulnerabilities and risks of different climatically derived processes. This initiative has the objective to contribute to decision making and adoption of ex ante and ex post measures in regard to the occurrence of a risk event and agricultural emergencies. The integration of geospatial information contributes and helps the incorporation of evaluation and monitoring models to be used during the agricultural campaign. One example is the models of water balance (deficit and excess) by area and crop.

ORA - Agricultural Risk Bureau (Oficina de Riesgo Agropecuario)

The creation of an office specialized in the management of risks in the agricultural sector emerged as a consequence of a study made by INTA and the secretary of agriculture (which is now the MAGyP) where two factors were identified:

- Scarcity of information to assess severe climatic risks;
- Weak coordination of actions between public and private sectors to generate and promote the use of instruments for risk management.

As a result, the ORA was created in 1999 with the aim of promoting and coordinating the work of different organizations in everything linked to production, commercial, and financial risks of the agricultural sector.

The areas of concern on which work is being done by this office are detailed below:

- Information system for climatic risk assessment;
- Design and implementation of risk management tools (agricultural insurance, insurance pilot programs of public-private partnership, early warning systems, and so on);
- Technical support and training to producers.

To be able to work on these main areas, ORA uses the following data collection instruments (some of which are explained below):

- Risk maps of water stress for the main crops (probability of water deficit and water surplus on crops' critical stage);
- Weekly monitoring of soil water storage for major crops (maize, soybean, sunflower, wheat, and cotton) and pastures;
- Analysis of the impact of the ENSO on seasonal rainfall and crop yield;
- Crop phenology survey.

Then, using these tools, ORA can monitor soil water storage, which allows evaluation of the water condition of the soil for different types of crops. The water balance is realized according to a methodology developed by ORA with information provided by the SMN and INTA. ORA is using a database of 37 years of climatic information. The water balance calculates daily the storage (ALM in millimeters) of water in the soil and the eventual surpluses (EXC). These values are calculated depending on the storage of the previous day, the evapotranspiration of the crop (ETR), rainfall (PP), percolation (PER,) and superficial runoff (ESC). Then, water balance is measured as follows:

$$\Delta ALM + EXC = PP - ESC - ETR - PER$$

This balance allows ORA to draw the risk map that reflects the probability of occurrence of stress situations and water excesses for the principal crops—a useful tool for the pricing of multirisk insurance as well.

Another important tool is the weekly monitoring of rainfall and temperature, with which the anomalies of temperature can be evaluated and compared with the average values in every zone of the country. At the end of every month, the monthly anomalies of rainfall are calculated and compared to the average rainfalls of the period 1970–2011. In this line, if one has a forecast of occurrence of anomalous events in the Equatorial Pacific Ocean and knows the climatic trends associated with each region, then one will be able to foresee major or minor levels of risk in comparison to a typical year.

In summary, ORA is an institution that has tools aimed at assisting producers to be able to have useful information for decision making.

Ecosystem and Climate Risk Financial Management Program

In recent years, and given the increasing climatic disasters and the degradation of ecosystem services, Argentina decided to address the issue of ecosystem and climate risk management in a multisectoral way, creating an interinstitutional committee to promote the important policy of risk management for sustainable development among the Ministry of Planning and Public Investment, the Ministry of Internal Affairs, and the Secretary of Environment and Sustainable Development. The committee focuses its activities on the integration of risk management when planning public policies through mitigation and adaptation measures.

This strategic program is designed to develop financial management tools for ecosystem and climate risks at the national, provincial, and municipal levels as a response to the Argentine priority to support the economy sectors through an efficient management of the risks.

Adverse weather events cause loss of tax revenue and require a public expenditure increase to react before and after emergencies, reducing the surplus. This fiscal exposure to catastrophic climate risks forces Argentina to have as a priority concern the use of financial instruments to transfer these risks to international markets, such as climate derivatives, reinsurance, catastrophe bonds, and others. As of signing the Framework Convention MDA (Master Derivatives Agreement)/ISDA (International Swaps and Derivatives Association) Argentina may request mediation by the World Bank on financial instruments related to weather and ecosystem events. There are provinces in which tax issues are deeply exposed to these situations, which require structural investment to mitigate such exposure. This program aims to transfer skills and knowledge for climate and ecosystem risk management and for the management of these new financial instruments to national and local entities related to financial and environment issues.

The World Bank has been providing specific support in agricultural risk management through the ORA for the introduction and strengthening of the design of agricultural insurance instruments based on climate indices, to be adopted by farmers.

Strategic Program Objectives

The overall objective is to reduce the negative impacts of climate change and the degradation of ecosystem services on Argentina´s economy and society through the transfer of risk with new financial instruments, promoting good practices to ensure a sustainable production system and with a distinctive federal nature. Over the next 5 years, Argentina, supported by the World Bank, intends to work in the following interrelated areas:

- Create and transfer capacity to the public and private sectors for the transfer of climate risks and the valuation of ecosystem services;
- Develop pilot projects to explain the use of those financial instruments;
- Conduct feasibility studies for decision making on the regulatory framework and on public policies for the transfer of climate risks and the valuation of ecosystem services;
- Analyze, design, and structure financial instruments that may eventually be used;
- Implement financial instruments for the transfer of climate and ecosystem risks, with the consent of the parties.

Budget

The estimated Strategic Program cost during the first 2 years is presumed to be around US$1,600,000, and US$3,850,000 for the following 3 years. Most of these resources are expected to come from grant funds to be managed through the World Bank, especially Spanish funds (Spanish Trust Fund for Latin America and the Caribbean, SFLAC).

Conclusion and Difficulties Found

Carrying out the depicted tasks is not easy. Many difficulties have been found and are described in this section.

First, the coordination of some government organizations is quite difficult for several reasons, most of them budget-related decisions. Government organizations work to very precise budget restrictions. When risk management organizations ask for results of information gathered and analyzed with no risk management–related purposes by technical government organizations, that information is not readily available.

Second, although by law only the Ministry of Internal Affairs is responsible for emergencies and disaster management, many government organizations have a share of responsibility in risk management. This role means that, while only the Office of Internal Affairs is responsible for emergencies management during emergencies, several organizations have responsibility in carrying out programs on risk prevention, preparedness, land use planning, public works, dam safety, basin management, and so on. This responsibility was illustrated in this chapter in the case of agricultural risk management.

Each organization carries out its own programs with little or no coordination with the others, including organizations belonging to the same ministry. Because of this lack of coordination, programs often duplicate work, generating the same information and wasting valuable resources. So, greater coordination is needed among different government organizations or perhaps Congress should enact legislative changes making coordination in risk management programs mandatory.

Records, particularly historical records, often are not available in magnetic support. And often, informatics programs used by different organizations (especially GIS [Geographic Information System]) are not compatible. Many times information generated by an organization is not easily usable by others.

In Argentina, data have been gathered for many years, but information is not easily available because it is scattered and poorly organized. Federal organization adds some problems too. According to the Argentinean constitution the right to implement certain decisions are kept under provincial jurisdiction, while several others are yielded by provinces to the federal government.

One of the most important issues yielded by provinces to the federal government is defense. For 60 years, emergencies and disasters were under Civil Defense's sphere of competence, through the Civil Defense National Direction. In those years, the Ministry of Defense merely ordered provincial governors to take actions regarding prevention and preparedness to deal with emergencies and disasters. In 1996, Civil Defense was transformed into Civil Protection, and responsibility was shifted from the Ministry of Defense to the Ministry of Internal Affairs. Prevention and preparedness were no longer a Civil Defense matter, and each province began to work without federal coordination.

Nowadays, each province has its own organization, and the degree of development among them is extremely variable, including disparity in human resources training and equipment, technologies, and so on. As a result, provinces often cannot use information available because they do not have staff capable to do so or equipment used is not the most adequate for the task.

The farming sector is often subjected to conditions of climate variability that threaten the foreseen food production. Therefore, in a context influenced by climate change, it is essential and necessary to have tools to assess and manage climate risk in the farming sector not only to safeguard food security, but also to ensure economic and social sustainability of the country's producers.

The quantification of the impact and frequency of adverse weather conditions for agricultural activities helps design strategies for prevention, mitigation, and transfer of agricultural and forestry risks, in coordination with public and private agencies involved in the issue. In addition, monitoring systems and early warning facilitate decision making of producers to manage risks, reducing the negative impacts of adverse weather conditions on production.

Accordingly, the government is leading a process aiming to design risk transfer instruments based on risk assessment developed through interagency cooperation, transfer of technology, existing technical capacities and human resources, and shared information.

In Argentina's experience, support of international organizations is key to achieving success.

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In the summer of 2010–11, Australia experienced widespread flooding and other extreme weather events that caused devastating losses across the nation.

This chapter provides a brief outline of Australia's arrangements for funding natural disaster relief and recovery activities. It then presents a case study outlining how these arrangements were implemented in response to the extensive damage incurred from flooding and cyclones in the state of Queensland during the 2010–11 summer, including some of the policy lessons learned from those events. Finally, the chapter discusses how the Australian Government is responding to policy issues about the availability and take-up of flood insurance.

CHAPTER 3: Australia's Recent Experience with Natural Disaster Risk Management

This chapter is a submission of the Government of Australia

Introduction

Australia faces a wide range of natural hazards, reflecting its size, location, geographically dispersed population, and diverse geophysical and climatic conditions. Natural disasters often result in large-scale expenditure by governments in the form of disaster relief and recovery assistance and infrastructure restoration.

Australia experienced widespread flooding and other extreme weather events in the summer of 2010–11 that caused significant and widespread losses. More than 320 of Australia's 559 local government areas were disaster declared as a result of flooding, storms, cyclones, and fires. Many areas were affected by more than one disaster. The 2010–11 disasters were, in financial and economic terms, some of the largest in Australia's history. In early 2012, communities in a number of Australian states were again hit by flooding caused by heavy rainfall.

The impacts of the 2010–11 disasters were particularly felt in the Australian state of Queensland. The area of land covered by the floods was larger than France and Germany combined. All 73 local government areas, or councils, in Queensland were disaster declared because of the flooding. The floods brought loss of life and significant damage to private homes and businesses as well as state and local government-owned infrastructure.

The Australian Government[1] and Queensland's state authorities responded swiftly to the 2010–11 floods through a coordinated national approach, with the Australian Government making the Australian Defence Force available to help in the immediate response phase. Responding to the need for urgent financial assistance, the Australian Government provided substantial financial support to individuals, businesses, and local governments, committing a total of $A 5.95 billion to recovery and reconstruction. It also established oversight and accountability measures to ensure that value for money was being delivered during the reconstruction phase.

Australia's successful response to the summer 2010–11 disasters provided a number of practical insights into the management of natural disasters. These included the importance of established arrangements, good public communications, and close coordination between different levels of government and agencies to achieve a swift response. The scale of the summer 2010–11 disasters also highlighted a number of policy challenges, including ensuring that government assistance does not supplant or operate as a disincentive for insurance or other private sector measures for disaster mitigation.

One issue raised by the events of the 2010–11 summer was the variability of home insurance policies. Some policies covered storm damage, including related water damage, but many did not cover flood damage. The Australian Government is responding to these problems with a range of initiatives aimed at improving the efficiency of the private insurance market and improving the transparency of insurance products so that consumers are better able to identify what is and what is not covered by their policies.

Australia's Disaster Recovery Policy Framework

Natural disasters often result in large-scale expenditure in the form of disaster relief and recovery assistance, including infrastructure restoration. The economic impacts of natural disasters are increasing, including as a consequence of the settlement and urbanization of risk-exposed areas and the increase of asset values.

Within the Australian federal system, constitutional responsibility for natural disaster planning, mitigation and recovery sits with state and territory governments. Local governments own a large proportion of essential public infrastructure, including roads, bridges, and sewerage and water treatment. The Australian Government also has a role both in assisting with the burden of relief and recovery after major disasters and in collaborating with all levels of government to strengthen communities' resilience to natural disasters and to minimize the impact of them.

Intergovernmental Arrangements in a Federal System: Sharing the Burden of Disaster Response

The Australian Government provides financial assistance directly to state and territory governments through the Natural Disaster Relief and Recovery Arrangements (NDRRA) to help alleviate the financial burden of responding to natural disasters and to facilitate the early provision of emergency assistance to disaster-affected communities. The Australian Government also provides a range of additional assistance, primarily focused on payments to individuals and businesses (see box 3.1).

Box 3.1 Definition of a Disaster under the NDRRA

In the context of the NDRRA, a natural disaster is defined as a serious disruption to a community or region caused by the impact of a naturally occurring rapid-onset event that threatens or causes death, injury, or damage to property or the environment and that requires significant and coordinated multiagency and community response. Such serious disruption can be caused by any one or a combination of the following natural hazards: bushfire, earthquake, flood, storm, cyclone, storm surge, landslide, tsunami, meteorite strike, or tornado.[2]

The impact of disaster-related expenditure on the finances of particular states and territories is also taken into account in the distribution of proceeds from the Australian Government's Goods and Services Tax (GST) to state and territory governments. This has the effect of sharing the overall burden of disaster recovery between the different state and territory governments.

Australia's Natural Disaster Relief and Recovery Arrangements

The NDRRA is the mechanism through which the Australian Government provides financial assistance to the states and territories to meet the costs of responding to natural disasters. NDRRA assistance is provided by the Australian Government and administered by the affected state or territory.

A system of support that adjusts with the scale of a disaster

The *NDRRA Determination 2011* (Attorney-General's Department 2011) sets out the arrangements under which the Australian Government provides support. The *NDRRA Determination 2011* establishes a "self adjusting" program that is automatically triggered once eligible state or territory government expenditure exceeds a specified small disaster criterion—currently set at $A 240,000.

Under the arrangements, the Australian Government contribution increases with the scale of disaster spending, with a maximum reimbursement of 75 percent payable to the state or territory for eligible relief and recovery measures. States and territories are reimbursed a proportion of expenditure that exceeds certain thresholds, which are calculated by reference to their annual general government sector revenue and grants (see table 3.1). The Australian Government may provide advance payments if it is satisfied that exceptional circumstances exist. This most recently occurred in response to flooding in Queensland and Victoria in 2010–11 where the exceptional scale of events demanded a rapid response.

Once the small disaster criterion has been exceeded, the proportion of the costs reimbursed by the Australian Government is determined by two thresholds. The Australian Government funds 75 percent of the cost of all eligible relief and recovery measures for all eligible events in a financial year assessed above the higher of two thresholds and 50 percent of the cost of all eligible relief and recovery measures between the two thresholds.

These thresholds are calculated as a proportion of state or territory revenue. The first of these thresholds is presently set at 0.225 percent of a state or territory government's general revenue in the two years before the relevant financial year, and the second is set at 1.75 times that amount. The threshold amounts for 2011–12 are listed in table 3.2. Linking the thresholds to government revenue helps link the level of support to the capacity of state and territory governments to meet the costs of disasters within their own means.

Table 3.1 Operation of Thresholds for the NDRRA: Levels and Nature of Australian Government Support

State expenditure	Australian Government reimbursement	Example of support provided
x < $240,000	None	None
$240,000 < x < first threshold	50% of Categories A, C.	Personal hardship and distress payments (Category A). Community Recovery Packages (Category C).
First threshold < x < second threshold	50% of Categories A, C 50% of Category B expenditure above the first threshold.	Personal hardship and distress payments (Category A). Community Recovery Packages (Category C). Restoration or betterment of essential public assets; concessional loans (Category B).
x > second threshold	75% of Categories A, B. and C	Personal hardship and distress payments (Category A). Restoration or betterment of essential public assets; concessional loans (Category B). Community Recovery Packages (Category C).

Source: Provisions of the NDRRA (Attorney-General's Department 2011a).
Note: x = NDRRA-eligible state expenditure.

Table 3.2 NDRRA State and Territory Expenditure Thresholds 2011–12 *Australian dollars*

State	State revenue	1st threshold	2nd threshold
New South Wales	59,962,000,000	134,914,500	236,100,375
Victoria	44,586,000,000	100,318,500	175,557,375
Queensland	39,729,000,000	89,390,250	156,432,938
Western Australia	21,913,000,000	49,304,250	86,282,438
South Australia	15,534,000,000	34,951,500	61,165,125
Tasmania	4,602,000,000	10,354,500	18,120,375
Northern Territory	4,652,000,000	10,467,000	18,317,250
Australian Capital Territory	3,815,000,000	8,583,750	15,021,563

Source: Attorney-General's Department 2011b.

Table 3.3 Categories of Support Available under the NDRRA

NDRRA category	Types of assistance available
Category A	Personal hardship and distress assistance to individuals
Category B	Restoration of essential public assets; concessional loans to small businesses, primary producers, volunteer organizations, and individuals; counter disaster operations for the protection of the general public
Category C	Community Recovery Packages (a community recovery fund, recovery grants for small business, or recovery grants for primary producers)
Category D	Additional recovery or relief measures in exceptional circumstances

Source: Provisions of the NDRRA (Attorney-General's Department 2011a).

The *NDRRA Determination 2011* sets out this support within four broad categories of assistance outlined in table 3.3.

A range of measures are available under the NDRRA, including support for personal hardship and distress assistance; counter disaster operations; loans for small businesses and primary producers; transport freight subsidies for primary producers; loans and grants to churches, voluntary non-profit organizations and sporting clubs; and the cost of restoring or replacing essential public assets (of state or territory and local governments) damaged or destroyed by a natural disaster. Following severe disaster events, additional packages to support communities for clean-up and recovery and grants for small businesses and primary producers may be activated.

Developing a package of assistance that responds to the situation on the ground

Under the NDRRA, the state or territory government determines which areas receive NDRRA assistance and what assistance is available to individuals and communities, according to an assessment of the impacts in particular locations.

The timing and nature of assistance varies from disaster to disaster and community to community. Assistance is tailored to particular locations to reflect the situation on the ground. Experience demonstrates that the impacts of each disaster and the needs of particular communities are different. A set of NDRRA guidelines have been developed to assist states and territories in meeting the terms and conditions for Australian Government assistance and to help promote a nationally consistent approach to the relevant aspects of disaster recovery.

The Australian Government works closely with the states and territories to continually monitor a disaster as it unfolds. This collaboration assists in building a longer view of the recovery needs of a community, particularly when an event is considered severe or catastrophic. Recovery packages under Category C and additional discretionary support in exceptional circumstances under Category D require consideration and approval by the Australian Government (see box 3.2).

Adjustments to the GST to Distribute Disaster Recovery Expenses between State and Territory Governments

The burden on state and territory budgets of dealing with the recovery from natural disasters, including replacing damaged infrastructure, is shared between the states and territories through the allocation process for the GST. The Intergovernmental Agreement on Federal Financial Relations (IGA), which provides the framework for fiscal equalization within Australia's federal system, requires that the GST be distributed among the states on the basis of horizontal fiscal equalization.

State spending on natural disasters in excess of that funded by the Australian Government through the NDRRA is taken into account in determining a state's GST share. The way the Commonwealth Grants Commission incorporates natural disaster expenditure and related Australian Government support ensures that the amount of NDRRA funding received by a state or territory does not affect its GST share. Net state spending on natural disasters has an effect on state GST shares when a state or territory spends more or less than the average amount for all states and territories combined.

Box 3.2 Additional Australian Government Support

In addition to supporting state and territory governments through the NDRRA, the Australian Government also provides a range of disaster-related support. These programs are provided solely by the Australian Government and delivered through Australian Government agencies.

The Australian Government Disaster Recovery Payment

The Australian Government Disaster Recovery Payment (AGDRP) provides short-term financial assistance to individuals adversely affected by a major or widespread disaster through a one off, non-means-tested payment under the Social Security Act 1991 to eligible Australian residents.[3] The AGDRP is activated when the impacts of a disaster are considered so severe that further Australian Government assistance, in addition to that provided under the NDRRA, is warranted. Currently, eligible adults are paid $A 1000 and eligible children are paid $A 400.

Disaster Income Recovery Subsidy

Additional support has been made available in some circumstances for employees, small business owners, and farmers who have experienced a loss of income following a disaster through the Disaster Income Recovery Subsidy (DIRS). This program provides payments every two weeks equal to the maximum rate of Newstart Allowance[4] or Youth Allowance,[5] depending on a person's circumstances.

Wage Assistance

Wage Assistance has been made available in some circumstances to employers, including businesses, primary producers, and not-for-profit organizations, that meet specific eligibility criteria. Wage Assistance is provided at the equivalent to the single rate of Newstart Allowance.

Other tailored assistance

A patchwork of additional payments and services also provide Australian Government support to individuals and local, state, and territory governments following a disaster. Responsibility for these payments is shared between the relevant Australian Government portfolios.

Working Toward a Risk-Based Approach to Disaster Management in a Federal System

Under Australia's federal system, the primary responsibility for disaster mitigation and response rests with the state and territory governments. However, given the broad range of disasters that Australia potentially faces, Australian state, territory, and local governments have recognized the importance of engaging in mitigation to limit the damage suffered in a disaster and to encourage the development of a resilient society.

A risk-based approach to disaster management allows for the most effective allocation of resources in the preparedness and prevention stages of emergency management. This approach also allows key decision makers to make more informed choices about the allocation of mitigation funding.

Additionally, a greater understanding of risk, coupled with effective community engagement and communications strategies, provides individuals, businesses, and communities with a better awareness of the risks they face. This greater understanding of risk builds resilience and allows individuals, businesses, and communities to make more informed decisions before, during, and after a disaster.

Mitigation—the National Partnership Agreement on Natural Disaster Resilience

Infrastructure is generally owned and managed either by state and territory or by local governments. In 2009, the Council of Australian Governments (COAG)[6] agreed to the National Partnership Agreement on Natural Disaster Resilience.[7] This National Partnership Agreement (NPA) provides for collaboration on natural disaster mitigation activities to strengthen communities' resilience to and minimize the impact of a range of natural disasters in Australia.

The NPA provides about $A 26 million per year for the states and territories to engage in mitigation activities. This funding is divided among the eight states and territories according to a formula agreed to previously.[8] The states and territories provide an implementation plan to the Australian Government each year detailing the activities they intend to undertake to improve mitigation and resilience in their jurisdiction. These activities address the following outcomes: reducing the risk from natural disasters, ensuring appropriate emergency management capability and capacity, and providing support for volunteers.

Since the commencement of the NPA in 2009, all jurisdictions have submitted implementation plans. These plans have covered a range of activities including natural disaster risk assessments, bushfire mitigation programs, and natural disaster resilience grant schemes offered to parties within the jurisdiction.

Resilience—National Strategy for Disaster Resilience

On February 13, 2011, COAG agreed to the National Strategy for Disaster Resilience (NSDR).[9] The NSDR acknowledges that Australia generally copes well with disasters through well-established cooperative arrangements, effective capabilities, and dedicated paid and unpaid people. The NSDR highlights a need to develop and embed new ways of doing things that enhance existing arrangements across and within governments, as well as among businesses, the not-for-profit sector, and the community more broadly, to improve disaster resilience and prevent complacency once the memory of a recent disaster has subsided.

The NSDR recognizes that disaster resilience is a shared responsibility for individuals, households, business, communities, and governments and is not solely the domain of emergency management agencies. A key objective of the NSDR is to develop resilient communities that function well under stress, can successfully adapt, are self-reliant, and have social capacity. A disaster-resilient community is one where people understand the risks to the community; have taken steps to anticipate disasters and to protect themselves; work together with local leaders to prepare for and deal with disasters; and work in partnership with emergency services and authorities before, during, and after disasters. Disaster-resilient communities also have a range of other features including having emergency plans that build disaster resilience over time, taking resilience outcomes into account when developing core services, and having a strong emergency management volunteer sector.

The NSDR provides high-level guidance on seven priority areas to build disaster resilience:

- Leading change and coordinating effort—leaders from all levels of government and the community undertaking activities to mitigate risks, driving the development of partnerships and networks to build resilience, and providing information and guidelines to the community;
- Understanding risks—undertaking activities to improve the understanding of risks facing the community, using new technologies to communicate risk information, and obtaining more consistent information on the cost and benefits of risk management and disaster impacts to build the evidence base for prioritizing and targeting interventions;
- Communicating with people about risks—encouraging a clearer understanding of the risks facing communities and what can be done about them to inform preparation and mitigation activities;
- Partnering with those who effect change—building links among policy, research, and operational expertise and mechanisms to effectively transfer information and knowledge;
- Empowering individuals and communities to exercise choice and take responsibility—encouraging individuals and communities to undertake actions that will limit their exposure to disasters (including taking up insurance options when it is cost-effective to do so);
- Reducing risks in the built environment—encouraging activities that limit the risk to the built environment, such as appropriate land use planning and building standards;
- Supporting capabilities for disaster resilience—ensuring that emergency management arrangements are sound, well understood, and practiced.

The NSDR contains a number of priority outcomes to implement, and the Australian Government is working with the states and territories to do so. Responsible ministers affirmed their commitment to a national, integrated approach to building disaster resilience at a meeting of police and emergency management ministers[10] July 28–29, 2011. Work will continue in implementing the outcomes to deliver a more resilient Australia.

Case Study: Australia's Response to the 2010–11 Queensland Floods and Tropical Cyclones

The 2010–11 Queensland Floods and Tropical Cyclones

Toward the end of 2010 and in the early months of 2011, the state of Queensland suffered from devastating floods and tropical cyclones that were Australia's largest natural disaster.

Following three weeks of heavy rainfall, Tropical Cyclone Tasha made landfall south of Cairns December 25, 2010, with 150–250 millimeters of rainfall. Tropical Cyclone Yasi, a Category 5 cyclone, followed February 3, crossing the Queensland coast at Mission Beach and Tully, south of Cairns. Tropical Cyclone Yasi was the worst cyclone to hit Australia since 1918, with winds reaching 290 kilometers per hour.

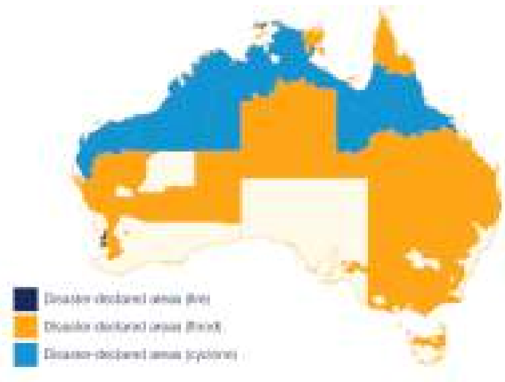
The floods caused 37 deaths (three of the victims were officially listed as missing), dozens of casualties, and the evacuation of more than 70 towns. A joint report prepared by the World Bank and the Queensland Reconstruction Authority estimated that total damages and economic losses were about US$15.9 billion (World Bank and Queensland Reconstruction Authority 2011, 1).

All 73 Local Government Areas (LGAs) in Queensland were disaster declared because of these events, which included flash flooding in some areas (map 3.1). The floods brought loss of life and significant damage to private homes and businesses as well as state and local government-owned infrastructure.

Reconstruction costs from the floods and cyclones in 2010–11 have been estimated to be at least $A 7.5 billion. This amount includes the following:

- Damage to more than 9,100 kilometers of state road network and approximately 4,750 kilometers of the rail network
- Power disruptions to approximately 480,000 homes and businesses
- Damage or disruption to 54 coal mines, 11 ports, 138 national parks, and 411 schools

Map 3.1 Disaster-Declared Local Government Areas, November 2010–February 2011



Source: Australian Treasury.

The events washed away roads and railways, destroyed crops, and brought Queensland's $A 20 billion coal export industry to a near halt, making the flooding one of Australia's most costly natural disasters. Examples of these costs included:

- A total of 130,989 insurance claims paid to insurance holders in Queensland with an estimated reserve value of $A 3.71 billion;
- Total agricultural impact from Tropical Cyclone Yasi and the floods in Queensland estimated at approximately $A 1.9 billion, with significant impacts on sugar, fruit, vegetables, cotton, and sorghum crops.

Ensuring a rapid and commensurate government response to the Queensland disaster

The scale of the disaster required an immediate and coordinated response across all levels of government. The Australian Government and Queensland's state authorities responded promptly to these circumstances. (See box 3.3 for a description of the Australian Government's crisis management arrangements.) About 300 troops from the Australian Defence Force were sent into Queensland to help in the immediate response phase, with the number soon boosted to a total of 1,900 troops from the army, navy, and air force. This response provided a large workforce and gave immediate reassurance to Queenslanders that the Australian Government would stand with them as they rebuilt.

The Australian Government recognized the urgent need for financial assistance and provided immediate assistance that significantly supported individuals, business, and local government. It committed a total of $A 5.95 billion to recovery and the reconstruction of the devastated state.

The funding was partly directed to the provision of immediate relief as follows:

Box 3.3 Australian Government Crisis Management Arrangements

Under the Australian Government Crisis Management Arrangements, the lead minister for natural disasters is the Attorney-General. Emergency Management Australia (EMA), within the Attorney-General's Department, coordinates the entire government's response to and recovery from natural disasters and administers the Australian Government funding arrangements.

The interim Australian Government Crisis Coordination Centre (CCC), an around-the-clock all-hazards facility managed by EMA, commenced operation in September 2010 as the central crisis coordination resource of the Australian Government and primary source of information and situational awareness in domestic emergencies and crises. Throughout the 2010–11 disaster season, the interim CCC operated 24 hours a day, seven days a week to monitor, inform, and coordinate the response to natural disasters. This prolonged period of operational activity demonstrated the capability of the new CCC operating environment.

- $A 775 million in immediate assistance payments made to 673,000 individuals through the AGDRP;
- About $A 69.5 million distributed to nearly 60,000 workers, small business operators, and farmers through the Australian Government–funded DIRS;
- A contribution of $A 11 million to the Queensland Premier's Disaster Relief Appeal, which gave nearly $A 73 million in emergency assistance to 40,000 people in immediate need (the appeal helped people with damaged or destroyed housing through donations it received, totalling almost $A 282 million);
- A contribution of $A 206 million to the $A 315 million Queensland Local Council Package, a joint initiative with the Queensland Government to help local governments repair utilities so that disaster-affected communities had water and sewerage services, transport infrastructure, and employment support.

Box 3.4 The Prime Minister's Business Taskforce

The Prime Minister's Business Taskforce was established January 18, 2011, with the mandate to leverage private sector support for recovery, specifically through cash and in-kind donations to community and local organizations that had sustained damage. The Business Taskforce contributed to 176 community organizations signing up for support through the Join Forces program operated by the Queensland Reconstruction Authority. There were 367 matches made between corporate donors and communities receiving assistance. The estimated total value of all cash and in-kind donations was in excess of $A 50 million.

The success of the Business Taskforce was largely attributed to its high profile membership and the personal involvement of the prime minister and deputy prime minister.

The vast majority of the funds were provided to the Queensland Government for immediate recovery and reconstruction work Under the NDRRA framework, the Australian Government became the majority funder of Queensland's recovery bill, meeting up to 75 percent of eligible reconstruction costs. The Australian Government's commitment of $A 5.95 billion allowed $A 4.1 billion to be fast-tracked as advance payments to Queensland to get reconstruction work started straight away. With this funding, the Queensland Government made advance payments of almost $A 668 million to local governments and $A 444 million to state government departments and agencies to assist with urgent work.

The Australian Government also established a taskforce (the Prime Minister's Business Taskforce) to harness private sector support for the response to the Queensland floods (see box 3.4).

Putting in place governance mechanisms to respond to the unprecedented scale of the Queensland floods

Recovery and reconstruction activities were governed by strong new oversight and accountability measures, which aimed to ensure that value for money was delivered in the massive task of rebuilding Queensland and also to ensure a rapid government response.

For the period requiring focused decision making, a National Disaster Recovery Committee of Cabinet was convened, involving key senior ministers.

The Australian Government established the National Disaster Recovery Taskforce, initially for two years, to coordinate the recovery effort across Australian Government agencies and to provide strategic direction and oversight of the Australian Government's contribution to reconstruction efforts. The taskforce led Australian Government engagement with Queensland reconstruction agencies during the recovery phase.

In February 2011, the Queensland Reconstruction Authority (QRA) was established by the Queensland Government to oversee and coordinate the recovery and reconstruction efforts. The QRA's mission is to "reconnect, rebuild, and improve Queensland and its communities and economy" through the development and implementation of a state plan. The QRA was vested with the power and authority to take charge of the reconstruction process and facilitate effective interaction between the relevant line departments at the state and local levels with local councils. Two QRA board members were appointed by the Australian Government.

To ensure value for money, the Australian Government also established the Australian Government Reconstruction Inspectorate, an independent body tasked with reviewing reconstruction spending. To advance its mandate, the inspectorate has created a value-for-money framework and a process for evaluating reconstruction projects. The inspectorate assesses value for money on a sample of reconstruction projects across Queensland and inspects damage and reconstruction in disaster-affected areas.

To guide recovery and reconstruction activities, the Australian Government entered into the Natural Disaster Reconstruction and Recovery National Partnership Agreement with the Queensland Government February 24, 2011. The agreement established additional reporting requirements for Queensland and oversight arrangements that reflected the scale and severity of the disaster. The agreement provided a greater level of scrutiny to the use of disaster recovery funding and allowed the Australian Government to make payments to Queensland in advance of incurring recovery costs. A timeline of the response to the Queensland disaster is provided in the annex.

Financing the Australian Government contribution

The Australian Government's contributions to disaster recovery costs under the NDRRA provide ex-post funding support to Australia's state and territory governments.

Two-thirds of the $A 5.95 billion provided by the Australian Government was funded from budget savings, including around $A 1 billion in delaying some infrastructure projects. This reflected a situation in which the strong Australian economy meant that Australia faced skills shortages, which were expected to increase in the face of the major rebuilding effort in Queensland. Deferring infrastructure projects made room for this demand, freeing up builders, carpenters, electricians, and other skilled workers to rebuild essential infrastructure in flood-affected regions.

Part of the reconstruction cost is funded by a flood and cyclone levy. The government introduced the levy to apply for one year beginning July 1, 2011, to individuals who were not affected by a natural disaster and who had an income greater than $A 50,000. The levy is estimated to raise $A 1.7 billion. It applies at five cents for every 10 dollars of income over $A 50,000 and 10 cents for every 10 dollars of income over $A 100,000. In deciding to introduce the levy, the government believed that, with a growing economy, it was important that disaster reconstruction was paid for "as we go."

Given the strength of the Australian Government's balance sheet and its AAA credit rating, the government is well placed to increase debt issuance (that is, raise cash) in a short time frame when needed. For the Queensland floods, the government's borrowing program was adjusted, as needed, to raise cash to finance immediate response measures.

For Australia, the concept of holding a cash fund to finance disaster recovery is ultimately a question of cash management and when the government chooses to raise its finance. The government can choose to borrow for disaster recovery (if necessary) and set cash aside ex ante, or it can finance disaster recovery after a disaster, as is currently the case. Holding a hypothecated cash fund in the expectation that it may be drawn upon at some stage in the future to finance natural disaster responses is not a costless exercise. It would expand the government's balance sheet by increasing borrowing on the one hand (and associated interest costs) and assets held on the other hand. For a country like Australia that is well placed to access the financial markets, raising cash as and when needed to finance disaster recovery measures is consistent with efficient balance sheet and cash management.

Lessons Learned from the 2010–11 Disaster Season

The Queensland floods and tropical cyclones presented a major disaster response and recovery task for all three levels of government. Australia's established policy framework provided the basis for a rapid response, with additional governance arrangements being put in place to cater to the scale of the disaster.

A report prepared by the World Bank in collaboration with the Queensland Reconstruction Authority observed as follows:

> *The Queensland reconstruction effort meets international good practice standards in many ways. Building on a wealth of experience, the Australian authorities have responded rapidly to save lives, provide emergency funding to individuals and communities, and to set-up the institutions charged with the management of the recovery and reconstruction. Four months after the floods, Queensland is well on the path of recovery: local reconstruction plans have been prepared, most coal mines are back in operation and many families have received financial assistance to cope with the impact of the floods. (World Bank and Queensland Reconstruction Authority 2011, 3)*

Some of the key policy lessons learned from the response are outlined below.

The existence of established disaster response and recovery arrangements and preseason preparation were critical to achieving a rapid response

Being able to begin relief and recovery activities as soon as a disaster occurs gives the public confidence in the government's ability to respond to a disaster.

Having a comprehensive disaster response and recovery strategy in place in advance of a disaster was critical to ensuring a timely, comprehensive, and appropriate response to the 2010–11 disasters. In particular, this strategy allowed assistance to be made available quickly to those individuals and communities most affected by the floods and cyclones. In its joint report with the Queensland Reconstruction Authority, the World Bank noted that "Australia's disaster response has benefited tremendously from prior disaster management arrangements and preparedness" (World Bank and Queensland Reconstruction Authority 2011, 7).

Australia's pre-established arrangements include legislated governance and coordination structures and arrangements for financial assistance to the states and territories as well as to individuals and communities. However, pre-established arrangements need to be flexible to be able to adapt to the unique circumstances of different disaster events. The NDRRA facilitates the tailoring of responses by state and territory governments to the circumstances of different locations as the situation develops.

Briefings and exercises held before disaster season are also valuable for ensuring that relevant people understand the arrangements and their respective roles within them.

Close coordination between relevant agencies and levels of government is essential

Australian Government–level governance and coordination arrangements were largely effective in the recovery phase. A dedicated decision-making committee of key senior government ministers was established in light of the scale of the disaster to coordinate and provide oversight for the Australian Government's response to the disaster.

Close engagement between Australian Government agencies with the relevant state and territory disaster management agencies was essential to promote coordination and facilitate information sharing. Early deployment of Australian Government officers to affected state or territory agencies aided communications, planning, and allocation of resources.

A new Crisis Coordination Centre CCC officially began operation in September 2011 after two years of development (see Box 3.3). The CCC has a standing capability to provide shared and up-to-date information on events to the Australian Government. An interim CCC was in operation during the 2010–11 disaster season, with the CCC being officially opened prior to the 2011–12 disaster season.

Additional Australian Government support is required for large and severe disasters

State and territory arrangements are well established and provide an appropriate level of support for most disaster events. However, additional Australian Government support is required for large and severe disasters.

The level of financial support provided by the Australian Government, whether it is provided to the states and territories or directly to individuals, is tied to the severity and impact of a disaster. For example, the NDRRA provides an established a transparent set of arrangements that allowed support provided by the Australian Government to adjust to the size and severity of a disaster. Further, arrangements should be aimed at helping those most affected.

In response to the 2010–11 floods, increased financial support to the states and territories was complemented by additional oversight, reporting, and accountability requirements to ensure value for money was achieved during reconstruction.

Accurate, timely, and accessible public communication is important during the response to a disaster

The public must have confidence in the governments' ability to respond to a disaster. This requires that the government makes information about the event and assistance available to the public as quickly and widely as possible, and that this communication is accurate, coordinated, and consistent.

The Queensland Government had lead responsibility in communicating to the public affected by the floods and cyclones in Queensland. The use of web tools and press releases as well as bringing members of the media on trips to survey damage helped ensure the public was informed in a clear, timely, and accurate way.

Given the severity of the 2010–11 natural disasters, the Australian Government also had a role in informing those who were affected about assistance that was available and in promoting, more broadly, confidence in recovery arrangements.

It is beneficial to encourage business and community involvement in recovery activities to complement government efforts

The Prime Minister's Business Taskforce (see Box 3.4) was established to harness private sector support to complement the efforts of government in responding to the Queensland floods. It was successful in obtaining financial and in-kind support from business to assist with the flood recovery effort. Its key initiative was the Join Forces website, coordinated by QRA, which involved matching community recovery with expertise and resources offered by business.

A key factor behind the success of the business taskforce was its high profile membership, which included the prime minister and the deputy prime minister, as well as senior business leaders from a range of industries. Business leaders were able to mobilize expertise and resources through their networks to provide support to affected communities.

The Queensland Premier's Disaster Relief Appeal was launched in response to the 2010–11 floods and Tropical Cyclone Yasi. It raised more than $A 280 million from individuals, business, and governments, and assisted more than 40,000 people.

Government assistance should not supplant or operate as a disincentive for insurance or other disaster mitigation efforts.

A key principle of the NDRRA is that the support provided is not to supplant or operate as a disincentive for insurance or disaster mitigation. The majority of decisions that affect the level of disaster risk and accompanying financial risk are taken by states or territories and local governments. These decisions relate to issues such as land use policies and building codes and standards. A desirable feature of any model of financial support related to disaster recovery would be to closely align decisions that affect the level of disaster risk with the financial consequences of those decisions.

Following the 2010–11 disaster season, changes were made to the previous NDRRA Determination to require a review of states' independent assessments of their insurance arrangements based on the following principles:

- A state has a responsibility to put in place insurance arrangements that are cost effective for both the state and the Australian Government.
- The financial exposure borne by taxpayers (at both levels of government) should be minimized.
- The onus is on a state to explore a range of insurance options in the market place and assess available options on a cost–benefit basis.

States are required to have an assessment of their insurance arrangements undertaken by an independent specialist.

The first such assessments have been completed and published. It is still too early to draw conclusions from the review, because information from local governments is still being prepared. Because this is the first time such assessments have been prepared, Australia is learning from the experience. Refinement of assessment procedures will be an iterative process.

The Private Insurance Market

The National Strategy for Disaster Resilience recognizes the role that insurance can play in risk management for individuals, businesses, and communities. Further, it recognizes that individuals and businesses need to have a strong understanding of the availability and coverage of insurance, including the risks that are included and excluded from their existing insurance policies.

Australia has a well-established private insurance market that offers products that insure against losses from a wide variety of risks. In principle, its existence allows the economy to manage risk more effectively, reducing financial uncertainty in the event of a disaster and allowing for a more efficient use of capital by individuals, business, and government. It assists individuals, business, and the community more broadly to recover from disasters by providing a funding source (Natural Disaster Insurance Review Panel 2011a).

The Queensland floods resulted in approximately 59,000 private insurance claims (from December 21, 2010, to January 14, 2011), and Tropical Cyclone Yasi resulted in approximately 73,000 claims (from February 2 to February 7, 2011), at a total expected cost to the industry of $A 3.78 billion (Insurance Council of Australia 2012). The scale of the claims on private insurance subjected the industry to intense public scrutiny and examination[12]. As a consequence, the Australian Government commissioned the Natural Disaster Insurance Review to examine insurance for flood and other natural disasters following the 2010–11 summer floods. The government responded to the recommendations in the Review's report in November 2011 (Minister for Financial Services and Superannuation and the Attorney-General 2011).

The following discussion examines issues and lessons associated with the insurance of home buildings and home contents arising from the Queensland floods.

Context for the Problems with Flood Insurance Experienced in the Aftermath of the 2010–11 Floods

At the time of the 2010–11 floods, only about 54 percent of policies for home buildings included coverage for flood (Insurance Council of Australia 2011). Further evidence emerged in the aftermath of the floods that a significant proportion of homeowners who had property damage had policies that did not cover flood damage. The fact that home insurance policies covered storm damage, including related water damage, but many policies did not cover flood damage created frustration and confusion among policy holders. This was the case for a number of reasons. Only some insurers offered coverage for flood and some of these offered partial coverage only. Some individuals had also opted not to take flood coverage where it was available. Some home owners were unaware that their insurance did not cover flood or only covered it partially (Natural Disaster Insurance Review Panel 2011b).

Insurers define water damage suffered during a ″storm″ very differently from damage resulting from a "flood." Damage from storms is typically considered to occur concurrently with heavy rainfall and as the result of falling water. Flood damage is typically defined to result from rising rather than falling water that takes place two or more days after heavy rainfall. Differing definitions of flood used by insurers in their policies also added to consumer confusion and frustration.

This distinction between storm and flood damage becomes centrally important to any insurance claim where water-damaged assets are insured against losses stemming from storms but not from floods. These circumstances effectively represented an insurance gap that exposed many homeowners to the risk of financial hardship.

Consumer Awareness of Flood Exclusions

Although the Australian Government requires insurers to offer a standardized form of coverage that includes flood, it does give insurers the ability to exclude specific risks from coverage. To exempt specific risks, the insurers must clearly inform the consumer of the exemption in writing, and this is usually done by providing the consumer with a product disclosure statement.

As to consumer awareness of flood exclusions in their insurance policies, a survey of policy holders who were assisted by various independent legal services in Queensland in 2011 found that about half did not read their policies or the associated product disclosure statement before having to make a claim. The survey found that 37 percent read their policies but misunderstood important exclusions and limitations, such as flood coverage (Insurance Law Service 2011).

The product disclosure statement, which provides details of the associated insurance product, is required to contain sufficient information so that a retail client may make an informed decision about whether to purchase the product. However, it can be quite long, often more than 50 pages. This length may be intimidating for some consumers. Additionally, the document is designed to be read in its entirety. A partial reading may fail to provide a proper understanding of the insurance product, including any exclusions.

Delays in insurance claim handling and consequent disputes

Many policy holders whose home buildings or home contents sustained water damage in the 2010–11 floods but who had not purchased flood cover did, nevertheless, submit an insurance claim, as was their right. This required their insurer to determine whether the damage resulted from storm or flood. For such a determination, a qualified hydrologist needed to prepare a report identifying the precise cause of the damage. These reports can be time consuming to prepare, and because they are prepared after the fact, their findings can sometimes be subject to dispute. The large number of reports commissioned following the 2010–11 floods led to some delays in their finalization. This, in turn, contributed to rebuilding delays for those policy holders whose insurance claims were paid.

The fact that so many homes were damaged by flood for which they were not insured also led to a significant number of denied claims, with many of these policy holders lodging disputes (Queensland Floods Commission of Inquiry 2012, 290).

The Australian Government's Response

The government responded with a range of initiatives that can be divided into two broad categories. The first category aims to improve the efficiency of the private insurance market so that flood cover is offered as part of most, if not all, home building and home contents policies and that insurance claims are handled promptly. The second category aims to improve the transparency of insurance products so that consumers are better able to identify what is and what is not covered by their policies.

These measures will enable consumers to make better-informed decisions about the purchase of insurance contracts and will reduce the current level of consumer confusion regarding what is and what is not included in their insurance contracts, in particular, the extent to which contracts provide coverage for flood and the definition of coverage for flood. This should reduce the risk of consumers purchasing inappropriate insurance cover.

Initiatives to improve efficiency

Australian Government initiatives to improve efficiency include the following areas of work.

Enhancing the quality and availability of flood risk information

To address the patchiness and inconsistency of flood risk information, the government is investing funds to collate existing flood risk data currently held by various levels of government. Data collation will be complemented by the development of national guidelines that will cover the collection, comparability, and reporting of flood risk information that will contribute, over time, to improved data quality and consistency.

Providing access to a standardized set of data will better enable insurers to price flood risk across the country. This will expand the range of insurers able to offer flood coverage and potentially increase competition in the provision of flood coverage.

The information collated could also play important roles in emergency management, land use planning, and environmental management as well as informing the setting of insurance premiums.

Expanding the availability of flood insurance and focusing consumer awareness on flood risk

The government is giving consideration to a further initiative intended to expand the availability of flood insurance and to focus consumer awareness on flood risk.[13] This possible initiative would require insurers to offer flood coverage as part of any home building and home contents policies that they offer. But insurers would be given discretion to provide consumers with the choice to opt out of purchasing flood coverage.

At the time of writing, the government is seeking community comments on the proposal and will decide the matter after considering those comments.

Strengthening the industry's Code of Practice

The Australian Government is working with the insurance industry to strengthen its Code of Practice to improve the handling of claims. Key changes include requiring that insurers resolve claims stemming from most natural disasters in the same time frame as other claims; that is, within four months of being made. Previously, no formal time limit applied in respect of such claims. Reports prepared on insurers' compliance with the provisions of the code will also be publicly released for the first time to improve transparency.

Initiatives to improve the transparency of insurance products

Two key initiatives are being implemented by the Australian Government to improve the transparency of insurance products, with Parliament recently passing the required legislation.

Introducing a standard definition of flood in specified insurance products

Draft regulations were released for consultation late last year, and further consultation will be undertaken to ensure the wording and application of the standard definition is appropriate. The definition will apply to contracts of insurance covering home buildings, home contents, residential strata title properties, and small businesses.

Requiring insurers to provide their customers with a one-page Key Facts Sheet summarizing the coverage provided by specified insurance products

The Key Facts Sheet is a one-page document that summarizes key information about home building and home contents insurance policies. A separate Key Facts Sheet will be required for each policy.

This document will allow consumers to quickly and easily check the basic terms of the insurance policy, including the nature of coverage and any key exclusions. It will also simplify the purchase of home building and home contents policies for consumers by making it easier to compare policies with a consistent document and by allowing for more informed decision making.

On February 29, 2012, the government released a discussion paper on the Key Facts Sheet that sought stakeholder views on the format, content, structure, and provision of the Key Facts Sheet by March 23, 2012. Stakeholder comments on the discussion paper will allow the government to develop a prototype Key Facts Sheet that will be consumer tested. Once consumer testing is completed, regulations will be made to give effect to the Key Facts Sheet.

The Overall Situation Regarding Flood Insurance

The events have put a spotlight on the scale of the problem nationally. The majority of Australians have no flood risk (93 percent of properties). Of the seven percent of properties that do have a flood risk, approximately 2 percent have a risk that results in an insurance premium so expensive that it would raise the question of whether insurance is appropriate, thereby putting a focus on alternative policy solutions such as mitigation, land use planning, and land buyback.

Summary of 2010–11 Natural Disaster Events and the Government Response to the Queensland Floods and Tropical Cyclones

Summary of Natural Disaster Events 2010–11

December 23, 2010	Much of Northeast Queensland was already soaked with the arrival of a monsoonal trough that brought torrential rain stretching from the Gulf of Carpentaria to the Gold Coast.
December 25–28	In the early hours of Christmas Day, Tropical Cyclone Tasha made landfall near Cairns, bringing 150–250 millimeters of rainfall, with the widest range of intense rainfall being reported on December 27. The following day, December 28, brought disaster declarations and mass evacuations in a number of towns in Southeast Queensland. The mandatory total evacuation of the town of Theodore became the first such evacuation in Queensland history.
December 30	A large proportion of Southern and Central Queensland was affected by the floods with the town of Bundaberg experiencing its most severe flooding in decades.
December 31	By the end of December, about 22 Queensland towns were affected by the floods.
January 3–5, 2011	In the city of Rockhampton, with a population of about 75,000, rail and air access was cut off and two people died in the floods. By January 5, 40 Queensland towns had been cut off and dozens of coal mines were unable to operate because of flooding.
January 10	Toowoomba and Grantham experienced severe flash flooding. By this stage of the flooding in Queensland, 59 people had been reported missing. The final number of deaths was 37, and three of these victims are still missing.
January 13	Heavy rains inland on the western fringe of the Brisbane River catchment and on the Great Dividing Range (including the catchments of Wivenhoe Dam and Somerset Dam) resulted in the flooding of the Brisbane River. Thousands of properties were inundated by the second-highest flood peak level in Brisbane in 100 years (highest flood peak was January 1974).
January 30	Tropical Cyclone Anthony struck the Queensland town of Bowen, leaving about 10,000 homes in Bowen, Airlie Beach, and Sarina without power and drenching affected areas in 200 millimeters of rain within 24 hours.

February 3	Tropical Cyclone Yasi made landfall at Mission Beach in Northern Queensland, leaving 150,000 homes in Mission Beach, Cardwell, Tully, Innisfail, and surrounding areas without power. The Bruce Highway became impassable and affected areas faced food shortages.

Australian Governments' Response to the 2010–11 Queensland Floods

January 5, 2011 — Major General Mick Slater was appointed head of the Queensland Flood Recovery Taskforce.

January 17 — The Queensland Commission of Inquiry was established.

January 18 — The Prime Minister's Business Taskforce was established.

January 19 — The Queensland Reconstruction Authority was announced.

January 27 — The Australian Government's disaster assistance package was announced.

February 7 — The Australian Government announced the Australian Government Reconstruction Inspectorate and National Disaster Recovery Taskforce.

February 16 — The Australian Government announced the Tropical Cyclone Yasi Assistance Package. It activated Category D of the Natural Disaster Relief and Recovery Arrangements (NDRRA) and introduced other new measures, including the following:

- Special concessional loans of up to $A 650,000 for eligible businesses, primary producers, and not-for-profit organizations suffering extreme damage, with a grant component of up to $A 50,000;
- Wage assistance for employers, including primary producers, equivalent to Newstart Allowance for up to 13 weeks to help maintain the viability of businesses and the local community;
- A $A 20 million Rural Resilience Fund, jointly funded by the Australian and Queensland governments, to be administered by the future Queensland Reconstruction Authority to help fund business and community support activities, such as farm cleanups, counseling, and social support measures;
- An upfront payment of $A 50 million to the Queensland Government as an advance on future liabilities under the NDRRA.

February 21 — The Queensland Reconstruction Authority was established.

February 26 — The Australian and Queensland governments announced the additional $A 315 million Queensland Local Council Package, to be funded under NDRRA Category D to provide support for day labor costs, repairs to public utilities, and support for the Brisbane City Council. Under the package, local governments are required to take actions necessary to mitigate the impact of similar future events, such as entering into appropriate insurance arrangements. Local governments are also required to have risk management practices and sources of finance to cover the costs of damage to their assets.

March 2 The Category D concessional loan and grant assistance measure (of up to $A 650,000) was extended to accommodate all Category C grant-active Local Government Areas in Queensland.

March 4 The Assistant Treasurer announced an independent review into disaster insurance in Australia.

March 6 The Queensland Minister for Employment, Skills, and Mining and the prime minister announced the $A 83 million Queensland Natural Disaster Jobs and Skills Package.

March 7 The Australian and Queensland government signed the National Partnership for Natural Disaster Reconstruction and Recovery agreement. The Australian Government made an advance payment to Queensland of $A 1 billion.

March 23 The Australian Government announced the $A 8 million Natural Disaster Recovery Package (Caring for Country). The funding included the following:

- $A 4.9 million to 26 regional natural resource management organizations in disaster-affected areas to undertake environmental recovery works;
- $A 1.35 million to Conservation Volunteers Australia to coordinate and deliver assistance from volunteers for on-ground environmental recovery activities;
- $A 1.08 million to address immediate impacts of floods and cyclones on the Great Barrier Reef;
- $A 785,000 for restoration activities in the Gondwana and Wet Tropics World Heritage Areas to respond to impacts of flooding and rehabilitate species and areas affected.

April 6 The Prime Minister and Queensland Premier jointly announced a $A 39 million package of measures to support Queensland communities during their recovery from the flooding and Tropical Cyclone Yasi.

The specific activities being funded under the package were developed by the Queensland Department of Communities as well as Emergency Management Australia and were consistent with the NDRRA. The package included the following:

- $A 20-million Community Recovery Fund that provided Community Support Officers for 22 high priority communities as well as funding for community engagement, events, and memorials;

- Up to $A 10 million for mental health services and $A 5.8 million for financial counseling ;
- $A 2.5 million granted to 25 successful small business support groups to help them deliver additional services to assist disaster-affected small businesses.

The Minister for Small Business announced additional funding of $A 3.3 million under the Small Business Advisory Services program for disaster-affected small businesses.

April 15	The Australian and Queensland governments announced the $A 15 million Cassowary Coast Support Package. Funding was provided under the package to restore vital council infrastructure as well as natural vegetation and beach damage.
May 4	The Minister for Agriculture, Fisheries, and Forestry announced the extension of Rural Financial Counselling Services for another four years. This extension will be worth $A 54.9 million.
June 7	Australian Government made advance payment of $A 1.05 billion to Queensland.
June 9	The Minister Assisting the Attorney-General on Queensland Floods Recovery and the Queensland Premier announced that Rockhampton Regional Council would receive $A 900,000 as a reallocation of the Local Government Package for emergency repairs undertaken to the runway at Rockhampton Airport.
June 23	The Minister for Families, Housing, Community Services, and Indigenous Affairs approved $A 1.2 million to be used for mental health services in targeted communities.
August 18	The Prime Minister agreed to extensions to the Local Government Package, granting an additional $A 9 million to Grantham Council and $A 4.2 million for riparian environmental repair.
September 30	Assistant Treasurer and Attorney-General received the National Disaster Insurance Report.

Notes

1. This chapter uses the term *Australian Government* to refer to the government of the Commonwealth of Australia, Australia's federal government.
2. However, the arrangements do not apply to drought, frost, heat wave, epidemic, or disasters resulting from poor environmental planning, commercial development, or personal intervention (other than arson).
3. Equivalent payments for New Zealander Special Category Visa holders affected by flooding were made available ex gratia.
4. Newstart Allowance is an income support payment for people who are unemployed or who are classified as unemployed and are looking for work, who are participating in approved activities designed to facilitate entry to employment, or who are undertaking some work.
5. Youth Allowance is an income support payment for young Australians generally aged 16–20 and for full-time students or Australian apprentices aged 21–24.
6. All Australian jurisdictions are represented at COAG by their first minister and treasurer. COAG announcements are generally considered to have been agreed upon by all Australian governments.
7. A National Partnership Agreement (NPA) is one of the mechanisms by which Australian Government funds are provided to the states and territories. NPAs define the mutually agreed objectives, outcomes, outputs, and performance benchmarks or milestones related to the delivery of specific projects, improvements in service delivery, or reform. A copy of the NPA is available at the Australian Standing Council of Federal Financial Relations, http://www.federalfinancialrelations.gov.au.
8. Clause 22 of the NPA provides the annual percentage allocations as follows: 26 percent for New South Wales; 16 percent for Victoria; 23 percent for Queensland; 12 percent for Western Australia; 8 percent for South Australia; and 5 percent each for Tasmania, the Australian Capital Territory, and the Northern Territory.
9. A copy of the NSDR is available at the Council of Australian Governments, http://www.coag.gov.au.
10. The Standing Council on Police and Emergency Management (SCPEM) includes ministers responsible for emergency management from each Australian jurisdiction. SCPEM is responsible for reporting to COAG on progress implementing the NSDR.
11. Although responding to the 2010–11 Queensland floods required close cooperation among Australian, Queensland, and local governments, this chapter focuses primarily on experiences at the Australian Government level.
12. Three separate inquiries examined different aspects of the events: (a) the Natural Disaster Insurance Review, http://www.ndir.gov.au/content/Content.aspx?doc=home.htm;
(b) the Queensland Floods Commission of Inquiry, http://www.floodcommission.qld.gov.au/home; and (c) a House of Representatives Committees' Inquiry into the operation of the insurance industry during disaster events, http://www.aph.gov.au/parliamentary_business/committees/house_of_representatives_committees?url=spla/insurance/report/index.htm
13. http://www.treasury.gov.au/ConsultationsandReviews/Submissions/2011/Reforming-Flood-Insurance-A-Proposal-to-Improve-Availability-and-Transparency.

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Over the past 40 years, the Rio de Janeiro city government has undertaken a series of major steps to reduce the risk of landslides and repeated damage from storm-generated instability of the city´s many steeply sloping hillsides. This chapter presents key risk-reduction activities carried out by the city government (mainly by the GEO-RIO Foundation), with a particular focus on recent measures including risk mapping, improvements to the early warning system against landslides (Alerta Rio) and an extensive program of public works aimed at stabilizing the densely occupied slopes prone to landslides. This set of actions constitutes the city government´s risk management plan, which seeks to eliminate risk for the areas in greatest danger from landslides.

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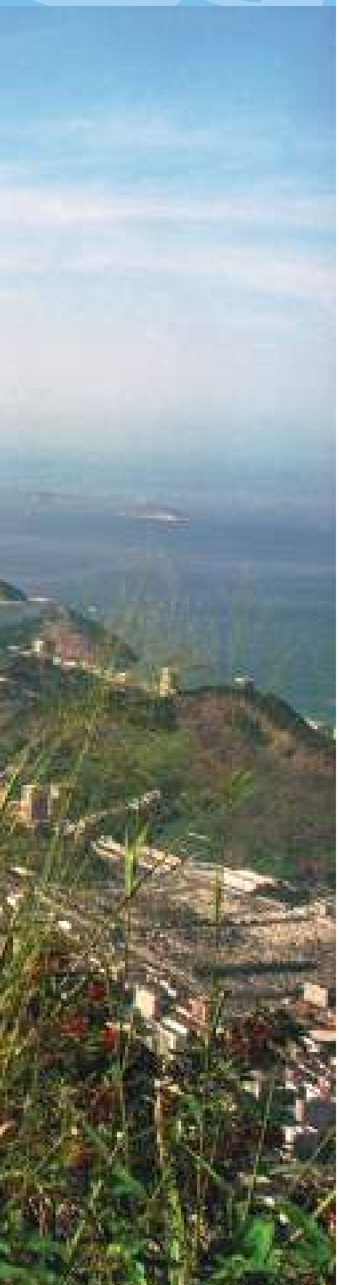


CHAPTER 4: Landslide Risk Reduction Measures by the Rio de Janeiro City Government

*This chapter is a submission of the Government of Brazil**

Introduction

To address the problems associated with landslides, the Rio de Janeiro city government has, for more than 40 years, called upon the services of the Institute of Geotechnics Foundation of the Municipality of Rio de Janeiro (commonly known as the GEO-RIO Foundation). This body, currently under the aegis of the Public Works Secretariat, was established on May 12, 1966, by Decree No. 609, signed by Ambassador Francisco Negrão de Lima, then governor of the state of Guanabara (which became the municipality of Rio de Janeiro in 1975). Although the institute was initially named the Institute of Geotechnics, it was soon given a typically informal name by the local Rio population: the Geotechnic or simply the IG.

The IG was established in response to strong popular demand for action following a period of exceptionally heavy rainfall that ravaged the city in January 1966. While these were not the heaviest rains recorded in Rio de Janeiro before then (box 4.1), up to 245 millimeters (mm) of rain fell over one 24-hour period, causing hundreds of landslides on the sloping hillsides of the city, leaving 70 people dead and 500 wounded. For a few days, the Cidade Maravilhosa (Marvelous City) experienced a serious public disaster situation with widespread national and international repercussions.

Box 4.1 Major Rainfall Events in the City of Rio de Janeiro

In the City of Rio de Janeiro, major rainfall events were as follows:

- September 1711
- April 1756
- February 1811
- March 1906
- January 1940
- January 1962
- January 1966
- January 1967
- December 1982
- March 1983
- February 1987
- February 1988
- February 1996
- February 1998
- January 1999
- January 2003
- December 2009
- April 2010
- April 2011

Source: GEO-RIO

The various statutory duties that the fledgling IG was to assume from 1966 included the preparation of long-term emergency plans for protecting the city's slopes against landslides. For this purpose, a group of technical experts, mainly civil engineers and geologists, was assembled. This group proceeded to dedicate unstinting efforts, day and night during the first few months after the events of January 1966,

*Ricardo d'Orsi, GEO-RIO Foundation

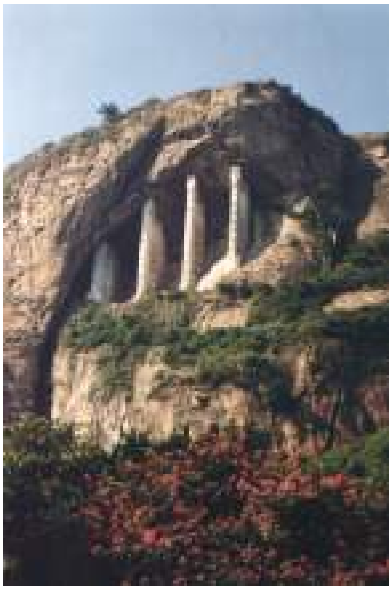


Photo 4.1: Corte do Cantagalo, Lagoa, Rio de Janeiro.

Photo 4.2: Av. Edson Passos, Alto da Boa Vista; Photo

4.3: Agulha do Ingá, Copacabana.

to formulate a realistic long-term plan for the city. The groundbreaking approach demonstrated by this new public body, based on the expertise and entrepreneurial flair of its technical staff, quickly led to its acknowledgment worldwide as a first-rate geotechnical agency.

In the IG´s early years, the city's population gradually grew accustomed to the various works being undertaken to shore up unstable slopes and hillsides. The earth-retaining structures, resembling sculptures in concrete and steel, appeared in large numbers in the most inaccessible places and were admired by the local population (photos 4.1–4.3). In addition to these initiatives, the recently established agency was also responsible for surveying and mapping the geological and geotechnical features of the entire Rio de Janeiro municipal area. Other areas of responsibility included ensuring that greater care and attention was applied to analyzing proposals submitted for the approval, licensing, and oversight of slope-retention projects and privately run quarries.

In February 1967, nine months after the agency was set up, and when the city had already begun to enjoy the first fruits of its efforts (39 slope-retention projects completed and pioneering methods developed for undertaking this kind of work in high and difficult-to-access areas), torrential rains again swept the city. This produced a new tragedy in which houses and streets in several neighborhoods were totally destroyed and 100 people lost their lives in landslides (photos 4.4). Notwithstanding the new problems arising from this tragic event, the IG succeeded in concluding another 50 stabilization works by the end of 1967 that significantly increased the safety levels of the slopes.

During the period between the creation of the IG and the emergence of the GEO-RIO Foundation (in 1992), the administrative status and title of the IG underwent a series of modifications. In 1973, for example, the agency was renamed the Superintendence of Geotechnics, and in 1975, after the merger of the states of Rio de Janeiro and Guanabara, it became known as the Geotechnical Board, subordinate to the Municipal Public Works Secretariat. In 1979 it was renamed the Superintendence of Geotechnics, and in 1986 it reassumed its former title as the Geotechnical Board.

Photo 4.4: Landslide in the Laranjeiras neighborhood, January 20, 1967, causing the deaths of about 100 people, with 300 injured.

Notwithstanding these various administrative and name changes, many of the members of its technical staff remained and continued to endow the agency with a unique knowledge of the problems involved in dealing with the city´s slopes and with a marked ability to promptly and accurately define and execute retention works. This relatively small group of public servants (box 4.2) has been, and continues to be, the agency´s greatest asset.

Box 4.2 GEO-RIO Foundation Staff Members, 2012

Currently, the GEO-RIO Foundation has 116 staff members:

- 43 engineers
- 9 geologists
- 3 architects
- 2 CAD operators
- 59 nontechnical staff members (administrative officers, lawyers, archivists, secretaries, and so forth)

In February 1988 (especially between February 18 and 21), more torrential downpours swept the city. In a short period of four days, around 449 mm of rain fell, with 177 mm recorded over a 24-hour period alone in various parts of the city, particularly in the neighborhoods on and around the Tijuca Massif (Maciço Montanhoso da Tijuca). The result was that hundreds of landslides left a death toll of 58. The landslides that caused the highest number of casualties occurred in the Morro da Formiga in Tijuca, in the Morro Santa Marta, Botafogo, and Santa Teresa. In the latter neighborhood, a catastrophic landslide caused severe damage to the Santa Genoveva Clinic. Once again, the IG was called upon to work day and night to respond to more than 1,200 requests from local residents for technical inspections to be urgently carried out on the slopes. Henceforth, the IG entered a period of rapid development, expanding its technical staff and executing a large number of slope-retention works. Together with the influx of new staff members, new technologies were introduced. The agency, while undertaking dozens of stabilization and drainage works, simultaneously began using new information technology to prepare the first risk map of the city of Rio de Janeiro. It also set up pilot programs to automatically monitor rainfall and geotechnical problems on the city's hillsides by radio link (the SIGRA project, Sistema de Instrumentação Geotécnica Via Rádio; Geotechnical Telemetric System).

The year 1996 can also be regarded as an important milestone in the history of the IG. During another period of heavy rainfall on February 13–14, 1996, a substantial number of landslides were triggered, mainly affecting the south and west zones of the city. Rainfall exceeding 190 mm over 7 hours was recorded in the districts of Alto da Boa Vista and the Jardim Botânico. Fast-moving debris flows, with enormous destructive potential, came down from the upper slopes of the Tijuca (photo 4.5) and Pedra Branca Massifs, destroying hundreds of homes and causing the deaths of 52 people. As a direct consequence of this catastrophe, the IG (henceforth known as the Institute of Geotechnics Foundation of the city of Rio de Janeiro, or as the GEO-RIO Foundation, or simply as GEO-RIO) experienced a new influx of technicians and investment. After 1996, GEO-RIO, in addition to its day-to-day functions, underwent a further development phase: new stabilization techniques were tested and applied, using alternative materials such as old tires and vegetable fibers; methods for geological-geotechnical and risk mapping on a larger and more detailed scale were developed and executed in dozens of populated slopes; physical demarcation of risk areas was implemented; and experiments were begun with a pioneering alarm system that would provide early warning of heavy rains and possible landslides. The Alerta Rio system is now a national and international reference point for public warning systems.

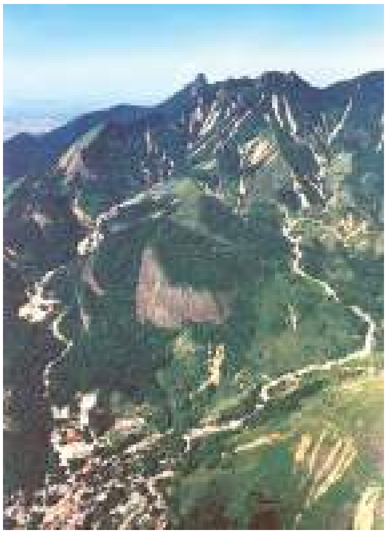


Photo 4.5: Aerial views of the massive debris flows that occurred in February 1996 in the Tijuca Massif, causing one death and substantial material damage.

With more than 40 years of direct experience of geological and geotechnical problems in Rio de Janeiro, and with accumulated expertise in the steeper areas typical of the city´s unique mountainous terrain, the GEO-RIO Foundation has conscientiously continued to fulfill its designated functions over the years, including planning and executing earth retention civil works throughout the risk areas of the city. In 2009, GEO-RIO completed its 3,000th retention work. Fully committed to improving the population´s quality of life and contributing to better urban planning, GEO-RIO´s technical staff has made every effort to continue to maintain its high-quality services and interventions (that is, civil works) in Rio de Janeiro. It is however important to note that while the works undertaken by GEO-RIO have contributed substantially to reducing the risks arising from landslides on the slopes in the so-called formal part of the city, the same does not apply to the informal areas of the city (poorer communities and informal urban settlements). In those areas, population density has expanded at a faster rate than the city government has been able to deploy projects, and the number of potential risk situations has continued to grow. Increased population density has not only produced a substantial environmental liability, destroying vegetation on the slopes and generating siltation and other forms of pollution in the formal part of the city, but also multiplied the number of high-risk areas, with thousands of people now directly threatened by the unstable condition of the steep hillsides.

On April 6–7, 2010, Rio de Janeiro and several neighboring municipalities were again the victims of extreme weather conditions. More than 250 mm of rain in a 24-hour period were recorded in several of the city´s rain stations (table 4.1) and hundreds of landslides occurred throughout the city (photos 4.6–4.8). As a direct consequence, 67 people were killed, hundreds of houses were destroyed, and vast stretches of road in various parts of the city and surrounding areas were partially ruined, causing heightened public concern and a substantial amount of material damage.

Table 4.1 Extreme Rainfall Event in Rio de Janeiro, April 6 and 7, 2012 *millimeters*

Rain station	Maximum rainfall in 24 hours	Rain station	Maximum rainfall in 24 hours
Vidigal	252.0	Jardim Botânico	288.2
Urca	159.6	Barra/Itanhangá	204.2
Rocinha	290.6	Cidade de Deus	161.4
Tijuca	269.8	Barra/Riocentro	195,0
Santa Teresa	233.8	Guaratiba	106,0
Copacabana	210.0	Santa Cruz	149.0
Grajaú	224.2	Grande Méier	255.8
Ilha do Governador	200.8	Anchieta	132.6
Penha	226.2	Grota Funda	227.6
Madureira	167.6	Campo Grande	137.2
Irajá	126.4	Sepetiba	164.6
Bangu	130.8	Av. Brasil/Mendanha	126.2
Piedade	181.6	Recreio dos Bandeirantes	188.6
Jacarepaguá/Tanque	165.4	Laranjeiras	211.4
Saúde	183.4	São Cristóvão	209.6

Source: GEO-RIO
Note: Maximum rainfall recorded at the rain stations of the city government's Alerta Rio System.

Photo 4.6: Morro dos Prazeres (14 fatalities).

Photo 4.7: Ladeira do Ascurra in Laranjeiras;

Photo 4.8: Estrada da Guanabara, linking Prainha to the Praia de Grumari.

A few days after the April 2010 disaster, when emergency activities were still in progress, the city's mayor, Eduardo Paes, tasked his team with producing a program of initiatives targeted at urgently reducing the risks associated with landslides. This program was to be long lasting, highly effective and targeted, once and for all, at making the slopes less vulnerable, at dealing effectively with the aftermath of landslides, and at enhancing the ability of the city as a whole to react even more positively to extreme rainfall events.

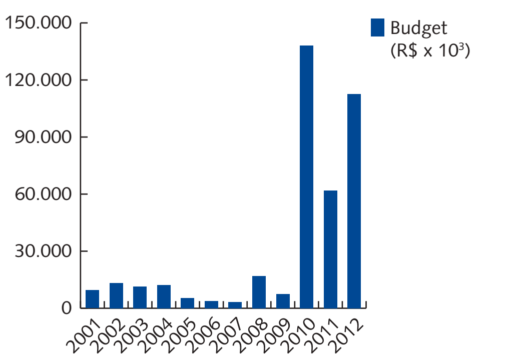
The Risk Reduction Action Program presented to the mayor by the GEO-RIO Foundation includes the following:

- Mapping of the "susceptibility to landslides" of areas throughout the entire municipal area of Rio de Janeiro (approximately 1,250 square kilometers [km2]) on a scale of 1 to 10,000;
- Qualitative mapping (low, average, and high) of the risks associated with landslides on a scale of 1 to 2000 (presented in georeferenced orthophotos on a scale of 1 to 5000) of the Tijuca Massif area and environs (approximately 120 km²), the most densely occupied area in the city, with the highest number of poor communities housed on steep hillsides;
- Improvement of the Alerta Rio system by expanding the number of technicians; updating technical equipment and programs; and purchasing, installing, and operating a weather surveillance radar system to be installed within the city limits;
- Installation of an audible early warning (siren) system linked to automatic rain meters in the poorer communities on the slopes where high-risk areas have been identified in the risk maps of the occupied parts of the Tijuca Massif and surrounding areas. These installations are to be undertaken in parallel with identifying safe emergency assembly areas (for example, schools) within the communities and with training the population (to be carried out by the Municipal Civil Defense Force);
- Deployment of projects and emergency works for stabilizing areas that are still subject to landslides following the storms of April 2010, and preparation of stabilization projects (including costs surveys) targeted at eliminating high-risk conditions in the communities mapped;
- Execution of the aforementioned work for eliminating high-risk situations in the communities mapped;
- Removal of dwellings in the areas identified in the mapping exercises as being at high risk and that have not received stabilization works (which would be unviable from a cost-benefit viewpoint);
- Removal of the audible warning systems from communities where high-risk situations have been eliminated.

This risk-reduction program presented by GEO-RIO was approved in its entirety by the mayor and work started in May 2010 on its implementation. The implications in budget terms were enormous (figure 4.1), with the annual budget of GEO-RIO increasing more than 10 times. This confirms the wisdom of the risk-reduction program adopted by the city government. Moreover, it enhances the commitment of the GEO-RIO Foundation to the people of Rio de Janeiro and confirms GEO-RIO´s technical and administrative status to carry out the planned work.

Details of the interventions planned in the GEO-RIO program are presented in the following sections.

Figure 4.1 Annual Budgets of the GEO-RIO Foundation

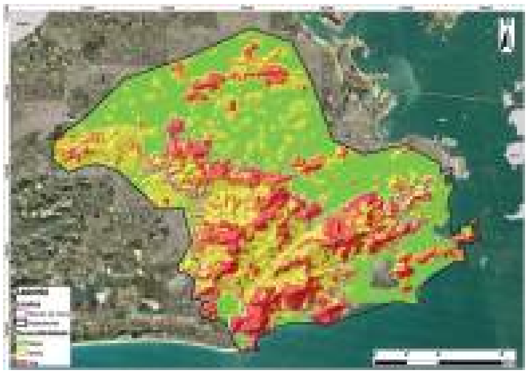


Source: Authors.
Note: In R$, millions
The 2012 budget is a forecast done in March 2012.

Landslide Susceptibility Map of the City of Rio de Janeiro and the Risk of Landslides in the Tijuca Massif and Environs

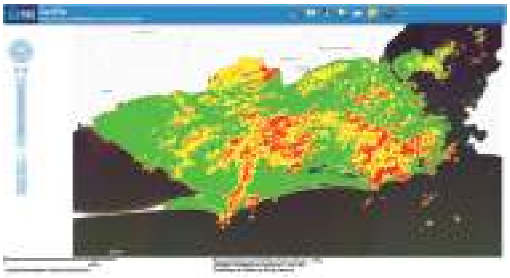
The Landslides Susceptibility Map of the City of Rio de Janeiro was designed to cover the entire municipal area on the scale of 1 to 10,000. Although a task of this size had already been carried out by GEO-RIO in 1989 (on a scale of 1 to 25,000), it was important to prepare a similar map, but on a larger scale and with better resolution, given that geoprocessing resources had developed substantially since then. The methodology used on both occasions, although fairly similar, basically involved cross-referencing different layers of information to arrive at a weighting matrix, pixel by pixel. For the above-mentioned new map, a number of thematic maps were either developed or adapted (for example, contour maps of slopes; geomorphological, geological-geotechnical, geological, and land-use maps; maps detailing Permanent Environmental Protection Areas, and nonbuilding areas according to the Code of Works, together with maps indicating the occurrence of landslides). Susceptibility to landslides was ranked on three levels: high, average, and low. Maps 4.1 and 4.2 present a general idea, including an area in detail, of the susceptibility map.

Map 4.1 Landslide Susceptibility, Tijuca Massif and Environs



Source: GEO-RIO
Note: Green = low susceptibility; yellow = average susceptibility; red = high susceptibility

Map 4.2 Landslide Susceptibility, City of Rio de Janeiro



Source: GEO-RIO
Note: Green = low susceptibility; yellow = average susceptibility; red = high susceptibility

The area most densely occupied by slums in Rio de Janeiro is in and around the Tijuca Massif. This area, together with the Complexo do Alemão and Penha Branca, was chosen for detailed landslide risk mapping. These three areas amount to about 70 percent of the poor areas occupying steep hillsides in the city. A total of 196 slums were mapped; 116 of these contained occupied areas identified as having high susceptibility to landslides—areas at very high risk. In addition to the mapping exercise, GEO-RIO undertook an emergency inventory of the actual dwellings at high risk. These amounted to about 18,000 units. The risk from landslides was ranked qualitatively at three levels: high, moderate, and low. The fieldwork was launched over a georeferenced orthophoto on a scale of 1 to 5000 (map 4.3), also using a topographic map on a scale of 1 to 2000. In each of the communities studied, a description was prepared of the situations and processes involved in the existing unstable areas and those areas that were potentially unstable. This description included geological and geotechnical schematic sections in the hope of improving understanding of the problems, clarifying the demarcated risk areas, and revealing the total number (by orthophotography) of homes at risk in each of the sectors.

The preparation of the risk maps made full use of the information assembled in the course of fieldwork. This information described, geologically and geotechnically, the risk situations to confirm the usefulness of the stabilization projects designed to eliminate these risks, while substantiating the information contained in the Intervention Plans (map 4.4). Once the fieldwork had been completed, it was found that of the 196 slums inspected, 116 possessed areas with a high risk of landslides. These areas contained a total of 20,197 dwellings distributed over 393 hectares. This amount, previously unknown with this degree of accuracy, clearly showed the size of the problem to be faced by city managers. In reality, taking steps to deal with over 20,000 houses posed a major challenge to be addressed: the need for the drastic and urgent reduction of the number of houses at high risk over the shortest possible time frame.

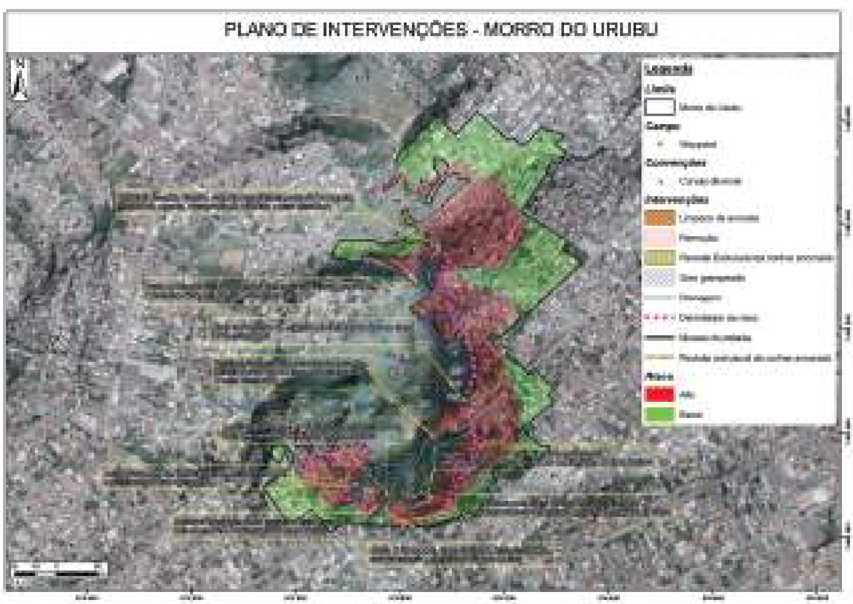
Aerial Photos with Laser Profiling

During the above-mentioned mapping exercises, an aerial survey was made to obtain a digital terrain model through laser profiling. This resulted in a visual rendering of the present contours of the area, without showing vegetation and the like. This is not practical when using conventional methods of aerophotogrammetric restitution but is essential for obtaining a clear picture of the morphology of the slopes. The final product was used as a topographical

Map 4.3 Risk Map, Morro da Formiga

Source: GEO-RIO

Map 4.4 Intervention Plan Prepared by GEO-RIO for 116 Poor Communities Occupying Hillsides Containing Areas Subject to High Risk of Landslides



Source: GEO-RIO

baseline for defining mitigation projects for the high-risk areas. The chosen method ensured that the contours of areas of potential risk were precisely defined, given that the mesh points used in the aerial survey had a minimum sampling density of 10 dots per square, which resulted in contour lines at 0.5 meter intervals. This exercise was undertaken only in the area of the Tijuca Massif (105 km² of area covered).

Audible Early Warning Alarm System in Communities Containing Sectors Mapped As High Risk for Landslides

Unlike other interventions designed and deployed as "permanent" fixtures, the audible early warning alarm system is designed to be temporary. The sirens are to be uninstalled from communities where high-risk areas have been eliminated through stabilization works, or by the removal of dwellings, when the civil works cost-benefit analyses show that the advantages to be gained from undertaking works are not outweighed by any perceived direct benefits (protection of homes) and indicate removal as the best option. In terms of equipment, the system comprises remote stations positioned in communities in accordance with the directions pinpointed on the risk maps prepared by the GEO-RIO Foundation. The overriding technical aim has been to ensure the deployment of a robust, weather-resistant system that is accurate, trouble free, and endowed with backup facilities, so that temporary evacuation of homes can be achieved during severe weather events (that is, rainfall greater or equal to 40 mm accumulated over one hour and forecast rainfall of above 5 mm per hour for the next few hours).

During the first stage of the system's installation, 117 siren stations were deployed, of which 58 were equipped with automatic rain gauges or meters (pluviometers). These rain gauges record and transmit data to the Municipal Operations Center (CO-Rio) at regular intervals of 15 minutes, uninterruptedly, so that critical rainfall can be monitored in the communities with high-risk areas.

The equipment used in the stations consists of data storage and processing modules linked to telemetric transmission modules for the remote activation of the sirens. Uninterrupted power supply modules using conventional electricity mains are backed up by batteries and "no-break" devices.

A typical self-reporting remote audible alert station with a rain gauge comprises the following: protective casing; data logger with a modem for cellular telephony, without the need for operator intervention; preamplifier; power amplifier; directional antenna for mobile phone; horn-type sirens; "tipping-buck'" type rain meter in stainless steel with an accuracy of 0.2 mm; and, finally, battery, cables, connectors, and an uninterrupted source of electricity with a no-break device in the event of total power failure.

The remote stations are connected to the central station in the CO-Rio and monitored by software programs specifically developed for this purpose. During rain-free periods, the amplifiers are disconnected, although the rain gauges continue to operate normally, sending their data on a regular basis. During rainy periods, the system can be triggered remotely, with the activation of the preamplifiers and power amplifiers.

In the event of a communication failure, the emergency evacuation message can be triggered manually with a coded key installed on the underside of the housing cabinet containing the equipment.

Training the Population

Following the deployment of the alarm system, the Municipal Civil Defense Force provided appropriate training for the residents in each of the communities protected by the system. The process can be summarized as follows:

- A course, restricted to community residents and lasting several weeks, for contracting and training civil defense agents was organized. The agents are intended to serve as arms of the Civil Defense Force and be responsible for assisting people living in the high-risk areas to vacate these areas quickly and direct them to the prearranged assembly points or shelters. The local agents possess a unique knowledge of the areas where they live, of the people living there, and of the location of the areas considered to be at high risk from landslides. Each agent is supplied with a mobile telephone by the city government to enable communication with the Civil Defense Force as well as to receive short message service (SMS) messages when severe weather threats are imminent and there is a high probability of the sirens being triggered. The agents are also responsible for manually activating the sirens in the event that remote activation by CO-Rio is not possible.
- Simulated emergency evacuations were organized involving community residents being moved to the designated shelters after activation of the alarms. Before the practice exercises got under way, the instructions to "stand by" were widely broadcast to the local population by means of pamphlets, posters, newspapers, radio, television, and so forth.
- The emergency assembly stations (shelters) in the communities were defined, prepared, and identified with signs as well as the escape routes to be used for proceeding from the high-risk areas to the shelters.

Since it was installed at the end of the first phase in 2011 and up to the middle of March 2012, the alarm system has been triggered three times, with excellent results. A typical case occurred during a storm that hit the community of the Morro de Formiga (in the Tijuca area) on the night of April 25, 2011. A landslide destroyed a home without harming the residents who were awakened by the alarm and were able to evacuate their home a short time before it collapsed and was swept away. Photo 4.9 shows some of the main aspects of the audible warning system.

Photo 4.9: Sirens and rain meter in the remote alarm unit in the Morro da Formiga community. The equipment was installed on the terrace of a local school, also used as a temporary refuge in the event of extreme weather.

Improvements in the Alerta Rio System

The main purpose of the Alerta Rio system is to issue emergency bulletins to warn of heavy rains and landslides affecting, or likely to affect, people living on steep hillsides and slopes in the city. This is a public service utility organized by the Rio de Janeiro city government and designed and deployed by the GEO-RIO Foundation in October 1996. The system has been in continuous operation since then, under the constant supervision of GEO-RIO. The system possesses a telemetric network of 33 stations located throughout the municipal area. These stations contain gauges and other meteorological sensors (wind, humidity, temperature, and air pressure) that collect relevant data automatically and uninterruptedly at regular intervals of 15 minutes. The data, once collected, are immediately dispatched to a central computerized station to permit continuous monitoring of the type of critical rainfall likely to trigger landslides. The Alerta Rio system functions 24 hours a day, seven days a week, with a dedicated staff of meteorologists, geologists, engineers, and technical-level personnel to run the system and maintain the equipment. Technical labor is supplied under a special contract (put out to tender every four years) for operating the central station and for maintaining and updating the equipment installed throughout the system.

Before 2010, the central station of the Alerta

Photo 4.10: Weather radar belonging to the city of Rio de Janeiro.

Map 4.5: Sample of a radar-generated image (generated every two minutes). The reflectivity scale is directly related to the amount of rainfall. Green signifies *light rain* and red *heavy rain*.

Rio system was located on the premises of the GEO-RIO Foundation. All the data generated by the system were stored there, and all communications related to extreme weather events that threatened to trigger landslides were issued from the GEO-RIO building. While this building possessed a good information technology network and electrical installations, it lacked a heavy-duty emergency system for generating electricity. Although the building was designed to function only during working hours, the central station nevertheless remained operational 24 hours a day despite a number of infrastructural deficiencies. A further drawback was that in the 10-year period from 2000 to 2010 the operations station had access to images from only a single weather radar belonging to the Air Force Command, used by the Brazilian Air Force (FAB) for flight control. This radar is installed on the Pico do Couto (municipality of Petropolis-RJ) at an altitude of approximately 1,800 meters, about 60 km from the city center.

With regard to implementation of the risk reduction program proposed by GEO-RIO, two interventions positively affected the performance of the Alerta Rio system. The first was the procurement and installation of its own weather radar facility (photo 4.10 and map 4.5), installed on the Morro do Sumaré, at an altitude of about 600 meters (within the city limits). This development substantially upgraded the accuracy of rainfall forecasting because the new radar could detect rainfall nuclei that previously were not captured by the Pico do Couto radar, given its altimetric positioning (the Pico do Couto radar recorded rainfall only occurring above the altimetric quota of 1,800 m). Moreover, the images from the radar belonging to FAB were available for consultation by the Alerta Rio meteorologists only at intervals of between 15 and 20 minutes, a period regarded as too long for the purposes of weather surveillance and damage reduction. With the acquisition of its own radar, the Rio de Janeiro city government can now access images generated every two minutes, spotting and recording rainfall originating at altitudes of between 600 meters and 1,800 meters that would be beyond the capabilities of the FAB's Pico do Couto radar.

The second significant development affecting the Alerta Rio system was the transfer of its central station in December 2010 to CO-Rio (photo 4.11). This move facilitated and significantly improved the weather analyses (very-short-term forecasting) and the speed at which information could be disseminated (Alert Bulletins), both internally in CO-Rio and externally for the benefit of the population in general, given that radio and television broadcasting stations also had staff working in the Operations Center. Thus, when critical rainfall indexes are reached or are imminent, all the municipal departments in CO-Rio and broadcasters from

Photo 4.11: CO-RIO, City Government Operations Center

the main radio and television stations have immediate access to, and use of, this information. Meanwhile, the Alerta Rio system has kept up its routine dissemination of information, using a variety of communication channels (e-mail, SMS, twitter, radio, mobile phones, and so on) and updating in real time all the data on its Internet site (http://www0.rio.rj.gov.br/alertario). As a result, anybody, at any time of day or night, can access the information free of cost.

Since the Alerta Rio system moved to CO-Rio, new technologies have begun to be tested and deployed, such as the high-resolution weather forecasting program (PMAR), developed by IBM especially for Rio de Janeiro. Another innovation is the lightning detection system known as StreamerRT, developed by Earth Networks, from which highly satisfactory results have been obtained for assisting with short-term weather forecasting. Furthermore, a number of internal protocols (general operation, defining of alert levels, and dissemination of weather reports) relevant to the Alerta Rio operation have been revised and improved, the team of meteorologists expanded, backup equipment improved (to correct faults in the rain gauge network, meteorological radar, and so forth), and the analyses of the correlations between the rainfall and occurrence of problems affecting the city intensified. It is worth emphasizing that these rainfall-related correlation studies are undertaken thanks to the rainfall databank that has been generated and maintained by the Alerta Rio system for the past 15 years and that, by March 2012, had logged 16.8 million precipitation entries. This feature is certainly one of the key differentiating factors of the Alerta Rio system, because it enables a large number of analyses to be made, including, for example, correlations of rainfall with forest fire risks, with the quality of seawater along the beaches, and with the average traffic speeds along the main highways in the city, and, of course, with the potential landslides on slopes and steep hillsides. The geologists and engineers at GEO-RIO are responsible for all of these tasks.

The improvements in the Alerta Rio system planned and carried out by GEO-RIO have had a positive effect on the quality of different aspects of this service supplied by the city government. Improvements range from an upgraded modus operandi of the rain gauge network (currently above 99.5 percent effective) to better rainstorm and landslide warning bulletins (now more than 85 percent accurate) delivered to a growing audience. All these improvements have helped reduce the damage associated with adverse weather events in Rio de Janeiro, especially the type of weather likely to cause landslides in the high-risk areas.

Undertaking Projects and Emergency Stabilization Works after Extreme Rainfall in April 2010

Emergency Works

A significant number of emergency works undertaken by GEO-RIO following the storms of April 2010 focused on the large number of landslides on the slopes or embankments (upstream and downstream) bordering the main roads that cut through the city´s unique mountainous terrain. Examples of such works were those along the Avenida Menezes Cortes, Avenida Edson Passos, Estrada das Furnas, and Estrada da Grota Funda.

The majority of the emergency interventions were carried out in 2010 in parallel with risk-mapping exercises and laser profiling in the slum communities. Beneficiaries of these interventions were principally the poorer areas where landslides had been triggered during the storms of April 2010 and where the scars of the debris flows still directly threatened a large number of homes. The various types of interventions undertaken included constructing cable-stayed structures (steel shoring mesh, grills, buttresses and so on), fragmenting boulders (hot and cold method), installing drainage systems and anti-erosion surface protection, erecting impact structures, and removing homes in imminent danger of collapse. A total of 1,650 housing units benefited from these interventions, and the risks were eliminated in many places, or at least mitigated to low and very-low levels. Thanks to these emergency measures carried out by GEO-RIO, the number of homes at risk highlighted in the risk inventories (Map of Susceptibility to Landslides in the City of Rio de Janeiro and the Risk of Landslides in the Tijuca Massif and Environs) was reduced to 18,547.

Projects and Works for the Areas Mapped as High Risk

Work on project design for the civil works needed to eliminate the risk from areas already mapped and marked as high-risk is scheduled for completion in 2012. Since its inception the project development phase has involved substantial effort by the GEO-RIO Foundation design team to meet the tight deadlines, and the number of projects in the pipeline may appear to be excessively large, particularly in view of the limited size of the team. The diversity of the geotechnical situations (each calling for tailored solutions), together with the problems of access to the localities (some of which, in addition to being perched on the top of very steep slopes, are also difficult for staff members to approach for personal security reasons) and the shortage of basic data (for example, topographical surveys) to assist project design, has turned this task into a major challenge. To face some of these problems, GEO-RIO has contracted for certain technical support services (geotechnical investigations, soil testing specialists, and so forth) to speed up the on-the-ground deployment of the projects designed by GEO-RIO experts. It is important to note that the risk-mitigation analyses have also encountered situations for which geotechnical stabilization has been totally unviable given the unfavorable cost-benefit ratios. The most appropriate solution has been the removal of the housing units from many of these places. By March 2012, the design work for 62 of the slums mapped as possessing high-risk areas had been concluded. In three slums, risk elimination works had already begun. Table 4.2 summarizes the type and number of key interventions planned for 62 communities.

City Government Operations Center

The City Government Operations Center—CO-Rio—can be considered as opening a special chapter in the recent risk management program implemented by city authorities. The headquarters of CO-Rio was built in record time (six months) in the Rua Ulisses Guimarães, No. 300 in the Cidade Nova neighborhood, less than 100 meters from the two principal municipal public buildings housing the city´s technical, administrative, and financial divisions. In this ultramodern building, CO-Rio was able to deploy various high-technology methods to bring together about 30 bodies of the city administration (for example, civil defense, traffic, conservation, municipal guard, and so on) and a number of key utility and service concession holders (for example, light, metro, LANSA, Rio-Niteroi bridge, and so on), all of which are customarily and directly involved in responding to the problems caused by severe weather events in the city.

CO-Rio´s infrastructure includes a computer network, protection against electrical breakdowns, access to high-speed Internet, and full backup telecommunications systems. The CO-Rio building possesses, in addition to individual offices for each sector, a crisis room,

Table 4.2 Main Interventions Planned for Mitigating Risks in 62 Slums with the Largest Number of Homes at High risk

Intervention	Number
Removing houses (units)	2,100
Steel retaining mesh to be installed (m^2)	176,500
Nailed green soil to be installed (m^2)	4,500
Rock blasting (m^3)	15,600
Estimated concrete requirement (m^2)	17,000
Impact barriers (m^2)	163,000
Types of retaining walls (m^2)	51,000
Buttresses (units)	150

Source: GEO-RIO
Note: m^2 = square meter; m^3 = cubic meter.

meeting rooms, an auditorium, a canteen, and space for in-house maintenance teams. For CO-Rio to function 24 hours a day, 7 days a week, 400 professional staff members are needed, working in three shifts over 24-hour periods. The data generated by the various divisions are assembled in the control room. This room has the largest screen (video wall) in Latin America, with 80 linked-in monitors. CO-Rio is in fact the first of its kind in the world to bring all the necessary crisis management practitioners together under one roof. When heavy rain is imminent or when rainfall in the city is reaching critical levels, the relevant information is immediately shared with all the bodies, agencies, and utility companies in the building. For their part, the entities trigger their own action protocols depending on the type of threat.

Given its size, CO-Rio, initially designed to operate only in crisis situations, has begun to act as a kind of general headquarters for the city and has a core mandate to anticipate solutions and minimize events likely to adversely affect the life of the city.

Conclusion

During the crises that assailed his term of office, U.S. President John F. Kennedy used to say that the word crisis consisted of two characters when written in Chinese: one character represented danger and the other opportunity. In April 2010, Rio de Janeiro faced one of the biggest crises in its recent history. Since then, the actions undertaken by the city government to reduce risks caused by landslides have shown that the "opportunity" certainly existed to substantially improve risk management. The methodological approach adopted by GEO-RIO (the city government´s main instrument for combating geological and geotechnical risks) in May 2010 has already begun to produce satisfactory results: a significant reduction in the number of landslides and a total absence of fatalities resulting from the 65 landslides recorded by GEO-RIO in Rio de Janeiro between May 2010 and March 2012.

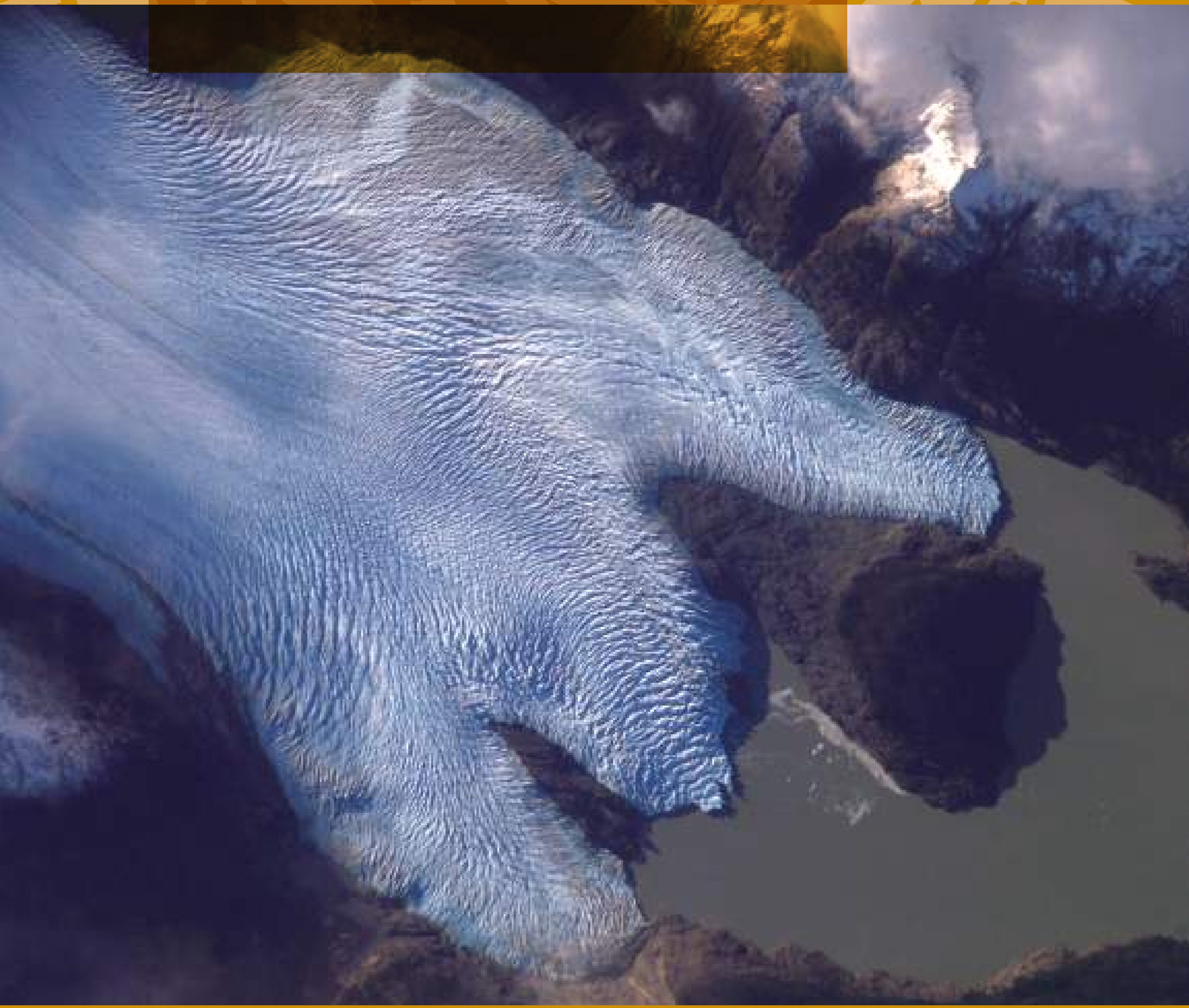
The temporary installation of an alarm system in the poorer settlements with high-risk areas has already saved lives,[1] and the rainfall warning bulletins issued by the Alerta Rio system have significantly reduced the damage caused by storms and heavy rains, given that the population and the public authorities in general have had more time to prepare for, and deal with, flooding or landslides in the vulnerable areas of the city. Note that since April 2010, a number of very substantial rainfall events (more than 50 mm per hour) were recorded along the different roads cutting through the mountainous terrain (the massifs) of the city without triggering any new landslides. In short, the city of Rio de Janeiro has demonstrated that it is well prepared, less vulnerable, and more resilient in its approach to adverse weather events. If one considers the short, medium, and long-term prospects, the recent risk-reduction interventions implemented by the city government have placed Rio de Janeiro in a leading position nationally. This has sparked visits to the headquarters of GEO-RIO, the Municipal Civil Defense Force, and CO-Rio by technical representatives of city governments, state governments, the federal government, and even from foreign governments. It is worth noting also that positive reports covering GEO-RIO´s performance have appeared in the print media and on national and international television.

The Rio de Janeiro risk reduction program is still at an early stage and therefore much remains to learn and improve. Nevertheless, through persistence with the current management approach, errors (and their associated costs) will undoubtedly be much reduced. The city of Rio de Janeiro has begun to emerge as a model in the area of risk reduction. This has generated a feeling of hope and enthusiasm among the staff members employed by the city government, especially those in GEO-RIO, who are confident that Rio de Janeiro, the "Marvelous City," can be assured of a safer future in terms of protection from extreme weather events and their consequences.

Notes

1. Veja, "Brasil: Tecnologia melhorou reação do Rio à enchente," http://veja.abril.com.br/noticia/brasil/tecnologia-melhorou-a-resposta-da-cidade-a-enchente.

This chapter focuses on the description and analysis of risk reduction strategies implemented in Chile after the major catastrophe that affected the country's most populated areas on February 27, 2010. Starting from a broad view of the scope of the disaster, the chapter moves to the role of the Ministry of Housing and Urban Development's Reconstruction Plan as a blueprint for the recovery process, and on to the risk reduction criteria and actions applied to improve resilience in urban areas exposed to natural risks, such as landslides and tsunamis, implemented in the main Chilean coastal cities with high-risk exposure that were severely damaged by the tsunami of 2010.



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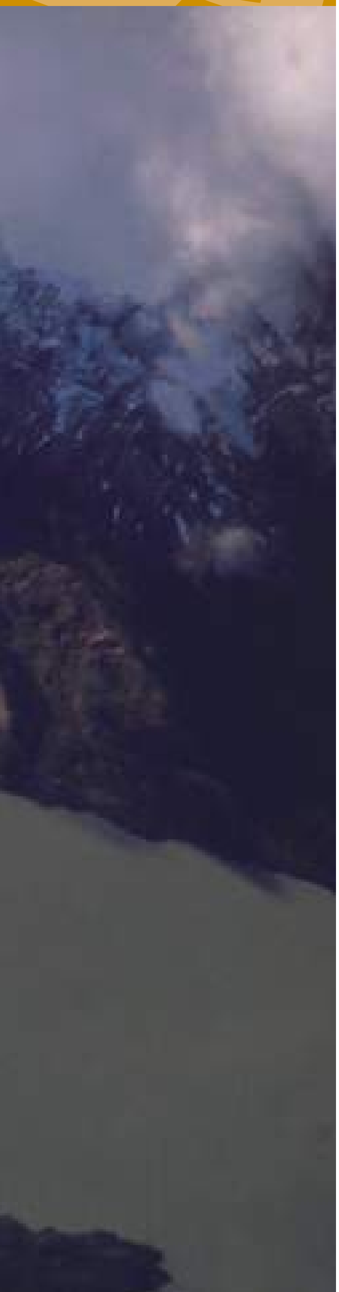

CHAPTER 5:

Building Resilience: Risk Models and Urban Planning

The Case of Chilean Coastal Cities' Reconstruction after the Earthquake and Tsunami of February 27, 2010

*This chapter is a submission of the Government of Chile**

Introduction

Chile is one of the many countries located in the Pacific Ring of Fire. It has more than 6,000 kilometers of coastline and specific geographic conditions that give it an extreme landscape involving a high exposure to natural hazards.

At 3:34 on the morning of February 27, 2010 (06:34 UTC), an earthquake of magnitude Mw 8.8 occurred off the south-central coast of Chile, with intense shaking lasting for more than 3 minutes (known as the "27F disaster"). It ranks as the sixth-largest earthquake ever to be recorded by a seismograph. It was felt strongly in six Chilean regions (over 630 kilometers in length, from Valparaíso in the north to the region of Araucanía in the south), affecting about 80 percent of the country's population.

The earthquake triggered a tsunami that devastated several coastal towns in south-central Chile and severely damaged the port of Talcahuano. The total cost of the damage produced by the disaster is estimated at US$30 billion, equivalent to 18 percent of the gross national product.

The earthquake and tsunami dramatically modified the territory, especially in the lowest coastal areas. Whether and how these high-risk areas should be redeveloped or inhabited are significant urgent questions that must be addressed by the Chilean government. This reality requires a proactive approach that incorporates risk assessment, risk mitigation infrastructure investments, and definition of land use conditions in these high-risk coastal areas.

In terms of criteria, the Chilean constitution restrains the delivery of reconstruction subsidies[1] to sites that are known to present a risk to life; however, knowing the attachment to the land and the long-standing cultural tradition of coastal communities, the government is loath to hinder reconstruction in these areas. Furthermore, acknowledging and understanding risk should be considered part of the responsibility of every government and society. Thus, this reconstruction process is considered the starting point to establish a public risk modeling platform which brings together government, academia, and civil society, estimating impacts of future disasters and developing risk reduction strategies to create better-prepared, resilient cities.

The 27F disaster taught Chile a hard lesson in terms of territorial and urban planning, the lesson that it must learn to plan its cities knowing and managing the natural risks to which the particular geography of the country creates permanent exposure. To face this challenge, the government implemented an action plan that consists of an integrated strategy, one that overlaps different types of risk mitigation measures and regulation while respecting coastal citizens' freedom and residence choices.

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The strategy to achieve a safe and responsible return to inhabit the coastal cities promoted by the Chilean government can be summarized in the following steps:

- First, develop risk assessment reports and tsunami simulations in flooding areas with the main objective of establishing differentiated risk zones, and disseminate that information among the population.
- Second, update the existing zoning plans and ordinances for all coastal municipalities and localities with risk conditions based on the risk analysis and the changes in the territory produced by the last earthquake and tsunami.
- Third, reduce future tsunami impacts in the reconstruction of urban areas exposed to high-risk conditions, targeting public investment for constructing mitigation projects when necessary.
- Fourth, define zones combined with special construction rules and suitable financial tools to promote the construction of tsunami-resilient designs for housing projects.
- And finally, complement all these measures with emergency plans, including actions such as the definition of evacuation routes and safe areas, added to prevention plans, thereby improving hazard awareness education to ensure a quick response from the population.

To guarantee a comprehensive holistic approach, the Ministry of Housing and Urban Development (Ministerio de Vivienda y Urbanismo, MINVU), with the collaboration of a series of public and private entities, prepared 25 master plans for the main urban centers located in the coastal area that was affected by the tsunami. Each master plan integrated risk assessment reports and modeling of tsunami propagation and inundation for several source scenarios, among projects and mitigation works, evacuation routes, zoning, and incentives for the construction of tsunami-resilient housing projects.

The challenge is not only about housing reconstruction but also about planning future cities and implementing strategies to minimize loss provoked by natural hazards. The reconstruction started with a sense of opportunity, delivering better standards and thinking for a national upgrade, going from reconstruction to reinvention.

If governments, communities, and individuals in hazard-prone areas are better prepared to manage disasters effectively, impacts and losses can be reduced. To help reach this goal, this chapter aims to disseminate the lessons learned by Chile during the last earthquake, specifically in the field of risk assessment combined with urban planning.

Overview

Nowadays, global awareness about the risks of natural disasters is increasing, and mitigating the damaging effects of those risks is becoming a global priority. Implementing different strategies for risk mitigation can help minimize the extreme damage associated with disasters in terms of human and financial costs. This chapter focuses on the description and analysis of risk reduction strategies implemented in Chile after the last major catastrophe that affected the country's most populated area. Starting from a broad view of the scope of the disaster, the chapter moves to the role of the Ministry of Housing and Urban Development's (Ministerio de Vivienda y Urbanismo, MINVU) Reconstruction Plan as a blueprint for the recovery process, and on to the risk reduction criteria and actions applied to improve resilience in urban areas exposed to natural risks, such as landslides and tsunamis, implemented in the main Chilean coastal cities with high-risk exposure that were severely damaged by the tsunami of 2010.

Currently, the frequency of natural disasters and the losses caused by them around the world are increasing, as the United Nations pointed out in the *2011 Global Assessment Report on Disaster Risk Reduction: Revealing Risk and Redefining Development* (UNISDR 2011). This fact highlights the political and economic imperative to reduce disaster risks and the benefits to be gained from doing so.

Natural disasters are inevitable, sometimes unexpected, and cannot be prevented; therefore, the implementation of different mitigation measures by public institutions, as well as private companies and civil society, should be considered as an investment to reduce damage and protect the population from future losses caused by risk conditions. Taking this fact into consideration, the Chilean government is fully aware that it must not only reconstruct what has been destroyed by the last disaster but also invest in risk reduction to minimize future losses.

The strategy to achieve better preparedness for disasters is supported by implementing various forms of mitigation. For example, avoiding or limiting land use in high-risk areas and enforcing building codes can help avoid the considerable costs that may be associated with disaster recovery and in turn save lives and prevent injury. The concept of mitigation implies the key message that damage can be reduced by taking different kinds of measures—such as doing risk identification studies, building mitigation infrastructure, amending zoning plans, requiring special construction designs, and implementing prevention and emergency recovery plans—to contribute to substantially reducing the damage that may be caused by a natural disaster. Understanding the benefits of investing in risk reduction measures encourages longer-term thinking that may otherwise be perceived as uncertain and even improbable in the framework of a reconstruction process.

In the case of the recovery strategy implemented by the Chilean government in the areas of high-risk exposure after the 27F disaster, the first step was to obtain accurate information about the affected territory. Detailed local risk studies and tsunami simulations were done, forming the basic input to define the measures applicable to minimize future losses and build a resilient society that will be better prepared to confront future disasters.

The risk studies and simulations recognize the importance and specificity of local risk patterns and local geographic conditions in implementing a precise strategy to reduce future damages and losses. Only where levels of certainty are high, are more detailed risk regulation measures and planning possible.

In a broad sense, one can distinguish between two groups of applied measures of risk reduction, the first are structural measures and the second are nonstructural measures.

Structural measures focus on reducing underlying risks. Different risk-avoidance strategies can be combined, such as land use policies (in particular, defining areas where settlements are regulated) and risk reduction strategies in buildings and infrastructure. The inherent objective of these kinds of measures is the anticipation of risk and the prevention of its realization: it is about looking forward, trying to be preventive rather than reactive.

Nonstructural measures are related to prevention and education, such as implementing early tsunami warnings and promoting disaster education. The main objective is to raise people's awareness and help them take the appropriate actions to save their lives.

To achieve an integrated risk reduction strategy associated with the reconstruction process that is taking place in Chile, both kinds of measures must be combined. Moreover, for these processes to be successful, they have to involve the whole society, including the public, private, and civil sectors. Promoting the development and strengthening of institutions, mechanisms, and capacities at all levels—in particular, the community level—that can systematically contribute to build resilience[2] to hazards is key.

The following sections describe and analyze the risk reduction strategy developed by MINVU, in the framework of the National Reconstruction Plan, for the recovery of the main coastal cities severely affected by the earthquake and tsunami of 2010. They summarize the lessons learned and formulate possible recommendations useful to others.

Scope and Complexity of the Challenge

The 2010 earthquake and tsunami was the worst natural disaster experienced by Chile in the past 50 years. At 3:34 on the morning of February 27, 2010 (06:34 UTC), an earthquake of magnitude Mw 8.8[3] occurred off the southwestern coast of Chile, with intense shaking lasting more than 3 minutes. It ranks as the sixth-largest earthquake ever to be recorded by a seismograph. It was felt strongly in six regions of the south-central area of the country, including the Metropolitan, Valparaíso, O'Higgins, Maule, Biobío, and Araucanía regions. It covered a distance of 630 kilometers in length, from Valparaíso in the north to Araucanía in the south, where more than 80 percent of the country's urban population—almost 13 million people—lives (Figure 5.1).

During the first days, some basic services were disrupted, such as electricity, telecommunications, and water. The government's cadaster of damages indicates that more than 4,000 schools were badly damaged (one of every three schools located in the area of catastrophe), which meant that more than 1,250,000 students could not start their classes until March 21, when emergency schools were opened. In addition, 40 hospitals were damaged, equivalent to 75 percent of the country's health network, 17 of which were rendered unusable. Public infrastructure was damaged at more than 2,500 connectivity points across Chile, including more than 1,500 public and concessionary roads and bridges, 8 airports and aerodromes, 53 port works, and 422 rural potable water systems. The tsunami damaged or completely destroyed hundreds of fishing boats and fishing coves, affecting the economic resources of coastal communities. More than 200,000 homes were seriously damaged or destroyed. Of the 345 municipalities distributed in 15 regions of the country, 239 were affected by the disaster. Irrespective of the scale of the physical damage caused by the earthquake, however, the greatest harm was the loss of 526 Chileans and the disappearance of another 25 people.

The 2010 earthquake and tsunami reconstruction process has imposed a completely new challenge because of the widespread and diverse nature of the damages. It involves a massive earthquake that severely affected 5 cities with more than 100,000 inhabitants, 45 cities of more than 5,000 people, and more than 900 small towns and villages spread across six regions. More than 220,000 families, required government help to repair or reconstruct their homes, which are scattered over more than 23,000 settlements, including isolated locations. Summarizing, the total cost of the losses caused by the disaster is estimated at US$30 billion, which is equivalent to 18 percent of the gross national product.

But despite the losses, particularly the hundreds of invaluable lives and thousands of families affected, the reconstruction process should be looked upon with a sense of opportunity. One should not only consider the challenge of replacing the physical losses, but also see it as a chance to improve Chile's cities and to build resilient communities.

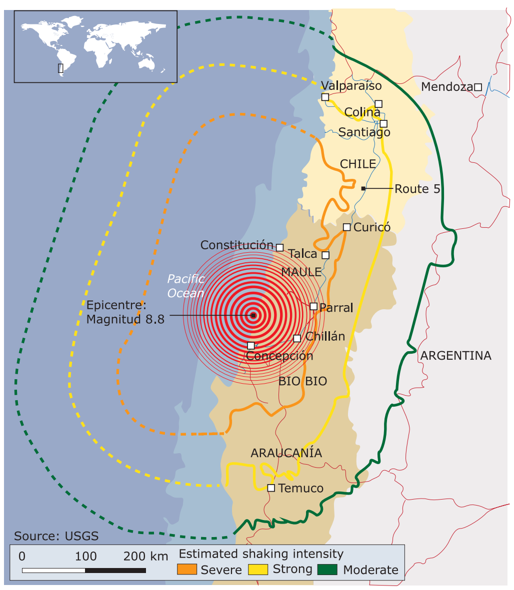
Chile is recognized by its particular landscape and diverse geography, characteristics that bring together a high exposure and vulnerability to natural disasters. In fact, the largest earthquake ever recorded took place in 1960 in the city of Valdivia, located in southern Chile, with a magnitude of Mw 9.5.[4]

Given the frequency of the historical events, the country has learned its lesson, which has resulted in the drafting and enforcing of consistent and sound building codes that have evolved over the years. This new disaster has again challenged the country in terms of preparedness and risk mitigation policies, as well as processes, regulations, and standards that should rule its planning and building industries in the future.

Any reconstruction process is always a long-term endeavor, which could last several years, and requires confronting great challenges and difficult government decisions. Many dilemmas are faced, such as how to build quickly enough to leave the emergency behind but slowly enough to ensure quality, preservation of identity, community participation, and conservation of the environment.

To achieve continuous progress, establishment of a pertinent reconstruction plan is fundamental. The plan should contain the guidelines and premises to follow in the process and promote flexible mechanisms to allow decentralized implementation.

Figure 5.1 Epicenter and Magnitude of the 27F Earthquake.



Source: U.S. Geological Survey.

Reconstruction Plan

After the 27F disaster, the Chilean government implemented a reconstruction plan based on two main work lines, the first one related to identifying and implementing the necessary measures to achieve better preparedness and disaster response to future events, and the second one with the main objective of reconstructing the country with better standards than before.

The reconstruction work is recognized as a national effort that requires national unity and coordinated efforts from all government areas. Therefore, a major structure needed to be created, called the Interministerial Committee for Infrastructure and Reconstruction and led by President Sebastián Piñera, where the work of all the ministries involved in the reconstruction is integrated, including MINVU; the Ministry of Public Works, Internal Affairs and Regional Development; the Ministry of Education; the Ministry of Health; the Ministry of Finance; the Ministry of Economy; and the Ministry of Social Development. This committee allows the integration of complex projects and their execution over time, and the reconstruction management is done at the regional and local levels to guarantee the sound and diligent progress from plan to project and from project to implementation.

MINVU's specific mission[5] during the past decades was centered on reducing the country's housing deficit. Because this problem was being solved and continuously decreasing, the public policies implemented by the ministry were shifting to contribute to improving the quality of life of the country's men and women, especially of the most vulnerable, respecting their diversity, promoting social inclusion, reducing inequalities, and strengthening citizen participation through policies, programs, and initiatives to ensure better housing quality, well-equipped neighborhoods, and socially and territorially integrated, competitive, and sustainable cities.

The 27F disaster modified those previous priorities, and the reconstruction program became one of the ministry's most important work lines, to provide housing solutions to the 880,000 people, equivalent to 22,000 homes, affected by the earthquake who needed government help. At the same time, a disaster risk reduction long-term strategy was integrated in this process to ensure a safe return to risk areas and reduce the damages in high-risk locations from future disasters.

Considering the new challenges imposed by the earthquake and tsunami, MINVU delivered its National Reconstruction Plan based on the following premises:

- Value existing communities, their ties to the land, and their sense of belonging;
- Reconstruct as quickly and as effectively as possible;
- Protect and recover the communities' physical and cultural identity, and history;
- Respect and understand the territory and its natural hazards;
- Promote strategic and sustainable urban planning;
- Promote responsible innovation;
- Ensure the legality and formality of the solutions.

Even though the premises have been maintained over time, the Reconstruction Plan is dynamic and has evolved during its first year of planning, being constantly updated and adjusted to integrate two main lines of action:

- Housing Reconstruction Program, including social condominiums and emergency camps;
- Urban Reconstruction Program, including historical heritage and a holistic territorial view.

These lines of action interact with a myriad of institutions, agencies, and policy decisions that go well beyond the reconstruction agenda, revealing the vision and spirit that the government wants to engrave in the process as a catalyst for a better future.

The implementation of the Reconstruction Plan recognizes the key role played by public and private collaboration at all levels. In the early days after the disaster, the myriad of initiatives that emerged from community organizations, foundations, private companies, nongovernmental organizations, universities, and international organizations offering help in the emergency and reconstruction process was unprecedented in Chile's history, and this impetus has continued even into the implementation phase of the plan. The mobilization and creativity of local initiatives demonstrate the great decentralization challenge and the government's trust in local capacities.

The Reconstruction Plan acknowledges the values of self-determination and solidarity, where the government grants access to opportunities, articulating more than US$2.5 billion in housing subsidies, urban infrastructure plans, and projects available to the affected communities, so they can make the most of the opportunities made available in this painful but hopeful reconstruction process.

Of the total number of homes that need to be rebuilt, approximately 25 percent are located in new developments for families who previously lived in other families' houses and are part of the country's historic housing deficit. Approximately 75 percent (MINVU 2012) are located on the same site where the families used to have a house, which means that the main problem of this reconstruction is not access to land, but rather rebuilding of individual homes that are spread throughout thousands of miles and distant localities. This process requires innovative building technologies and designs that take into account the logistical difficulties and costs to bring solutions to all these families. High comfort standards are included to ensure that what was destroyed by the disaster not only will be replaced, but also will provide a better grounding for the future of Chilean families.

Reconstruction not only refers to repairing or rebuilding homes, but also refers to the reconstruction of the social and urban tissue that was devastated by the earthquake and tsunami. In this holistic perspective, the reconstruction—and, in many cases, conversion—of towns and cities requires both economic and social development with necessary infrastructural changes to promote the communities' competitiveness and resilience in facing future natural disasters.

One must take into consideration that Chile will reach the per capita income and welfare standards of a developed country by the end of the decade. This fact points to the highest qualitative challenge for reconstruction, which is to merge this cultural transition with new levels of complexity in the design, delivery, and sustainability of the solutions into an integrated vision.

The reconstructed cities and towns should provide a sound platform for the betterment of their communities, as well as the necessary public spaces for social interaction, energy efficiency, sanitation, waste and stormwater management, transportation, and productive and risk mitigation infrastructure.

The Reconstruction Plan is a long-term, visionary, and realistic navigation chart that attempts to leverage all resources possible not just to rebuild better, but in most cases also to prepare Chile's cities, towns, and communities to become drivers for the country's future.

Integrate Disaster Resilience Criteria into Urban Development

MINVU has deployed an intense decentralized collaborative platform with regional governments; municipalities; and, in some cases, private institutions, universities, and nongovernmental organizations to comprehensively orient and coordinate the various efforts and initiatives that emerged for the reconstruction process.

The scope and magnitude of the disaster encompassed the most widespread urban earthquake ever recorded. It was experienced by more than 12 million people in the country's most populated south-central area.

The greatest portion of the damage is found in postindustrial towns, rural communities, and historical villages with fragile economies that were undergoing complex processes of economic and social conversion or redefinition. That is the case of the port-city of Talcahuano, the fishing towns in Maule region, and the hundreds of small colonial villages that were betting their future on the development of special-interest tourism.

All these geographical and economic variables compound the complexity of integrating multisectoral projects and investments, not only for urban reconstruction but also for provision of sound coordination of infrastructure, transportation, and regulation and implementation of public services.

One of the greatest challenges of the urban reconstruction process is finding the right instances for intersectoral coordination in an unprecedented context of decentralization in Chilean history. The local communities, the six regions, and the 239 municipalities affected by the earthquake and tsunami played a key role in converting a disaster of these dimensions into an opportunity for the future.

Adding to the magnitude of the challenge, one of the main complexities of the reconstruction process is the consideration of future hazards with a view to improving construction standards for buildings and cities. Chilean building codes were known to be some of the oldest and most advanced in terms of structural resistance to earthquakes, but the country lacked any regulation for construction in tsunami-risk areas, despite historical evidence of tsunami risk and the fact that in the case of the last earthquake, nearly 25 percent of the fatalities were attributed to the tsunami.

This does not mean that historic coastal living traditions will be ignored or high-risk areas that comprise most of Chile's territory will be abandoned. Rather, the country's cities will be planned and designed to become more secure, resilient, integrated, and competitive, and risk reduction and prevention will be considered key elements of infrastructure and lifestyle.

The 27F disaster, along with the 2008 Chaitén volcano eruption and other regular natural disasters, has proved that Chile must learn to live with its privileged nature while taking into account its risks.

Reconstruction of Coastal Cities

In the case of the Chilean coastal cities severely affected by the earthquake and tsunami, the government established several premises that acted as guidelines to drive the reconstruction process.

Premises

These premises were the following:

- The protection of life is one of government's primary roles, so informing and giving timely warning to the inhabitants of areas subject to tsunami risk and the specific conditions of risk to which their property is exposed is necessary.
- The coastline is a natural font of resources and labor for Chile, so the government recognizes the priority and necessary support for communities whose livelihoods depend on economic, cultural, social, and touristic activities based on the coastline.
- The use of the coastline should consider all types of activities but should be regulated considering the risk through the updated territorial planning tools (instrumentos de planificación territorial, IPTs),[6] to ensure that the conditions of construction and urbanization are complementary to the reconstruction risk reduction criteria.
- There should be proper evacuation routes, education programs, and adequate training to carry out emergency plans at all sites at risk.
- The destruction or damage of public and private property, especially equipment deemed critical,[7] should be avoided by regulating the uses in high-risk zones, minimizing future losses.
- If the economic and social benefits justify the costs, there should be investment in mitigation measures and infrastructure in existing developments to reduce damages from future disasters.

Action Plan and Criteria for the Reconstruction of the Coastal Areas

The action plan and criteria defined for the reconstruction of urban settlements located on the coastline affected by the tsunami consider the early reconstruction of homes and infrastructure and promote the safe development and quality of life in the localities beyond the emergency. These considerations depend on the necessary technical criteria to direct land uses and to guide the allocation and execution of housing subsidies, as well as the execution of public investment work for repositioning or constructing new mitigation infrastructure in high-risk areas.

For the definition of the coastline reconstruction criteria, a series of technical studies were developed, providing planning teams with the information for each locality affected by the tsunami. In parallel with those studies, MINVU developed specific simulations and scenarios of tsunami risk and mitigation infrastructure in the localities of Constitución, Dichato, Talcahuano, Llico, and Tubul that are complementary to the studies developed by the National Geology and Mining Service (Servicio Nacional de Geología y Minería, SERNAGEOMIN) and the Hydrographic and Oceanographic Service of the Chilean Navy (Servicio Hidrográfico y Oceanográfico de la Armada de Chile, SHOA).

The proposed criteria for the reconstruction of the affected coastal towns establish land use conditions in direct relation with the IPTs, construction and technical regulations, allocation of housing subsidies, and prioritization of public investment. The criteria used and action plan implemented for the reconstruction of coastal cities respond to the constitutional mandate of prioritizing the safety of the citizens, as well as promoting public policies to ensure the rational, efficient, equilibrated, and sustainable use of the coastal area, compatible with the economic and social interests of the public and the private sectors.

Criteria

The earthquake and tsunami dramatically modified the territory, especially in the lowest coastal areas such as fishing coves, river deltas, estuaries, wetlands, and ponds, as well as slopes and ravines. These places were in some cases inhabited by formal and informal settlements dating from before risk assessment studies were available, and many of them are now gone.

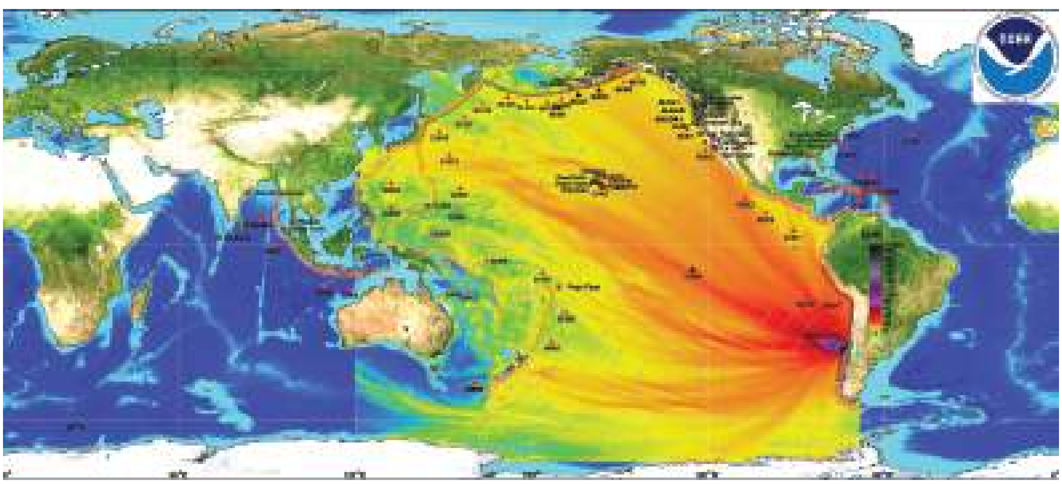
Whether and how these zones should be redeveloped or inhabited are significant questions in many countries around the world. In the case of Chile, the constitution restricts the delivery of reconstruction subsidies in sites that are known to present a risk to the life of individuals. Nonetheless, the government cannot hinder reconstruction, knowing the population's attachment to the land and the long-standing cultural tradition of coastal communities. This reality requires a proactive approach that incorporates risk assessment of coastal areas, evaluation of risk mitigation infrastructure, investments, and land use conditions of those localities exposed to future natural disasters.

Action plan

To respond in a timely manner to the demands of reconstruction of the affected population, the plan works along three parallel lines of action that will be assumed by the different levels of government following the competences established by law and regulations:

1. Support of local government in updating the IPTs and establishing a tsunami protocol;
2. Implementation of mitigation infrastructure;
3. Allocation of housing subsidies.

Figure 5.2 Expected Wave Heights of Tsunami Travelling across the Pacific Basin Following the Earthquake in the Chilean Coast, February 27, 2010.



Source: Elaborated by the NOAA / PMEL / Center for Tsunami Research.

Risk Reduction Strategy

The 27F disaster taught Chile a difficult lesson in terms of territorial and urban planning: the country must learn to plan its cities knowing and managing the natural risks to which the particular geography of the country permanently exposes it.

Update of Risk-Based Planning Tools

The zoning plans and ordinances for all coastal municipalities and localities are now in the process of being updated on the basis of the risk analysis and the changes in the territory produced by the earthquake and tsunami. Of the 239 municipalities affected by the earthquake and tsunami, 173 do not require any change or update to their zoning plans and ordinances derived from natural risks, and 69 require a change or adjustment to the instruments, 29 of which correspond to coastal municipalities and the remainder to inland municipalities exposed to specific limited risks related to landslides or streams.

General Prevention Measures Considered

Prevention of natural disasters is part of the prospective nature of urban planning, in the sense of anticipating what might happen in future disasters through robust methodologies to adequately define the risk areas and establishing applicable restrictions.

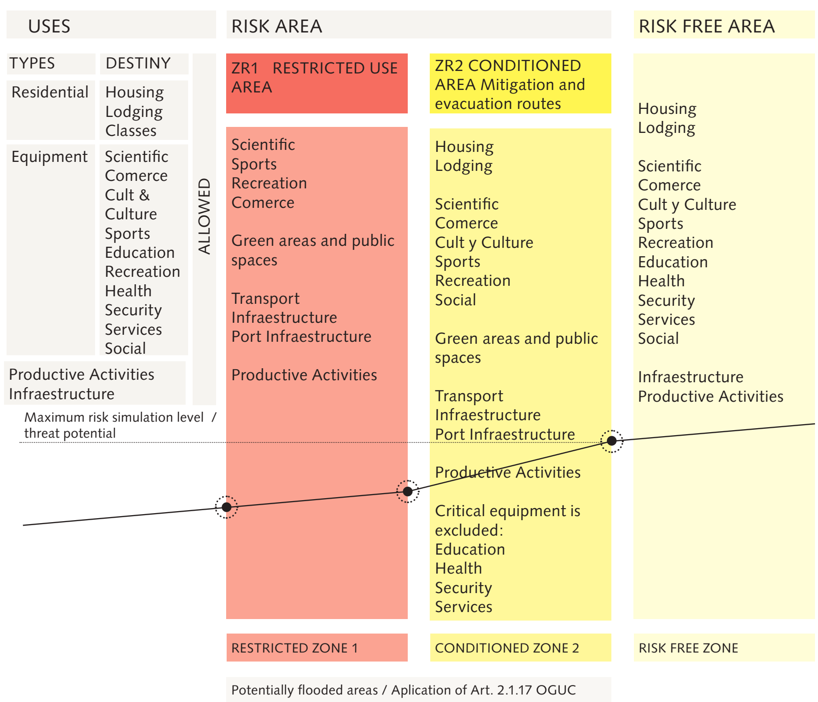
Structural prevention measures

To prevent the occupation of high-risk areas to safeguard human life, appropriate land use regulation is necessary:

- Risk-avoidance strategies: Land use policies and, in particular, defining of areas where settlements are forbidden or regulated;
- Risk-reduction strategies: In buildings and infrastructure through improvements of construction codes and mitigation projects;

Figure 5.3 Referential Scheme of the Risk Avoidance Strategy Applied in the Urban Areas of the Chilean Coastal Edge

Referential scheme for the occupation of the coastal edge



Source: MINVU

The remaining measures are outside the legal purview of the IPTs and refer to structural mitigation measures.

Nonstructural prevention measures

To achieve an effective integrated risk reduction strategy, nonstructural measures refer to preventive actions such as improving existing early warning systems, strengthening telecommunications, defining evacuation routes and safe areas, and implementing continual disaster education programs to raise people's awareness. The integration of all these actions will help the population take the appropriate action in time and reduce regrettable losses.

Master Plans for 25 Coastal Cities

During the first year of the reconstruction process, MINVU and several public and private entities developed 25 studies of master plans for the main urban areas along the southern coast that were affected by the tsunami, with the objective of integrating and coordinating the reconstruction projects and the risk reduction strategy with a long-term holistic vision. Through these plans, the reconstruction process goes further than just replacing what was there before, taking into account the previous city's problems and recognizing and seizing new opportunities.

The master plans developed for each location included urban infrastructure and mitigation projects, combining an integral vision with a participatory process and including different actors.

Master Plans for 25 Coastal Cities:

01. Cobquecura / 02. Perales / 03. Dichato / 04. Los Morros / 05. Caleta del Medio / 06. Vegas de Coliumo / 07. Cocholgüe / 08. Penco / 09. Tumbes / 10. Talcahuano / 11. Caleta lo Rojas / 12. Isla Santa María / 13. Tubul / 14. Llico / 15. Lebu / 16. Isla Mocha / 17. Quidico / 18. Tirúa / 19. Constitución / 20. Duao / 21. Iloca / 22. La Pesca / 23. Pelluhue / 24. Curanipe / 25. Juan Fernández

The master plans involve technical studies and preliminary proposals for mitigation, infrastructure, and housing projects, combined with instances of community participation. Another feature of urban planning is to ensure the integration and coordination of interministerial projects, such as mitigation projects, fishing coves, river and coastal banks, rainwater, sanitation, road works, parks, infrastructure, and so on.

The Public-Private Association Agreement was the legal mechanism used to coordinate and finance the master plans during the emergency phase. Those agreements were made among municipalities, regional governments, businesses, and social organizations. MINVU acted

Figure 5.4 Master Plans of Cobquecura, Coliumo Los Morros, Penco.

Source: MINVU

as guarantor to ensure that the outcome generated valid inputs in updating master plans and scheduling investment plans after technical, economic, and social validation by the corresponding agencies.

To summarize, each coastal town has three concrete products leading to the reconstruction of the town: risk studies and tsunami simulations to define specific local risk conditions; mitigation projects to reduce the speed and strength of the waves caused by future tsunamis; and the definition of special-subsidy zones to set incentives for the construction of housing projects with tsunami resilient design considerations.

Risk Studies: Risk Studies and Tsunami Simulations

The big shock of the tsunami of February 27, 2010, in coastal urban settlements demonstrated the priority of the need to generate knowledge about the potential behavior of tsunamis on Chilean shores.[8] The anticipation of such danger allows territorial organization on the basis of the threat, and therefore, propose mitigation measures to reduce potential damages, develop effective response plans, and properly handle potential emergencies.

MINVU's Reconstruction Plan is aware that the detailed knowledge of the danger of tsunami allows reconstruction of sustainable human settlements with coastal risk. In this context, the purpose of these studies was to define hazard areas differentiated by tsunami flooding, understanding that the process of flooding is not a homogeneous process and that it manifests itself differently in urbanized areas, resulting in varying levels of danger.

To make informed, targeted decisions for building resilience, the risk assessment reports and studies focused on delimiting differentiated risk areas and directing reconstruction, taking into consideration a tsunami similar to the one that struck the coast in 2010. The studies led to the following measures:

- Clearing and immediate release of areas free of geological or tsunami risk for immediate reconstruction;
- Determination and delimitation of the areas of moderate risk where an eventual recurrence requires development of infrastructure, land use, or mitigation measures, accompanied by early warning and evacuation protocols;
- Delimitation and oversight of areas of exceptionally high risk that may not be apt for permanent residential use or location of critical facilities because of geographical changes or geological conditions. These areas are expected to be as few as possible in order to minimize the resettlement and displacement of communities whose economy depends on coastal activities.

The methodology followed by the risk studies and risk simulations establishes the following:

- Maximum heights of tsunami in the coastal cities analyzed;
- Maximum flooding area by tsunami;
- Hydrodynamic parameters of flooding;
- Differentiated areas of risk;
- Arrival time and number of tsunami waves;
- Maps showing differentiated areas of risk.

Mitigation Projects: Breakwater Wall Plus Mitigation Forest

The objective of the mitigation projects is to reduce the energy and height of the tsunami waves, allowing flooding, but reducing the level of destruction and damages produced. With a scenario similar to the one that occurred in the 27F disaster, different kinds of mitigation projects were evaluated, from massive breakwater walls to tsunami forests. Considering the financial costs and social benefits, MINVU finally decided that the most advisable strategy was to integrate and merge different measures.

In the Chilean reconstruction, the mitigation projects have a double function: the reduction of future risk and damages by adding mitigation infrastructure to protect the most exposed areas and the improvement of quality-of-life standards in urban areas. In this way, the mitigation projects under construction will preserve or even improve quality of life in the affected cities, adding features such as public spaces and cultural programs, to promote and drive a shift from industrial to tourist-oriented economies.

One of the main government concerns was to minimize the forced relocation of population caused by the reconstruction process. For this reason, the only expropriated land is that subject to high-risk conditions and used for the construction of mitigation projects to protect the population so that flooding zones can be inhabited safely. The mitigation projects against natural hazards minimize the expropriations and contribute to the safe return of the affected families to the coast and, at the same time, generate new public spaces for the benefit of the community.

Zoning and Zones for Special Subsidies: Differentiated Zones by Risk Conditions

Considering the information from risk studies and tsunami simulations done by specialists, MINVU in collaboration with the local governments defined specific zones of exclusion for the construction of mitigation projects and areas where special construction regulations are recommended to promote the construction of tsunami-resilient designs for permanent housing. The exclusion zones are dedicated to the construction of mitigation projects, and the areas where the use of special construction regulations are recommended correspond to the urban areas subjected to flooding, located immediately behind the mitigation projects.

To promote the construction of tsunami-resilient housing designs, a set of technical rules was developed and is available for the community. Currently, application of these rules to every construction is not mandatory, but its application is suggested in the case of permanent houses located in flood-risk areas.

In the case of construction financed or partially financed by the government, a special financial tool is available to cover the major costs associated with the tsunami-resilient designs.

Case Studies

This section presents the cases of two coastal cities, Constitución, located in the Maule region, and Dichato, located in the Biobío region, both severely affected by the earthquake and tsunami of 2010. Both cities are currently in the process of recovery, implementing the MINVU strategy described previously.

Case 1: Constitución, Maule Region

Constitución is one of the most important cities in the Maule region, with a population of more than 53,000 inhabitants, and was one of the coastal cities most affected by the disaster of February 27. More than 5,000 families of the district of Constitución were affected by the disaster and required government help to rebuild or repair their homes and their livelihoods. The earthquake and tsunami caused the devastation of much of the city with many fatalities; more than 50 percent of the buildings located in the flat area were lost.

In consideration of the magnitude of the damage, the adverse scenario, and the challenge of rebuilding the city, a private entity together with the municipality and the national government created a master plan to study and plan the reconstruction process to avoid or mitigate the effects of a future tsunami. The three products defined by the MINVU for the reconstruction of coastal urban areas were applied as guidelines to rebuild a safer city.

Figure 5.5 A and B, Before and after. Overview of the damages caused by tsunami in Constitución

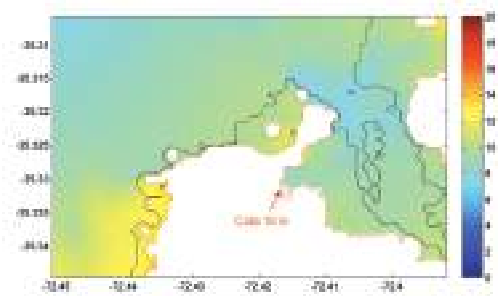
Source: ELEMENTAL.

Risk studies and risk simulations

Maximum flooding area by tsunami

For Constitución, the maximum height of inundation covers the coastal shore exposed to the Pacific and the riverfront areas of the Maule River, where the city is located. In the simulation, the heights of the tsunami could reach 13 meters in the coastal area, fluctuating between 7 and 12 meters of height in the urban area. The hill located at the edge of the city is a natural barrier that protects the interior areas.

Figure 5.6 Constitución: Maximum flooding area by tsunami



Source: Risk Areas Final Inform, PUC Geographic Institute.

Hydrodynamic parameters of flooding

The depth of flooding and the speed of the sea current show the high degree of danger when a tsunami occurs. The spatial behavior in relation to the maximum parameters is evidence of the differentiation of risk areas, showing that the coastal shore and the oceanfront are the higher-risk zones. The depth of the flooding presents values higher than 4 meters at the edges, and the maximum speed of the flood reaches values near 4 meters per second in urban areas.

Figure 5.7A: Constitución maximum inundation depth by tsunami

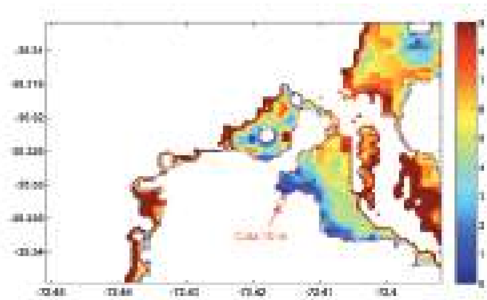
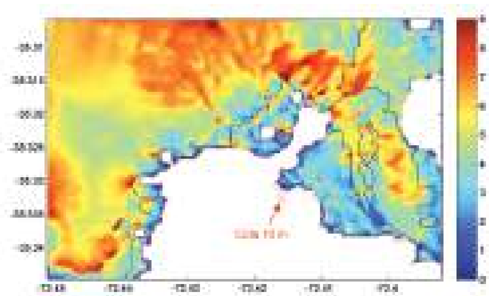


Figure 5.7B: Constitución maximum wave speed by tsunami (meters by second)



Source: Risk Areas Final Inform, PUC Geographic Institute.

Differentiated areas of risk

The danger areas for human life are located in relation to the depth of flooding. In this case, most of the urban center is exposed, with depths over 2 meters predominating. Meanwhile, the speed of the sea current in the most dangerous areas exceeds 1.5 meters per second.

Figure 5.8A: Constitución: depth of flooding

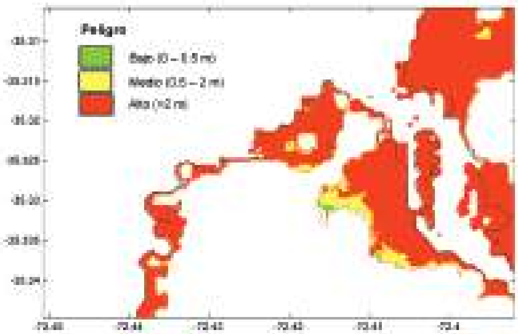
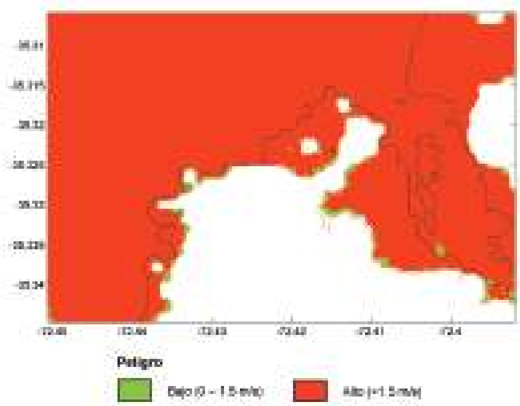


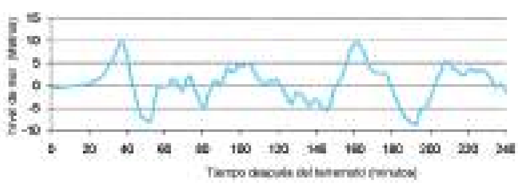
Figure 5.8B: Constitución: speed of the wave.



Source: Risk Areas Final Inform, PUC Geographic Institute.

Figure 5.9A: Constitución arrival time of tsunami waves and number. Point A (model area)

Figure 5.9B: Constitución waves model



Source: Risk Areas Final Inform, PUC Geographic Institute.

Arrival time and number of tsunami waves

Figure 5.9 shows the location of the simulation of the behavior of sea waves and the behavior of the sea level 4 hours after the earthquake (240 minutes) of the numeric simulation.

Maps showing differentiated areas of risk

Figure 5.10 summarize the danger of a tsunami in the city of Constitución. It shows differentiated danger areas affected by the tsunami, the height of the wave, speed of the current, and depths of flooding.

Master plan and mitigation projects

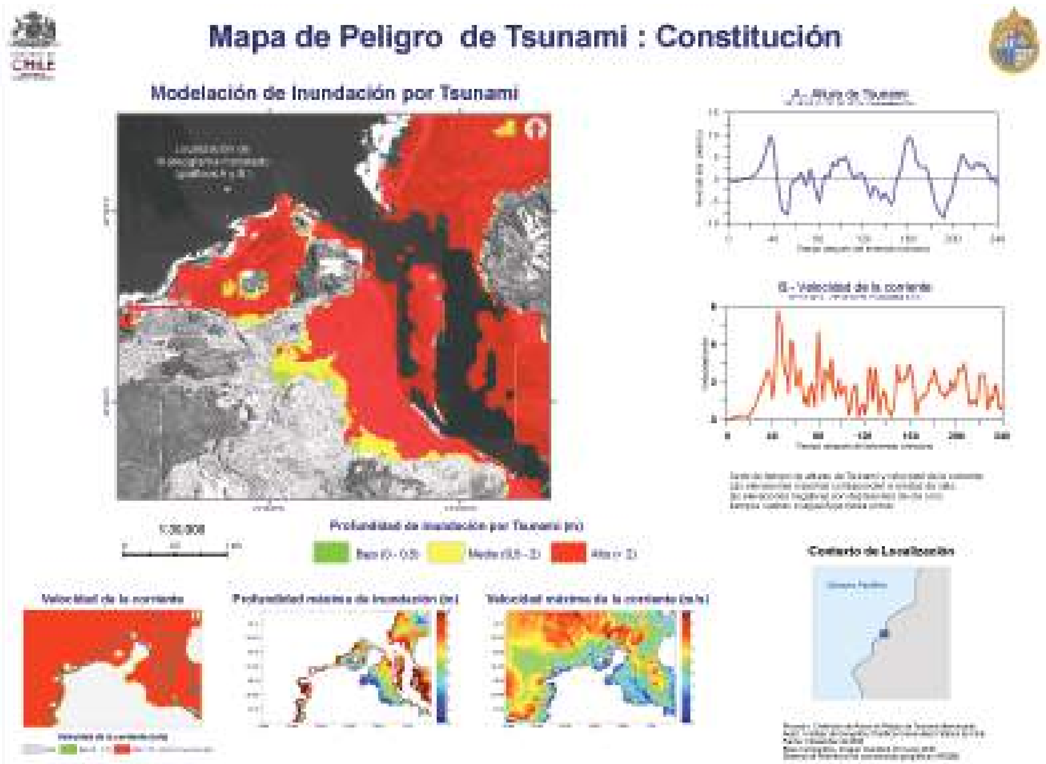
The master plan was prepared through a private-public agreement that established conditions and responsibilities for all the actors involved. In the case of Constitución, this agreement was made among local and central entities, including the municipality of Constitución, Maule region local government, local social organizations, Arauco Timber Company, and MINVU, among others.

MINVU's role was to guarantee that the outcome matched the criteria and action plan previously defined to ensure the viability of the projects and the investment plans by the relevant government agencies. The role of the private entities was to provide the resources to finance the master plan, in this case, developed by ELEMENTAL architecture office.

The master plan is considered a mechanism that allows rethinking of the original city to capitalize on the opportunity of building a better city than before, to respond to the need for integrated operation and coordination between different entities, and to think about the emergency and reconstruction contingency as incremental actions that can be improved in time.

The Constitución master plan mainly seeks to construct a resilient city with a mitigation park on the coastal edge that protects the flooding area and at the same time recovers the coastal edge as a public space that belongs to all citizens. The public space urban standard fixes a

Figure 5.10: Maps of Constitución showing differentiated risk areas



Source: Risk Areas Final Inform, PUC Geographic Institute.

Figure 5. 11: PRES Constitución. Sustainable Master Plan

Source: ELEMENTAL.

historical deficit of the city, climbing from 2.2 square meters per inhabitant to 6.6 square meters per inhabitant (the World Health Organization recommends 9 square meters per inhabitant).

The operation allows the recovery of the tourist potential of the city, diversifying the original economic structure. In addition, the master plan proposes the replacement of the destroyed public buildings and housing with designs that seek to preserve the character of the city.

An important aspect to consider is to ensure a continuous participatory process in the planning phase to prevent misunderstandings or mistaken expectations from the community and to develop a plan that fulfills the real needs of the citizens.

Zoning and zones for special subsidies

In terms of land use policies and MINVU's differentiated risk zoning areas, in the case of Constitución two zones were defined following the criteria recommended in the referential scheme for risk avoidance applicable in coastal urban areas (Figure 5.12).

In the first area, defined with green color, it is recommended to avoid the location of permanent housing construction and critical facilities; all other uses are allowed, such as economic facilities and public spaces. In Constitución, the green area is equivalent to a surface area of approximately 22 hectares of land (100 properties before the tsunami). Today this area has been used for the construction of the mitigation park.

The second area, defined with red color, is equivalent to the flooding zone; all uses are allowed, but consideration is recommended for special tsunami construction regulations for housing projects if financed by the government. Location of critical facilities in safe areas is also recommended.

Figure 5.12: Constitución zoning plan, marking the flooding area for special subsidies for tsunami resilient designs

Source: MINVU

Case 2: Dichato, Biobío Region

Dichato is a small touristic city located on the southern side of the Bay of Coliumo, district of Tomé, in the Biobío region, with a population of 3,488 inhabitants (according to the Chilean Census of 2002).

The particular geographic conditions of the location and the presence of an estuary increased the effect of the tsunami wave, resulting in massive destruction of almost 80 percent of the city's infrastructure, including commerce, houses, water pipes, sewerage, bridges, and urban roads.

In this case, the local government assigned the challenge of the reconstruction of the 18 most affected coastal cities of the Biobío region to a special group. This group was in charge of coordinating the efforts of different sectors, including various public entities and academia.

Figure 5.13: Before and after. Aerial photos of the damages caused by tsunami in Dichato

Source: Google Earth

The reconstruction of the city was done following the guidelines and products defined by MINVU to achieve safer standards.

Risk studies and risk simulations

Maximum flooding area by tsunami

In Dichato, the tsunami simulation floods the lower areas, exactly where the city is located. In the flooding area, the height of tsunami waves reaches average values near 8 meters and does not exceed 10 meters in height. Those heights and flooding areas are consistent with the ones observed February 27.

The flooding is partially caused by the presence and low height of the Dichato estuary. Because of the particular geographic conditions of the location, the city is highly exposed to future tsunamis.

Figure 5.14: Dichato maximum flooding area by tsunami

Source: Risk Areas Final Inform, PUC Geographic Institute.

Hydrodynamic parameters of flooding

In Dichato, maximum depths of flooding are concentrated in the coastal edge and the river mouth, spanning the center of the city. The maximum values are near 6 meters and lower in the interior flooding areas. The Dichato estuary is a natural corridor that facilitates the penetration of tsunami waves, allowing depths of flooding between 3 and 4 meters in most of the interior areas. The maximum speed of the current is over 3 meters per second.

Figure 5.15A: Dichato maximum inundation depth by tsunami

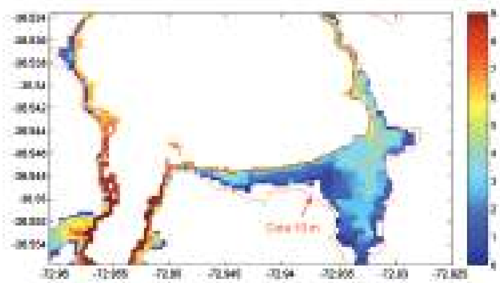
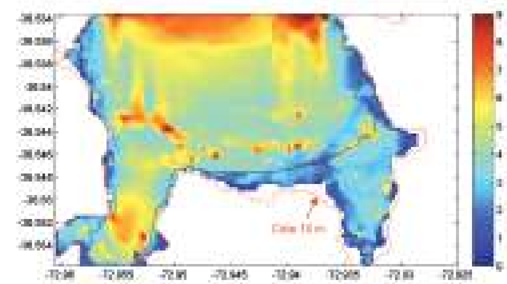


Figure 5.15B: Dichato maximum wave speed by tsunami (meters by second)



Source: Risk Areas Final Inform, PUC Geographic Institute.

Figure 5.16A: Dichato: depth of flooding

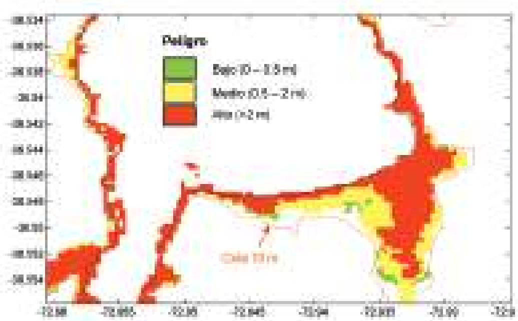


Figure 5.16B: Dichato: speed of the wave

Source: Risk Areas Final Inform, PUC Geographic Institute.

Differentiated areas of risk

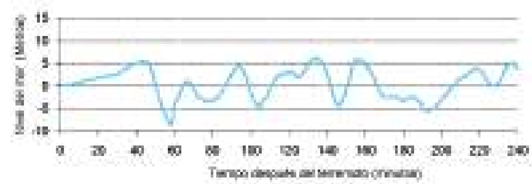
Dichato presents a high-risk exposure for human life. Most of the urban center presents depths of flooding greater than 2 meters, only decreasing at the limits of the flooding area. The maximum speed of the waves is located in the edge of the flooding area.

Arrival time and number of tsunami waves

Figure 5.17 shows the location of the simulation of the behavior of sea waves and the behavior of the sea level 4 hours after the earthquake (240 minutes) of the numeric simulation.

Figure 5.17A: Dichato arrival time of tsunami waves and number. Point A (model area)

Figure 5.17B: Dichato waves model

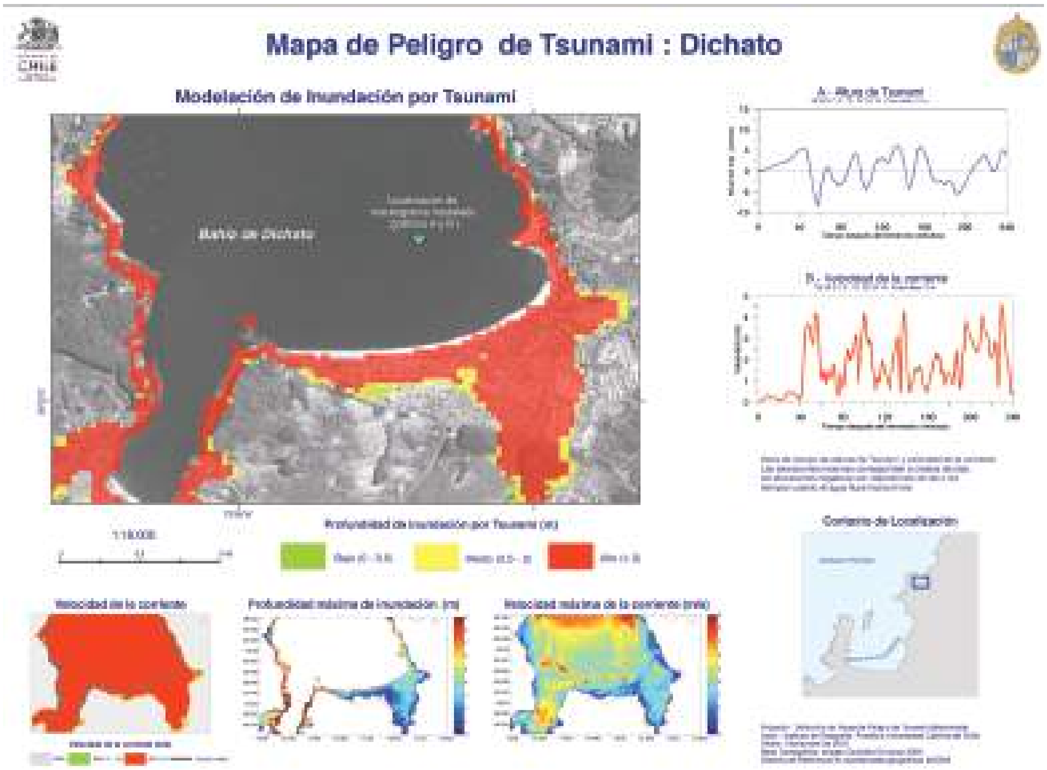


Source: Risk Areas Final Inform, PUC Geographic Institute.

Maps showing differentiated areas of risk

Figure 5.18 summarize the danger of a tsunami in the city of Dichato. It shows differentiated danger areas affected by the tsunami, the height of the wave, the speed of the current, and depths of flooding.

Figure 5.18: Maps of Dichato showing differentiated risk areas



Source: Risk Areas Final Inform, PUC Geographic Institute.

Master plan and mitigation projects

The genesis of the Dichato master plan is in the maintenance and reinforcement of the predominantly touristic role of the city, combined with strengthening the secondary productive role that is associated with the extraction of sea products.

The main objective of the security and mitigation measures is to improve security for the inhabitants and tourists, and at the same time the quality of life, providing a space for leisure and recreation and promoting the touristic character of the city. The plan also includes definition of evacuation routes, definition of safe areas, and education programs to promote disaster awareness among the population and reduce potential losses in the future.

In the case of housing projects, differentiated risk areas and building typologies were considered in the plan, according to the level of risk. Other reconstruction projects were defined in relation to the predominant economic activities and to tourism and fishing, as well as to complement the livelihood of the permanent residents.

The master plan of Dichato integrates a view that reinforces the idea of mitigating the effects of a future catastrophe, increases connectivity, and absorbs the change in an emergency scenario.

The master plan was prepared through a private-public agreement, which established conditions and responsibilities for all the actors involved. In the case of Dichato, this agreement was made among local and central entities, such as the municipality of Dichato, the Biobío region local government, social organizations, universities, and MINVU, among others. The technical team that developed the master plan was established by the local government to plan the reconstruction of 18 cities severely affected by the tsunami in the Biobío region.

Figure 5.19: Master Plan of Dichato, elaborated by the local government

Source: MINVU

Zoning and zones for special subsidies

In terms of land use policies and differentiated risk zoning areas, the case of Dichato is very similar to that of Constitución. According to the criteria of the referential scheme for risk avoidance for coastal urban areas, two risk zones were defined (Figure 5.20).

In the first area, defined with red color, avoiding permanent housing construction and critical facilities is recommended; all other uses are allowed, such as economic facilities and public spaces. In Dichato, the red area is equivalent to a surface area of approximately 4 hectares of land (65 properties before the tsunami). Today this area has been used for the construction of the mitigation park and a coastal boulevard project.

The second area, defined with orange color, is equivalent to the flooding zone; in this area, permanent houses are allowed, but consideration of special tsunami construction regulations is recommended for government-financed projects.

As a general recommendation, critical facilities should be located in safe areas to reduce losses caused by the disaster and, at the same time, to ensure that those facilities will be working as soon as possible after a catastrophic event.

Figure 5.20: Dichato zoning plan. Special subsidies area for tsunami resilient housing projects designs

Source: MINVU

Lessons and Recommendations: The Challenge of Planning Resilient Cities

Using risk reduction strategies in the mitigation of natural and other disasters can contribute significantly to reducing the risks and costs associated with these disasters. Factoring disaster risk considerations into national planning and public investment decisions can radically scale up risk reduction. But the measures taken should be used strategically; this is especially relevant in the case of large-scale territories and countries in development, where the targeted focus of public investment should be considered to make a particular strategic entry point for addressing risk drivers.

In countries with a high level of exposure, natural disasters are considered tragedies that imply severe losses, but they also could be considered as a unique opportunity to implement risk reduction measures that would otherwise not be implemented. The catastrophes that have plagued Chile throughout its history taught the country to constantly improve construction codes, and Chile can proudly affirm that those improvements contribute to considerably reducing the risk of collapse of constructions and constitute an effective protection measure for the population. But this process of learning and improvement is not nearly done, and the country should continue implementing measures to reduce risk in other fields.

Regarding the process of learning and making constant improvements to reduce risk, one of the main objectives of the reconstruction plan is not only to achieve the recovery of the destroyed areas, but also to learn about the disaster and integrate some strategic considerations to reduce damage and promote the conformation of a society better prepared to confront future disasters.

Before the 27F disaster, the Chilean government was not aware of the need for reliable risk studies or tsunami simulations that would allow the risk conditions to be understood in relation to Chile's territory. Urban planning policies were far from considering risk as a relevant assessment, and prevention measures were focused on the improvement of building codes. In this sense, it is important to recognize that part of the new knowledge generated by the last disaster in Chile is an integrated approach to disaster risk reduction, which comprises a mix of structural and nonstructural risk reduction measures.

How can Chilean cities be better prepared to confront disasters? This is a key question that the reconstruction process is trying to address. It is one of the biggest innovations contained in the National Reconstruction Plan, and Chile is proud to share it with other countries.

The following points summarize Chile's experience and develop some of the general conclusions and specific recommendations learned in relation to the risk reduction strategy implemented after the last disaster.

General Conclusions

Take leadership on risk management

The progress in risk reduction partially depends on the government taking decisive steps to explicitly recognize, and take ownership of and responsibility for, its share of risk. Even if this responsibility entails political risks, the real costs and consequences of unmanaged risk of an unexpected disaster could be higher.

Public policies driven by the government should be the guidelines to promote risk reduction measures by all sectors of society and a channel of communication to highlight the importance of these measures to the country to avoid losses.

Leverage existing instruments

Innovation is implicit in this process, but instead of starting from scratch, studying the existing development mechanisms and instruments and improving them is worthwhile to reduce risks and strengthen resilience. Upgrading instead of reinventing could increase the speed of the reconstruction process and achieve similar results.

Target public investments with high impact

Be specific in areas with high risk exposure and establish investment priorities; more detailed risk regulation measures and planning should be done to achieve this goal. Do not waste unnecessary efforts and resources with a high volume of hypothetical risks.

Communicate

Media and civil society play an important role in creating the social demand for strengthened disaster risk reduction programs and in ensuring the implementation of those measures. Citizens must be aware of disaster risks and have access to comprehensive public information about risk assessments and programs. The need to develop culturally sensitive and practicable means of communication at all levels is part of the successful implementation of risk reduction policies.

Create networks and partnerships

Collaborate with local and international partners to construct networks for information, support, resources, and leadership, and ultimately to share knowledge about the experience.

Adopt a new culture of public administration supportive of local initiatives and based on partnership between governments and civil society.

Promote spontaneous alliances and initiatives. The government should set up a work structure by which all initiatives can be channeled and formalized as agreements and plans that can be implemented and are viable in the future.

Specific Recommendations

Have a reconstruction plan

Before starting the reconstruction process, think carefully about the first decisions that will be the guidelines of a long-term process. The plan should be considered the blueprint or navigation chart for reconstruction, incorporating a dynamic nature that allows modifications but with strong premises to guide the process.

Integrate interventions

Reconstruction should go beyond the physical aspects, this means promoting better housing standards, improving livelihood through urban planning, not neglecting psychosocial recovery for the affected families, and considering economic aspects.

Take advantage of local capacities

Over the past 2 years, Chile has proudly seen how communities in small and large localities have moved quickly to plan the reconstruction and recovery of their homes with the aid of civic organizations, businesses, and regional agencies. Enhancing local capacities is a way to encourage empowerment and development of depressed local economies.

Decentralize implementation

Working locally to enhance sustainability and resilience is important in all areas vulnerable to extreme events. To achieve this objective, decentralize responsibility, capacities, and resources. The support and involvement of local governments is a key aspect to achieve the successful implementation of risk reduction measures.

Chile's reconstruction program imposed a great challenge of decentralization that has no precedent in the country's history. It is a mistake to pretend that the government, centrally, would be capable of defining the reconstruction of more than one thousand cities and towns. It is about a commitment to delegating a considerable part of the management and decision making to municipalities, regional agencies, and local government because they know their needs and those of their communities better.

Adopt regulations that allow flexibility

Design a homogenous plan to provide regulations that can be tailored to local circumstances. Such regulations are typically principles rather than rules, allowing for flexibility and discretion in implementing them in various situations.

Public policies promoted by the government should stipulate local government responsibility for planning and control while ensuring adequate resources to plan and regulate development.

Flexibility and adaptation are key considerations, rather than imposing rules. The consequences of this kind of approach are the promotion of responsibility at a local level and the assurance that the measures respond to local conditions.

Promote community empowerment

Include the local community with a participatory approach in the planning phase to ensure the success of a sustainable and workable approach. It requires the adoption of a culture of planning and regulation based on partnerships and joint ownership among local and central governments, involved stakeholders, communities, and organizations that represent them.

Respect local identities

The reconstruction process should consider the local identity, from the tangible to the invisible heritage. The process is not only about reconstructing quickly but also about the recovery of identity and urban image. The government should generate the appropriate incentives and guidelines to create an environment that allows communities to be the drivers of their own reconstruction.

Quantify losses and future risks

The systematic recording of disaster losses and impacts is the first step in allowing the government to measure and value the costs caused by recurrent disasters and to identify underlying drivers of risk. The impact related to livelihoods, health, economy, and other sectors is the basic input to consider the need for mitigation and effective risk reduction measures.

But countries not only need to know what they are losing, but also must estimate potential future losses for which they need to be prepared. A comprehensive probabilistic risk assessment is the key to developing a cost-effective portfolio of disaster risk management measures.

Integrate urban planning with risk management

The disaster taught Chile to innovate in the deployment of new planning mechanisms, such as master plans, and new instances that guarantee the development of sustainable cities, including safety standards and promotion of risk assessments. These instruments allow and promote the participation of the community, mayors, and regional authorities in the decision-making process of their own cities and towns.

The new dimension of risk conditions applied to urban planning should be one of the drivers of recovery and new developments. Taking into account that mitigation projects could contribute to improving livelihoods while at the same time minimizing risk conditions.

Combine different types of risk mitigation measures and regulations

Greater benefits could be achieved when public investment projects for disaster risk reduction are combined with national planning policies, including future developments, and sectorial land use planning. An integral risk reduction strategy should combine different types of structural and nonstructural measures.

Ensure prevention as public policy

In a country continuously affected by unexpected different types of natural disasters, one should learn to live with risk, and the government's duty is to ensure the reduction of future losses and damages by creating a culture of prevention. This goal could be addressed mainly by implementation of programs for the education of the population and with actions such as evacuation simulation exercises in case of a tsunami warning. The education programs should be complemented with an early warning system, sea-level monitoring stations, improvements in telecommunications, and a monitoring network.

Summary

The time and magnitude of an earthquake cannot be predicted, but certain places on earth know they are always at risk from big tremors, and Chile is one of those places. Through its history, major disasters are considered a tragedy that involves losses and damages, but they are also opportunities to learn and strengthen the country's knowledge about disaster recovery and prevention. Little by little, Chile has demonstrated constant improvements in this field, and the last major disaster was not an exception.

We hope that the conclusions and recommendations in this chapter contribute to improving preparedness for future disasters around the world, learning to live in territories subject to high-risk conditions by preventing and reducing damages, and most important of all, protecting lives.

Progressing quickly while procuring a long-term vision, integrating everyone by trusting in local capacities, recovering Chile's cities, and projecting the country into the future are the challenges and opportunities that Chile is willing to assume in its reconstruction program so that together, government, communities, and individuals can rebuild a better and more resilient country.

Notes

1. *Subsidy* is a financial mechanism implemented by the government that fully or partially finances housing projects to reduce the existing housing deficit. A housing subsidy is given only once to a family, for the acquisition or construction of their home. Source: MINVU
2. *Resilience* means "The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determinate by the degree to which the social system is capable of organizing itself to increase this capacity of learning from past disasters for better future protection and to improve risk reduction measures." (UNISDR). Source: http://www.unisdr.org
3. According to the U.S. Geological Survey, http://www.usgs.gov.
4. According to the U.S. Geological Survey, http://earthquake.usgs.gov.
5. For MINVU's mission, see http://www.minvu.cl.
6. IPTs are zoning plans and regulations that guide the development of urban centers. These urban planning tools contain a set of conditions for buildings and urban spaces that ensure an integral functional relationship between the residential areas, commerce, equipment, and recreation.
7. *Critical facilities* are defined by the U.S. Federal Emergency Management Authority, as the facilities that should be given special consideration when formulating regulatory alternatives and floodplain management plans: hospitals, fire stations, police stations, storage of critical records, and similar facilities. Communities should develop emergency plans to continue to provide these services as soon as possible. For more on critical facilities, see U.S. Federal Emergency Management Authority, http://www.fema.gov.
8. This section was prepared by SERNAGEOMIN, Universidad Católica, and Universidad del Biobío.

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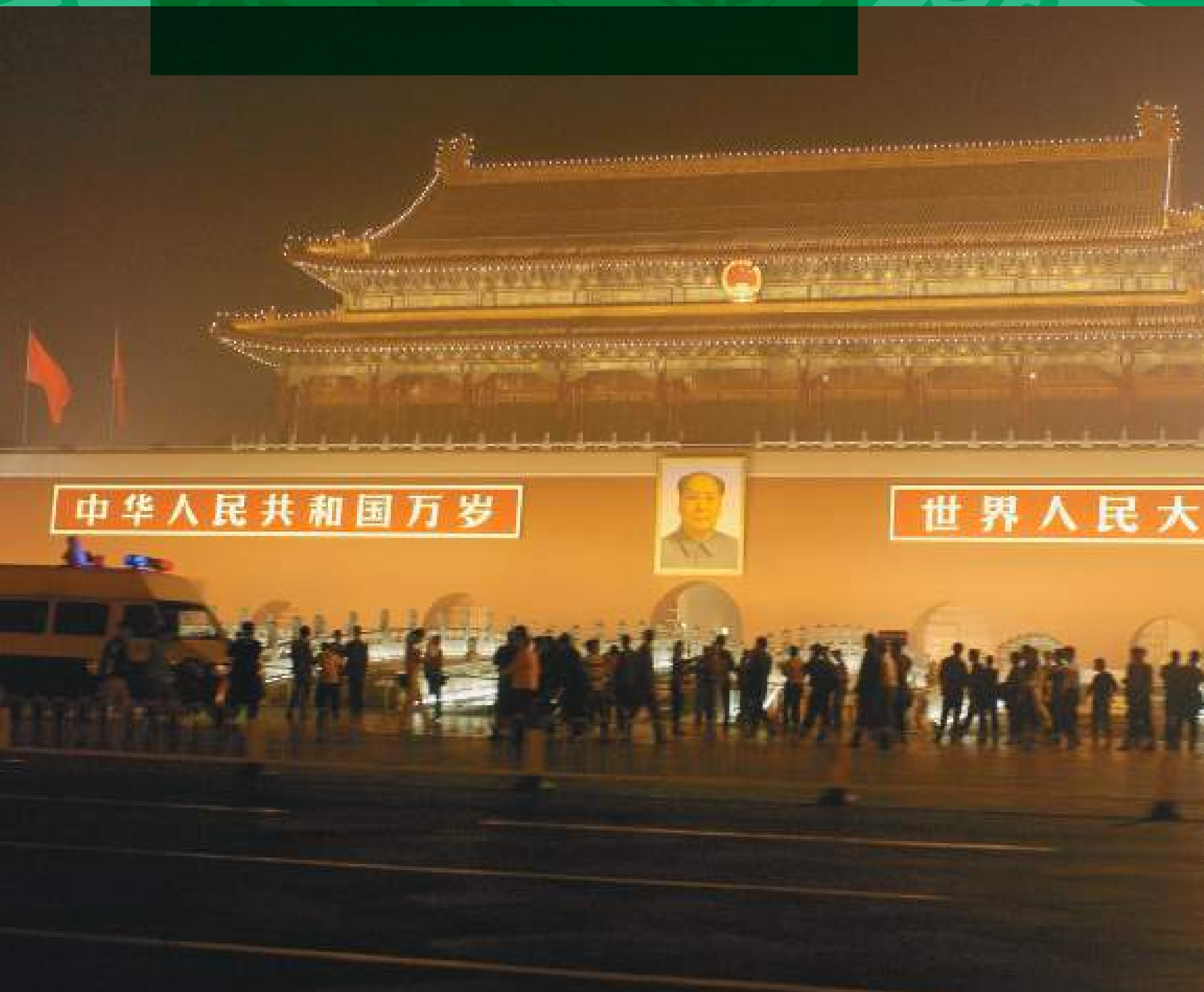
The Chinese government has continuously put the protection of people's lives and property on the top of its agenda and has mainstreamed natural disaster risk reduction into its economic and social development plan as an important guarantee for sustainable development. This chapter focuses introduces China's main practices in natural disaster risk management from the perspectives of preparing the plans, constructing legal systems, risk investigation, monitoring and early warning, disaster reduction projects, risk assessment, disaster insurance, community-based disaster reduction, and international cooperation. It also addresses questions about information sharing mechanisms, disaster risk assessment, and risk financing strategy. Finally, it outlines the priority areas of China's natural disaster risk management in the future.



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CHAPTER 6:

China's Natural Disaster Risk Management

*This chapter is a submission of the Government of China**

Introduction

In recent years, frequent natural disasters have caused enormous loss of life and property, and such disasters have become a common challenge to all countries. China, with its vast territory, complex terrain and landforms, as well as various climate types, is one of the countries in the world that sustain the most natural disasters. Along with global climate change and the country's fast economic growth and accelerating urbanization, China endures increasing pressure on resources, environment and ecology.

Prevention of and response to natural disasters has become more serious and complicated. Always putting people first, the Chinese government has unceasingly ranked the security of people's lives and property at the top of its agenda and has mainstreamed disaster prevention and reduction in its economic and social development plan as an important guarantee for sustainable development. In recent years, China has comprehensively implemented its Outlook of Scientific Development and adhered to the working principle of "prioritizing disaster prevention while combining disaster prevention, resistance and relief." It has also firmly upheld the philosophy of active and comprehensive disaster reduction and disaster risk management and further strengthened relevant legislation and building of natural disaster risk management systems and mechanisms. Moreover, it has actively pushed forward capacity building for comprehensive disaster reduction, encouraged public participation, and actively participated in international disaster reduction cooperation to continually champion the cause of disaster reduction.

China's Main Practices of Natural Disaster Risk Management

China has adopted a natural disaster risk management regime featuring central leadership, departmental responsibility, and graded disaster administration with major responsibilities on local authorities. Under the unified leadership of the State Council, central government agencies that are responsible for coordination and organization of disaster reduction and relief include the National Commission for Disaster Reduction, State Flood Control and Drought Relief Headquarters, Earthquake Resistance and Disaster Relief Headquarters of the State Council, and State Forest Fire Prevention Headquarters. Local governments have set up corresponding units with similar functions in coordinating disaster reduction and relief.

*Office of National Commission for Disaster Reduction, P. R. China

During natural disaster risk management work, the Chinese government has attached importance to the combination of engineering and nonengineering measures and to the combination of administrative measures and market mechanisms. It has comprehensively adopted legal, engineering, technical, financial, and insurance tools to improve the efficiency of disaster reduction and diversify disaster risks for systematic measures that can maximize policy effects. The following sections describe the main practices.

Incorporating Natural Disaster Risk Management in Economic and Social Development Plans

For years, the Chinese government has consistently incorporated natural disaster risk reduction into its sustainable development strategies at the national and local levels. In China's Agenda in the 21st Century, issued in 1994, the central government clearly defined the relation between disaster reduction and ecological and environmental protection at the national level. In 1998, the nation released the Disaster Reduction Plan of the People's Republic of China (1998–2010), which, for the first time, put forward the guidelines, goals, main tasks, and major measures of disaster reduction work in the form of specialized plans. In 2007, the nation released the 11th Five-Year Plan on Comprehensive Disaster Reduction, which explicitly stipulates that local governments should incorporate disaster reduction into their economic and social development plans.

In 2011, the Chinese government issued the National Comprehensive Disaster Prevention and Reduction Plan (2011–15), which explicitly defined the development guidelines, main tasks, and major projects of China's disaster reduction work during the 12th Five-Year Plan period (2011–15). Moreover, China has promulgated the National Anti-Drought Plan; the National 12th Five-Year Plan on Geological Disaster Prevention; the National General Plan on Small and Medium-Sized River Improvement, High-Risk Reservoir Reinforcement, and Mountain Torrents and Geological Disasters Prevention and Comprehensive Treatment; the National Middle and Long-Term Development Plan on Forest Fire Prevention (2009–15); the National Plan on Protection Against and Mitigation of Earthquake Disasters (2006–20); the National Plan for Meteorological Disaster Prevention (2009–20); and the 12th Five-Year Plan on Disaster Prevention and Reduction in Urban and Rural Development.

Improving the Legislative System for Natural Disaster Risk Management

China attaches great importance to legislation regarding disaster prevention and reduction and has enacted a number of laws and regulations in this regard, thus gradually institutionalizing its disaster reduction work. Since the 1980s, the nation has promulgated more than 30 laws and regulations concerning disaster prevention and reduction, including the Emergency Response Law of the People's Republic of China, the Law of the People's Republic of China on Water and Soil Conservation, the Law of the People's Republic of China on Protection Against and Mitigation of Earthquake Disasters, the Flood Control Law of the People's Republic of China, the Law of the People's Republic of China on Desertification Prevention and Transformation, the Meteorology Law of the People's Republic of China, the Agriculture Law of the People's Republic of China, Regulation on the Prevention and Control of Geological Disasters, and Regulation on Prevention Against Meteorological Disaster.

China has established a natural disaster contingency plan that features cross-cutting and in-depth coverage. It has released specialized plans on natural disaster relief, flood control and drought relief, earthquake resistance and rescue, geological disaster emergency, large-scale forest fire handling, medical aid, meteorological disaster prevention, and communication guarantee. The concerned departments have devised their own emergency plans, and local governments and relevant departments have devised or revised the various plans at their levels. Natural disaster risk management, as an indispensable part of the plans, provides important support to disaster preparedness and relief.

Pushing Forward Natural Disaster Risk Investigation and Zoning

The Chinese government has conducted risk investigation and zoning for commonly encountered natural disasters, such as flood, earthquake, geological hazard, and oceanic disaster, and has achieved some important results. It has organized the compilation of a flood risk map and conducted a flood hazard survey and caution area zoning, and on the basis of those efforts, completed the compilation of 56 trial flood risk maps of different types and typical historical charts of seven large drainage basins. It has compiled four generations of earthquake zoning maps and conducted active fault probe and earthquake risk assessments in more than 100 large and medium-size cities, which has provided basic statistics for national earthquake disaster management and anti-earthquake preparation in construction projects. The government has also conducted a land survey and the geological disaster environment, completed the geological disaster survey and zoning in some cities and counties and established corresponding information systems and geological hazard monitoring networks. It has conducted agricultural and rural meteorological disaster investigation and completed agricultural meteorological disaster risk zoning in some cities and counties. It is currently conducting investigation of marine disaster risks for large-scale coastal projects and national marine disaster risk assessment and zoning.

Vigorously Strengthening Capacity Building for Natural Disaster Monitoring and Early Warning

The Chinese government attaches great importance to natural disaster monitoring and early warning and has established a three-dimensional natural disaster monitoring system covering land, marine and seabed, and space-air-ground monitoring. A disaster monitoring, early warning, and forecasting system is taking shape. Since the 1990s, in particular, China has accelerated the building of a national natural disaster monitoring and early warning system through the use of modern earth-observation technology, satellite communication technology, and network technology and has launched small satellites (Constellation A and Constellation B) for environmental and disaster monitoring and forecasting. It has also launched a number of meteorological, oceanic, and resource observation satellites for natural disaster risk management. A satellite disaster reduction application system has taken initial shape.

In recent years, China has continually strengthened the construction of its disaster remote-sensing monitoring system, meteorological early warning and forecasting system, hydrologic and flood monitoring and early warning and forecasting system, earthquake monitoring and forecasting system, geological disaster monitoring system, environmental monitoring and early warning system, wild animal epidemic monitoring and early warning system, insect pest monitoring and forecasting system, marine disaster forecasting system, forest and grassland fire early warning and monitoring system, and sandstorm disaster monitoring and assessment system, and has achieved remarkable results in capacity building for natural disaster monitoring and early warning.

Steadily Pushing Forward Development of Disaster Prevention and Reduction Projects

The Chinese government has increased inputs in key disaster prevention and reduction projects and infrastructure, such as those concerning flood control and drought relief, earthquake prevention and resistance, typhoon and storm surge prevention, desertification and sandstorm control, and ecological construction. It has engaged in a series of disaster prevention and reduction projects, including flood control on major rivers and small and medium-sized rivers, mountain torrent disaster prevention, seepage prevention and reinforcement for unsafe reservoirs, geological disaster and soil erosion prevention and control, highway disaster prevention, housing renovation for impoverished rural residents, drinking water safety in rural areas, and ecological construction and environmental improvement, all of which effectively improved the nation's capability in natural disaster prevention. Through the flood control project on major rivers, China has accelerated its harnessing of major rivers and lakes, and the pivotal water conservancy projects at the Three Gorges on the Yangtze River, Xiaolangdi on the Yellow River, and Linhuaigang on the Huaihe River are playing their full part. China's flood control capability on major rivers has been further improved.

It has also implemented the earthquake-resistance program for construction and engineering projects and improved the earthquake security assessment management system for major construction projects. China has also pushed forward the rural housing earthquake-resistance program nationwide. Since 2001, it has implemented renovation projects for high-risk buildings in primary and middle schools throughout the country. Since 2009, it has implemented the safe school building project, in which school buildings have been reinforced nationwide to meet the earthquake-resistance standards applied for key projects, and the overall capabilities of schools in earthquake resistance and disaster prevention have been enhanced.

Strengthening the Study of Natural Disaster Risk Assessment Technology

In recent years, the relevant Chinese government departments have consistently strengthened the scientific study of disaster risk modeling and assessment and have enhanced the work of regional demonstration. They have established specialized databases for comprehensive disaster risk prevention work and studied development risk assessment models for coping with such natural disasters as drought, flood, typhoon, earthquake, landslide and mud-rock flow, snowstorm, frost, and hailstorm. They have constructed rough models for national-scale and provincial-scale single-disaster risk and multidisaster comprehensive risk assessment and have completed demonstrative assessment. They have also compiled and published the Atlas of Natural Disasters in China, the Atlas of Natural Disaster System of China, and the Atlas of Natural Disaster Risks in China and have finished a compilation of a series of works on a comprehensive risk prevention system, which covers scientific issues, key technologies, standards and regulations, modeling methodology, database and charting, disaster relief guarantee, and transfer of comprehensive natural disaster risks.

Actively Pushing Forward Natural Disaster Insurance

Since 2004, the Chinese government has launched disaster insurance trial programs that focus on agricultural insurance and rural housing insurance. As the relevant national policies have been released, the Chinese government has defined the role of disaster insurance as a guarantee for disaster relief, and the disaster insurance work has developed in a healthy and orderly manner thanks to the guidance, support, and supervision of the government.

In 2007, the government adopted the policy of using the central fiscal funds to subsidize agricultural insurance costs, which combined the roles of the government and the market, the fiscal and financial funds, and the public and private sectors. Since then, the public has been motivated to purchase insurance products while the sustainable development of the disaster insurance system has been ensured. From 2007 to 2011, China realized a total of nearly 60 billion yuan (Y) of agricultural insurance premium income, providing 580 million of insurance policies worth about Y 1.8 trillion for peasant households, from which farmers have benefited enormously. In 2011, China's agricultural insurance premium income amounted to Y 17.4 billion, an increase of 236 percent from 2007; 169 million of agricultural insurance products were purchased by peasant households, an increase of 240 percent from 2007. In the same year, China provided an insurance guarantee of Y 650 billion, an increase of 480 percent from 2007. According to the statistics from the Property and Casualty Company Limited under the People's Insurance Company (Group) of China Limited (PICC), in the 2007–11 period, the rural housing insurance program provided Y 1.9 trillion for 192 million units of insurance policies for Chinese peasant households, playing a positive role in helping disaster-hit farmers rebuild their dwellings and in providing services to agriculture, rural areas, and farmers.

Vigorously Pushing Forward Community-Based Natural Disaster Risk Management

The Chinese government attaches great importance to community-based disaster risk reduction management. It has established 2,843 National Comprehensive Disaster Reduction Demonstration Communities to push forward the establishment of a working mechanism for disaster reduction in communities. It has also devised a disaster emergency relief plan and carried out the investigation of disaster risks and hidden dangers in communities. In addition, it has helped those communities compile a disaster risk map so that residents can know the distribution of disaster risks in those communities and a roadmap for residents to use in getting to shelter areas if disasters hit. Residents are also taught basic methods and skills of self-aid and mutual aid for disaster prevention and reduction. The government has implemented the construction of some demonstration counties for mass monitoring and prevention of geological disasters, the development of urban emergency shelters for earthquakes, and the establishment of demonstration communities for meteorological disaster prevention and reduction to further solidify the foundation of urban and rural disaster reduction work.

In 2009, the Chinese government designated May 12 as National Disaster Prevention and Reduction Day. All departments and regional authorities made use of the platform to develop a series of products for promoting disaster reduction so that the public gains disaster prevention and reduction knowledge and skills regularly, leading to enhanced social awareness of disaster prevention and reduction.

Strengthening International Exchange and Cooperation in the Field of Natural Disaster Risk Management

Adopting an open and cooperative attitude, China takes an active part in international efforts in the field of disaster reduction, the establishment and improvement of international cooperative mechanisms of disaster reduction, building up of worldwide capacity in this regard, and provision of mutual aid with other countries in major natural disasters. China has provided Asian, African, and Latin American countries with official aid in disaster relief, incorporating disaster reduction and relief into bilateral aid.

Meanwhile, it has actively participated in international disaster reduction cooperation within a multilateral framework and stepped up efforts to promote regional cooperation in the field of disaster reduction and relief. China has established close cooperative partnerships with disaster-related United Nations (UN) agencies, including the United Nations Development Programme (UNDP), the United Nations International

Strategy for Disaster Reduction (UNISDR), the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), and the United Nations World Food Programme (UNWFP), in the field of disaster reduction and has actively participated in disaster reduction cooperation within the UN framework.

Since 2003, the China International Search and Rescue Team (CISAR) has carried out nine international rescue operations. In 2005, the Chinese government held the first Asian Ministerial Conference on Disaster Reduction in Beijing. The conference adopted the Beijing Action for Disaster Risk Reduction in Asia, which laid the foundation for Asian countries to further strengthen cooperation on disaster reduction. In 2007, China officially joined the International Charter Space and Major Disasters (CHARTER) and coestablished the International Centre for Drought Risk Reduction (ICDRR) with UNISDR. In 2010, the Beijing office of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) was set up. China has actively pushed forward the establishment of the dialogue and exchange platform for disaster reduction and many times sent experts to the UN disaster assessment team to perform disaster assessment tasks.

Response to the Issues

This section addresses three main issues: information sharing mechanisms, disaster risk assessment, and risk financing strategy.

Information Sharing Mechanisms

China's main experiences in collecting data and establishing basic databases for risk assessment

- *Strengthening the development of information standardization*. The Chinese government has set up the National Standardization Technical Committee for Disaster Reduction and Relief to study the network technology standardization of disaster reduction, relief, and services, so that the country can experiment with the information services management system to make it more effective and devise relevant technical standards and step-by-step rules.
- *Strengthening database development*. China's disaster-related departments have continually improved the natural disaster risk database system. The National Disaster Reduction Center of China formulated the data resource plan and defined 15 types of tier-1 databases, 200 types of tier-2 databases and 829 types of tier-3 databases.
- *Strengthening the development of an information sharing mechanism*. A disaster early warning and consultation mechanism and an information sharing mechanism were established, involving the main disaster-related departments such as civil affairs, land resources, water resources, agriculture, statistics, forestry, earthquake, meteorology, and ocean. In terms of international cooperation, China has joined major disaster space information sharing mechanisms, including CHARTER and UN-SPIDER.
- *Strengthening the development of a disaster information sharing platform*. China has developed disaster information databases, launched the establishment of the National Platform for Common GeoSpatial Information Services, established a disaster information sharing and release system, and built up a national information platform for comprehensive disaster reduction and risk management to provide effective support to central and local governments in disaster-related emergency decision making.

China's main challenges in building mechanisms for exchange and sharing of information

- A standard and unified data standardization system for natural disaster risk management is yet to be set up at the national level, leaving information standardization a formidable task.

- Multiple departments are charged with China's natural disaster management, and there is a lack of an effective and comprehensive sharing platform for the large amount of data. The data resources of the relevant departments need to be optimized.
- The temporal and spatial precision of data concerning China's major natural disaster environment background and its economic and social background needs to be further improved and still falls short of demand for high-precision assessment of major natural disaster risk and loss.

Disaster Risk Assessment

Suggestions concerning the enhancement of international cooperation in disaster risk modeling and assessment

- *Strengthen international scientific research exchange and cooperation*. The concerned countries could discuss relevant scientific issues and key technologies regarding disaster risk modeling techniques and risk models and could exchange information on their latest developments through intergovernmental coordination and cooperation among academic institutions. Those countries can also conduct studies on research results integration and application demonstration in line with their real circumstances and successful cases.
- *Establish a platform for demonstrating achievements*. UNISDR and the World Bank can jointly lead such efforts as establishing a specialized website on natural disaster risk modeling and risk assessment to provide a sound interactive platform for exchanging information on the latest research progress and cases of various countries.
- *Carry out targeted financing cooperation*. A regular exchange and cooperation mechanism for risk modeling and assessment between developed and developing countries should be encouraged and established. A cooperative method featuring targeted financing (with fixed fields of financing and fixed number of years) by developed countries for developing countries can be adopted to establish and improve disaster risk modeling and assessment studies and demonstrative application in developing countries.
- *Prioritize the design of the disaster risk assessment and adaptation plans for global climate change*. Given the increasing frequency and intensity of extreme weather and climate incidents caused by global climate change, attention should be paid particularly to the impact of climate change on a disaster risk formation mechanism, the new disaster risk assessment models, and the new disaster risk landscapes.
- *Formulate and implement the international cooperation plan on catastrophe risk models and assessment as soon as possible*. In recent years, the world has suffered from increasing numbers of catastrophes and extreme losses. Unlike ordinary disaster risks, catastrophes are often compounded by multiple disasters and the disaster chain effect. The international community has a huge demand for study in catastrophe formation mechanisms, scenario analysis, and numerical simulation, and such cooperation is of great significance.

Suggestions concerning the establishment of an open and unified hypothesis and methodology to promote exchange between the government and the financial market

On the one hand, cooperation among government, research institutions, and enterprises should be promoted. Enterprises should be encouraged to fully participate in the risk assessment process of major natural disasters. The mechanism for enhancing coordination among the government, research institutions, and enterprises should be strengthened to promote exchange and cooperation between government and enterprises and to realize effective communication between the government and the financial market. Studies on the relationship between natural disasters and risk-sharing holders should be enhanced.

On the other hand, the threshold value of natural disaster risks should be defined. Because of the high uncertainty of natural disaster risks, holders of risks and insurance companies have difficulty in grasping the characteristics of losses. The risk assessment methods should be continually improved so that risk losses can be calculated within a proper value and the market's financial entities can have some understanding of the threshold value of natural disaster risks.

Risk Financing Strategy

Suggestions with regard to helping policy makers establish a comprehensive strategy for natural disaster risk financing and transfer through optimizing risk information and risk models

On the one hand, the publicity and standardization of natural disaster risk information should be promoted. The key to implementing disaster risk financing and transfer strategies is to achieve the publicity and standardization of risk information and, in turn, enhance information sharing by optimizing risk information and integrating data.

On the other hand, risk losses and costs to mitigate them should be clearly defined. Many methods, such as risk calculation, loss assessment, demand analysis, and analysis of disaster reduction capabilities, can be used to help governments at all levels learn about the severity of risks and their distribution, the measures that should be taken in coping with the risks, and the costs incurred in avoiding the risks, so that rational decisions can be made in industrial distribution, urban planning, and residential district construction.

Suggestions with regard to improving cost-effective returns from market-based risk transfer plans through optimizing risk information

On the one hand, it is the common responsibility of the government, enterprises, and the public to strengthen the awareness of risk prevention, publicize risk information in a timely manner, and allow the public to know and recognize disaster risks so that they can have a correct understanding of disaster risk prevention. Stakeholders should be encouraged to accept the market transfer plan of risks implemented by the government.

On the other hand, the accuracy of the risk assessment model should be improved so that the government measures can be more in line with the development rules of natural disasters to lower the implementation costs of risk transfer plans. In this way, government compensation and market risk transfer plans can be optimized.

China's main experiences in emphasizing the role of the government, the private sector, and public-private cooperation to push forward the sharing of risk information and risk assessment tools

- *Strengthening legal system construction*. Legal protection should exist for the participation of private entities in natural disaster risk sharing, and market supervision should be strengthened and explicitly defined so that the responsibilities and duties of the concerned parties are unambiguous.
- *Strengthening information disclosure.* Information should be made public. In 2005, the Chinese government announced it would make public the documents concerning the death toll caused by natural disasters and related materials. In the wake of the 2008 Wenchuan earthquake, the earthquake information was publicized in a much more transparent and timely manner, which played a positive role in pushing forward the

participation of enterprises and the public in disaster reduction and relief work.

- *Strengthening information sharing*. China's disaster-related departments have experimented with and established information sharing mechanisms with insurance companies, reinsurance companies, and insurance regulators, and they jointly carried out major research projects, such as catastrophe insurance, which has pushed forward and improved the application of risk assessment tools in the practice of disaster reduction and relief.
- *Adhering to the principle of government leadership and social participation*. The government should play a leading role while society should participate in the process of natural disaster risk management. In this process in China, on the whole, the government still plays a leading role and is actively guiding the development of a market mechanism and building a public cooperative mechanism, in which the government, enterprises, nongovernmental organizations, and individuals participate in disaster management. With resource integration and optimization, tremendous synergy has been created for natural disaster risk prevention.

Priority Areas of China's Natural Disaster Risk Management in the Future

Against the backdrop of global climate change, China is suffering from more severe natural disaster risks. Risks from droughts, floods, typhoons, low temperatures, ice and snow storms, high temperatures and heat waves, sandstorms, plant diseases, and insect pests have increased, and disasters such as collapse, landslides, mudrock flows, and mountain torrents have been on the rise. The temporal and spatial distribution of disasters, losses incurred by disasters, and the intensity and scope of their impact have changed, and disasters have become increasingly unexpected, abnormal, and unpredictable. Natural disasters have become a major factor that hinders China's economic and social development. In the coming years, the Chinese government will actively implement its National Comprehensive Disaster Prevention and Reduction Plan (2011–15) and the *Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters* to promote the development of major natural disaster–related projects and continually improve the nation's capabilities for comprehensive natural disaster risk management.

Strengthening the Capacity Building of Natural Disaster Monitoring and Early Warning

China will accelerate the development of natural disaster monitoring and early warning systems and improve the monitoring network of natural disasters. It will strengthen the development of monitoring stations to monitor natural disasters, such as meteorological, hydrological, earthquake, geological, agricultural, forestry, oceanic, grassland, and wild animal epidemic hazards, and strengthen information sharing among different departments to avoid duplication of construction. It will improve the natural disaster forecasting, early warning, and information release mechanism to strengthen the early warning capabilities with regard to natural disasters. It will also enhance national space information infrastructure for disaster prevention and reduction to improve its capabilities of comprehensive observation, high-resolution observation, and emergency observation of natural disasters.

Strengthening Capacity Building for Disaster Prevention and Reduction Information Management and Services

China will improve its management in disaster prevention and reduction information and make scientific plans and effectively use various types of information resources to expand channels and means to obtain information and improve information handling and analysis capabilities.

It will study the feasibility of establishing a national comprehensive disaster prevention and reduction database to improve the dynamic updating mechanism for disaster information. It will strengthen disaster prevention and reduction information sharing capabilities and study the feasibility of establishing a national comprehensive disaster prevention and reduction and risk management information platform to improve the integration, intelligent treatment and services of disaster prevention and reduction information. It will also strengthen information exchanges, and coordination services among relevant departments at all levels on disaster prevention and reduction.

Strengthening Capacity Building for Natural Disaster Risk Management

China will strengthen its comprehensive risk management of natural disasters at the national level and improve measures for mitigating disaster risks. It will establish a natural disaster risk transfer and sharing mechanism and experiment with a multiplayer mechanism, including fiscal and financial tools, to achieve economic compensation and loss sharing when natural disasters hit and to accelerate the establishment of the disaster investigation and assessment system. It will conduct a national survey and investigation of natural disaster risks and disaster reduction capabilities at the county level so that the nation can establish comprehensive databases to improve its dynamic data updating capabilities. It will establish a national and regional comprehensive disaster risk assessment indicator regime and assessment system and study methodologies of comprehensive natural disaster risk assessment and the critical conditions that trigger disasters. It will also conduct comprehensive risk assessment trials and demonstration work.

Strengthening Defensive Capacity of Natural Disaster Prevention and Reduction Projects

China will strengthen the construction of key disaster prevention and reduction projects in flood control and drought relief, earthquake prevention and resistance, cold and frost resistance, typhoon and storm surge prevention, desertification and sandstorm control, forest fire prevention, plant disease and insect pest prevention and control, and wild animal epidemic prevention and control to improve the country's defensive capability of its major and extraordinary disaster prevention projects. It will improve the disaster defensive capabilities of buildings in urban and rural areas and push for the construction of safe school buildings and safe hospital buildings across the country. It will also strengthen the management of small and medium-size rivers, seepage prevention and reservoir reinforcement, mountain torrents and geological disasters prevention, as well as the comprehensive treatment and management of the ecological environment in regions susceptible to disasters.

Strengthening Capacity for Disaster Prevention and Reduction at the Regional and Urban-Rural Grassroots Levels

China will coordinate capacity building in regional disaster prevention and reduction and integrate disaster prevention and reduction into regional development planning, main function area construction, industrial structure upgrading, and ecological environment improvement. It will improve the disaster-resistance standards of urban and rural buildings and public infrastructure and strengthen disaster-resistance capabilities of urban and rural infrastructure. It will also strengthen grassroots disaster prevention and reduction capabilities in urban and rural areas and improve its urban and rural disaster prevention and reduction mechanism. It will continue to push forward the establishment of National Comprehensive Disaster Reduction Demonstration Communities.

Strengthening Capacity Building in Technical Support to Disaster Prevention and Reduction

China will strengthen scientific research on disaster prevention and reduction and conduct a study on the formation mechanism and evolution rules of natural disasters. It will focus on scientific studies on early warnings of natural disasters, major and extraordinary natural disaster chains, interaction between natural disasters, and social and economic environment and natural disasters against the backdrop of global climate change. It will strengthen scientific and technological exchange and cooperation in disaster prevention and reduction and introduce and learn advanced international technologies in disaster prevention and reduction. It will also push forward the construction of national key laboratories, engineering technology research centers, and Asian Regional Catastrophe Research Centers in the field of disaster prevention and reduction.

The management of contingent liabilities in Colombia is an essential component of fiscal risk management. In this context, the Ministry of Finance and Public Credit (Ministerio de Hacienda y Credito Público, MHCP) considered two types of contingencies: (a) explicit contingencies from legal proceedings, contracts related to public-private partnerships (PPPs), and guaranties of public credit operations; and (b) implicit contingencies from occurrences of disasters caused by natural phenomena.

The MHCP is in charge of developing a disaster risk financing and insurance (DRFI) strategy, aimed at reducing the state's fiscal vulnerability to natural disasters and developing an approach to the different layers of risk.

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CHAPTER 7:

Contingent Liability Management in Colombia and the Financial Strategy Associated with Natural Disasters

This chapter is a submission of the Government of Colombia

Introduction

The fiscal impact generated by catastrophic events in Colombia made the government devise a strategy to reduce these impacts, which is set out in the National Development Plan and Strategic Plan of the Ministry of Finance and Public Credit (Ministerio de Hacienda y Credito Público, MHCP). This plan suggests the development of a financial strategy to mitigate fiscal volatility and managing risks of natural origin as implicit contingent liabilities.

This chapter presents the policies and tools developed for managing the explicit contingent liabilities caused by legal proceedings, contracts with public-private partnerships (PPPs), and guaranties of public credit operations further it, describes the development of disaster risk financing and insurance (DRFI) mechanisms, a strategy intended to reduce the fiscal vulnerability of the state to disasters caused by natural phenomena in accordance with Article 220 of the National Development Plan 2010–2014: Prosperity for All.

In this process, the government of Colombia recognizes that the occurrence of disasters caused by natural phenomena may generate fiscal risk, which is the reason they must be taken into consideration as implicit contingent liabilities; it implies that their risk must be managed. In this context, the chapter presents the advances and challenges as a reference in the conceptual framework for contingent liabilities.

Contingent Liabilities in Colombia

Legal Framework

With the establishment of the Deputy Directorate of Risk within the Directorate General of Public Credit and National Treasury, the MHCP began the identification, assessment, mitigation, and control of the different sources of the nation's contingent liabilities. In 1998, following the financial crisis, measures were taken concerning the management of contingent liabilities of state agencies, and rules were issued on public borrowing.

In 1998, the government of Colombia issued Law 448, taking action regarding the management of contingent liabilities. In addition, this law set up the contingency fund as a hedging mechanism that is aimed at meeting the contingent liabilities of state entities that have been approved by the government. The law also established in Article 6 that responsibility for approving and monitoring the valuation of contingencies lies with the General Directorate of Public Credit and National Treasury, MHCP.

Subsequently, in 2003, the government of Colombia enacted Law 819, which provided regulations for the Medium Term Fiscal Framework (Marco Fiscal de Mediano Plazo, MFMP), which must be submitted by June 15 of every fiscal period to the Economic Commissions of the Senate and the House of Representatives and must include a statement of contingent liabilities that may affect the nation's financial position.

Currently, the Deputy Directorate of Risk publishes in the MFMP the valuation of contingent liabilities caused by risks associated with public credit operations, legal contingencies, and PPPs, framed as explicit contingent liabilities. For implicit contingent liabilities such as contingent liabilities caused by natural disasters, Article 220 of the National Development Plan 2010–2014: Prosperity for All, charged the MHCP with developing a DRFI strategy aimed at reducing the state's fiscal vulnerability to the occurrence of disasters arising from natural hazards.

Contingent Liabilities from Public Credit Operations

At present, different state entities enter into a significant number of credit transactions in which the nation acts as guarantor and, as such, is in constant fiscal risk in the event that debtors may not comply with the payments. Under this scenario, the MHCP, Deputy Directorate of Risk attempts to measure the credit risk exposure of public finances, which originated in a common practice in some Latin American countries by which the central government acts as guarantor of credit agreements between lending institutions and organizations at the national and subnational levels. In general, the guarantee provided takes the form of liquid collateral in credit agreements with international financial agencies.

According to methodological guidelines, as of December 2011, the government of Colombia faced an estimated contingent liability from public credit operations amounting to Col$1.18 billion for a medium-term fiscal period from 2011 to 2021. It represented a modest 0.22 percent of the country's gross domestic product (GDP) (see table 7.2 later in this chapter).

Contingent Liabilities from Public-Private Partnerships

The PPP projects incorporate contingent liabilities primarily related to guarantees of trade, geological, property, environmental, and general contingencies associated with the risks assumed by the nation. For this reason, the government of Colombia established Contractual Risk Policy guidelines—CONPES [Consejo Nacional de Política Económica y Social, National Council of Economic and Social Policy] 3107 and 3133 of 2001—that set forth principles, guidelines, and directions for state agencies in risk identification and classification.

The Deputy Directorate of Risk implemented the methodology for the estimation of the level of exposure and potential state contingent liabilities and the amount to be saved in the Contingency Fund for State Entities. Furthermore, by means of Resolutions 2080 of July 31, 2008; 6128 of December 22, 2008; and 446 of February 24, 2010, the MHCP published the methodology to calculate the discount rate for road and railway concessions. Subsequently, Law 1508 of 2012 established the legal framework for PPPs, and Article 11 of the law established risk identification, classification, and approval of the valuation of contingent liabilities by MHCP, as a prerequisite for the bidding of a contract for PPP projects.

The contingent liabilities from infrastructure projects developed under PPPs as of December 2011 is Col$1.42 billion (constant price as of December 2010) for the medium-term fiscal period (2011–21). It represented 0.26 percent of the country's GDP (see table 7.2 later in this chapter).

Contingent Liabilities Caused by Legal Proceedings against the Nation

In 2004, the Deputy Directorate of Risk began assessing legal proceedings dealt with at the higher courts and district courts from the State Council and the High Court to determine the probability of conviction in each for the subsequent calculation of the total probability of judgments against each of the active judicial procedures. Since then, the Deputy Directorate of Risk has made significant efforts that allowed the following: first, the implementation since 2010 of a methodology for the valuation of contingent liabilities from national litigation activities,[1] and second, support in structuring a sound database and material that allows the estimation of the contingent liabilities arising from litigation activity of the different law enforcement agencies nationwide.

Contingent liabilities from legal proceedings against the nation totaled Col$76.66 billion[2] (constant price as of December 2010), for fiscal period 2011–21. This represents 14.04 percent of the country's GDP, which places legal proceedings against the government of Colombia as the most important source of contingencies (see table 7.2 later in this chapter).

Contingency Fund of State Agencies

Proceeds managed in the Contingency Fund correspond to the contributions made by state agencies, contributions from the national budget, financial returns generated by these proceeds, and recovery product portfolio. The proceeds going to the fund have been determined through methodologies developed by the MHCP.

The Contingency Fund had an available balance of US$255 million as of 2011, of which 87 percent corresponded to the contributions from highway infrastructure concessions and 13 percent to contributions on account of guarantees of public credit operations (see table 7.1).

Disaster Risk Financing Strategy as a Component of Contingent Liability Management

The fiscal risk management strategy to deal with the occurrence of natural phenomena is under development. Important progress has been undertaken toward the formulation of an ex ante disaster risk financing strategy in Colombia. Focusing on sovereign disaster risk financing, the MHCP

Table 7.1 Accumulated Balance for the Contingency Fund for State Entities
US$, millions

Period	Contributions		
	Infrastructure	Public credit operations	Total
2005	8.7	1.7	10.4
2006	14.6	3.7	18.3
2007	27.9	6.4	34.4
2008	40.1	10.6	50.7
2009	53.0	17.3	70.3
2010	96.9	25.4	122.3
2011	221.4	33.1	254.5

Source: Fiduciaria La Previsora S.A.
Note: Constant US$ millions as of December 2010.

has assessed contingent liabilities of the government associated with natural disasters and integrated such contingencies in a disaster risk financing strategy, relying on risk retention and risk transfer mechanisms, which is currently under development.

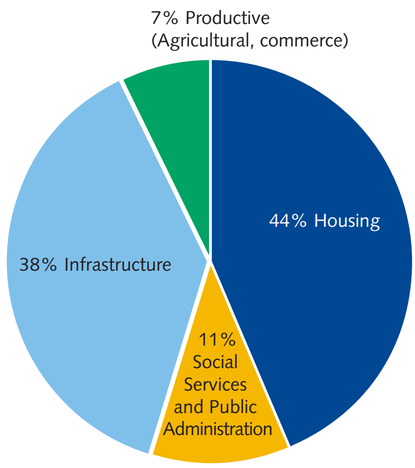
Economic Losses Caused by the Occurrence of Disasters

The government of Colombia has been affected by the occurrence of disasters caused by natural phenomena that produced fiscal impacts, high vulnerability of human settlements, and socioeconomic impacts. According to ERN-GAR (2011), the biggest historical losses per presidential period for Colombia have been US$3.5 billion (1998–2002) for the period in which the earthquake in the coffee region (1999) occurred, considered one of the greatest-intensity events with the estimated damage amounting to US$1.558 billion (see figure 7.1).

Since 2011, the country has been affected by widespread floods, specifically in the agricultural and infrastructure sectors. The estimated losses are US$4.461 billion,[3] higher than those caused by the earthquake in the coffee region. Major losses recorded were in the housing and infrastructure sectors, which amounted to about 82 percent of total economic losses. The estimated losses in primary and secondary road networks are US$ 1.703 billion (see figure 7.2).

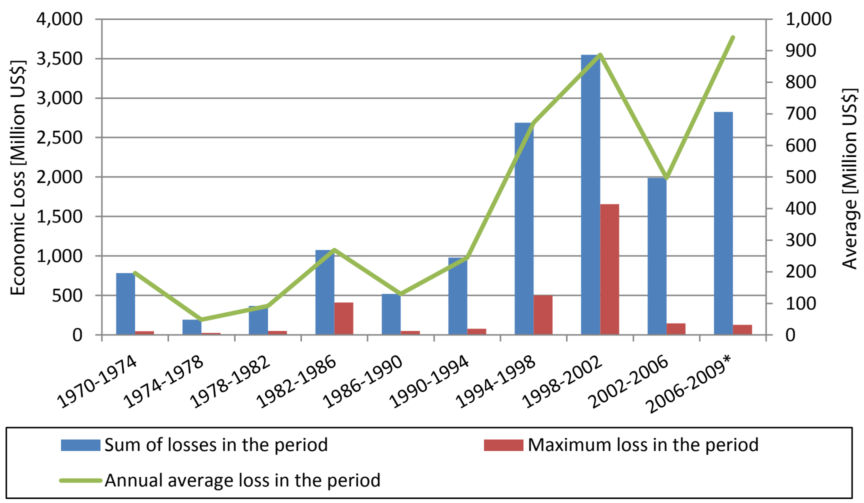
The Colombian government has been managing the fiscal risk of those events with budget transfers, international cooperation, and a

Figure 7.2 Economic Losses Per Sector, Rainy Season



Source: DNP and IDB-ECLAC

Figure 7.1 Economic Losses Per Presidential Period, Colombia



Source: ERN - GAR (2011).

contingent loan from the World Bank (through a Catastrophe Deferred Drawdown Option, Cat DDO). In the institutional framework, the government created a special account (Colombia Humanitaria) in the National Calamities Fund (Fondo Nacional de Calamidades, FNC) for the response to emergencies and an Adaptation Fund, whose purpose was response and rehabilitation in emergencies, which as of June 2011 was nearing Col$6.8 billion.

Fiscal Disaster Risk Management

In 1983, Colombia experienced an immense natural disaster, the Popayan earthquake. For this reason, the government took its first great step in risk management, setting up the FNC by means of Decree 1547 of 1984, to respond to needs arising from catastrophes. With losses of US$246 million, the government gave high priority to establishing by means of Law 46 of 1988 a coordinating system for the actions directed at prevention and response to natural disasters, creating the National System for the Prevention and Attention of Disasters (Sistema Nacional de Prevención y Atención de Desastres, SNPAD). Subsequently, CONPES document 3318 of 2004 provided guidelines for the execution and procedures of an external credit with multilateral banks in an amount of US$260 million to partially finance the Adjustable Program for Vulnerability Reduction with an implementation period of 10 years starting fiscal year 2005, financing the various targets proposed in the framework of national policies and disaster prevention with a Cat DDO loan of US$150 million.

The plan for the Implementation of the Project for the Reduction of Fiscal Vulnerability of the State facing Natural Disasters is divided into five basic components developed by different institutions. In component E, "risk transfer," the MHCP was designated as the unit responsible for the design of public policies that the national government should put in place to encourage the development of an insurance market for natural disasters as a strategy to reduce the state's fiscal vulnerability.

Given this institutional framework, the Colombian government has used various instruments to deal with the occurrence of disasters caused by natural phenomena, including the following:

- Ex post:
  - Budget reassignment. The amount of budget resources which could be reallocated for emergency response is not very flexible. According to the Interagency Technical Committee (2010), 86 percent of the nation's 2010 general budget was composed of inflexible items, because the constitution allocates income to specific destinations (debt service, pension payments, and transfers to territorial entities).
  - Ministry proceeds. Some ministries, such as Housing and Transport, have budget resources in response to emergency events, including resources for subsidies.
  - Municipality proceeds. Some municipalities have disaster funds; for example, Bogotá has its own cumulative fund for risk prevention and assistance.
  - Domestic and external debt.
  - Tax creation.
  - Sale of assets.
- Ex ante:
  - FNC. This noncumulative fund responds only to recurrent events.
  - World Bank contingent credit loan (Cat DDO). This prenegotiated credit facility was fully disbursed because of La Niña 2010–2011, complying with its objective of providing immediate liquidity in case of the occurrence of a disaster.
  - Public asset insurance. Law 42 of 1993 provides for the mandatory financial protection of state property. However, the government of Colombia has not yet taken advantage of risk diversification and economies of scale associated with managing a portfolio of public assets.

Financial Strategy to Strengthen Fiscal Disaster Risk Management

If one uses the methodology to estimate the Disaster Deficit Index (DDI) developed in the framework of risk indicators and management for the Americas by the Interamerican Development Bank (Ghesquiere and Mahul 2010; IDB 2000), the plan for Colombia is as follows:

- DDI 100 = 1.28
- DDI 500 = 2.07
- DDI 1,000 = 2.37
- DDI 1,500 = 2.53

From the the DDI list, one can conclude that the current national government could not cover the cost of extreme disasters; that is, it could not replace items for which it is the main responsible party.

Disasters caused by the occurrence of natural phenomena are the second most important source of contingent liabilities for the government of Colombia. Contingent liabilities associated with legal proceedings are the largest ones (see table 7.2).

Table 7.2 Estimated Contingent Liability

Contingent liability	% of GDP
Legal action	14.04
Infrastructure project	0.26
Public credit operation	0.22
NATURAL DISASTER*	
Fiscal Portfolio (Contingent Liability)	1.40
Public and Private Portfolio	11.3

Sources: MHCP 2011. Contingent liability associated with natural disasters is calculated from PML estimated by UNISDR (2011) US$35.615 billion (TR 250 years).
PML: Maximum Probable Loss
TR: Return Period (Years)
* Contingent liability associated with natural disasters is calculated from PML estimated by UNISDR (2011). The contingent liability is 1.40% GDP (US$4.417 billion – Return period 250 years) and the PML public (contingent liability) and private is 11.3% (US$35.615 billion (Return period 250 years))

Development of Risk Transfer Solutions and Development of a Retention Strategy

After a review of the responsibilities assumed in past disasters, two responsibilities assigned to the state stand out: on the one hand, the state's public buildings, that is, buildings of national entities, which are clearly a responsibility of the national government, and on the other hand, buildings for strata 1 and 2 of the population.[4]

In this vein, the MHCP in November 2007 contracted a consultant to produce maps and georeferencing of state properties. The consultant concluded that 5,530 properties should be assessed, concentrated among 140 entities, to establish the value at risk.

In late December 2007, the consultant's final report on implementation of mechanisms to ensure that nationally owned property is financially protected against catastrophic risk was delivered by the ERN- Consortium. The study's main conclusion is that the best alternative for risk management for natural disasters is to insure the public real estate portfolio for fire and catastrophic risk through a single policy with an insurer or temporary union of insurers.

In accordance with these results and Article 220 of the National Development Plan 2010–2014: Prosperity for All, which established that the MHCP is in charge of developing a DRFI strategy aimed at reducing the fiscal vulnerability of the state against the occurrence of disasters caused by natural phenomena, the MHCP is developing a DRFI strategy that considers an approach to the varied layers of risk.

For the lower levels of risk (high frequency/low cost), instruments such as reserve funds can be considered. For middle-risk layers, reserves would not be sufficient and contingent credit facilities can be used. For high-risk layers, catastrophe bonds or risk transfer strategies can be used. In this context, the main components of the strategy being designed are as follows:

- *DRFI strategy note on fiscal risk management of disasters caused by natural phenomena.* This note includes the general activity plan for developing the DRFI strategy.
- *Development of risk transfer solutions for public buildings, key transport infrastructure, and housing of vulnerable population*. As a first stage, the MHCP foresees improving the current insurance scheme for the central government's public buildings. Currently, each of these government entities is buying its own insurance policy (as legally mandated). The MHCP has determined that managing the insurance as a diversified portfolio will allow improvements in the current insurance scheme. Consequently, a mechanism for grouping risk for buying a collective insurance policy for central government buildings is being developed. By late 2012, a financial tool using CAPRA (a disaster risk information platform for use in decision-making) will be developed for supporting the financial decision process regarding the design and implementation of a solid and sustainable DRFI strategy for public buildings of the central government (including health and education sector buildings).

  Transport infrastructure has been one of the sectors more affected by earthquake and flooding events. Consequently, it has been identified as a second priority for the development of the DRFI strategy. A financial risk assessment study is being prepared for input in designing the DRFI strategy for key transport infrastructure. Preliminarily, the strategy will evaluate parametric insurance and instruments from capital markets, among other options.

  Housing of vulnerable parts of the population has been the other sector severely affected by earthquake and flooding events. It has been identified as a third stage of the development of the DRFI strategy. Financial risk assessment must be done to design the DRFI strategy for this sector. Preliminarily, and as for the key transport infrastructure, the mentioned strategy will evaluate parametric insurance and instruments from capital markets. Additionally, the MHCP is evaluating internal procedures to assign proceeds of a second DPL with Cat DDO to housing of the vulnerable population and to health and education sector buildings.

- *To create a strong retention strategy, the government of Colombia is generating a legal and institutional framework for developing a cumulative disaster risk management reserve fund.* Like FONDEN (Fondo Nacional de Desastres Naturales, National Fund for Natural Disasters) in Mexico, this fund must be able to get financial instruments in the market. This fund would be in charge of issuing, subscribing, and buying financial protection instruments for central government public buildings, key transport infrastructure, and housing of the vulnerable population.
- *Budget execution mechanisms.* The availability of funds is one of the determining factors to address the catastrophic events, but this must be accompanied by mechanisms for efficient budget execution.
- *Capacity building*. Developing and implementing a sustainable disaster risk financing strategy requires capacity building.

To strengthen the design and implementation of a sound DRFI strategy, the government of Colombia issued a legal framework to support and supplement the DRFI strategy: (a) Decree 48, of December 2001 established that earthquake reserves would be established taking into account the real country exposure, which must be measured through technical models; (b) Article 11, number 4, of Law 1508 to avoid the generation of disaster risk conditions; (c) law on contracting process; (d) CONPES 3714 of December 2011, defined the occurrence of natural phenomena as a source of risk which must be estimated.

Challenges

The design and implementation of a risk financing strategy to reduce fiscal vulnerability to natural disasters is a challenging priority for Colombia's ministry of finance. Capacity building and generation of the required data for financial risk assessment are needed for a sustainable process. In this vein, the MHCP will do the following:

- Negotiate the second DPL with Cat DDO in 2012 as an instrument to reduce the fiscal vulnerability of the state against the occurrence of natural disasters. Implement the improvement of the current insurance scheme for the central government's public buildings pursuant to existing regulation and valuation.
- Diagnose the proceeds being allocated for structural reinforcement of public buildings and in health and education sector buildings after the design and implementation of a risk financing strategy to reduce fiscal vulnerability to natural disasters in this sort of buildings.
- Make explicit the natural hazard risks in procurement, for which the country has advanced funds, so the government has policy guidelines regarding the identification of the types of risk as required by CONPES 3133, 3107, and 3714 and by Law 1508 of 2012, which sets forth as a requirement for contracts of public-private partnerships a study of threats and vulnerability to disaster risk conditions. This should be submitted to the MHCP.
- Dedicate special effort to the transport infrastructure to evaluate its vulnerability to different hazards, particularly floods, as well as to flood modeling to estimate the risk of a highly vulnerable sector with the Ministry of Transport.
- In addition, a more accurate risk assessment for the housing of vulnerable population is needed. Half of the housing in Colombia was built before the enactment of any building code, and half of the current housing is built informally without complying with all the regulations, making this a very vulnerable sector too.
- The MHCP is committed to develop a financial catastrophe risk model, which would include an actuarial/financial model to build on the modeled losses of the catastrophe risk model and the historical losses. This tool would assist the MHCP in the design and implementation of the national DRFI strategies, including determining budget allocation for reserves and any disaster risk transfer strategy (such as insurance).
- The MHCP will evaluate parametric instruments or instruments of the financial market to protect priority infrastructure of the country.

Similarly, the MHCP will move to include in the Manual of Good Practices for Contracting, natural events such as practical tools in the recognition of an optimal insurance, for which it would count on the support of government entities, according to their skills. It would include clauses of solidarity with the private sector in disaster relief to strengthen the procurement system and the establishment of a Manual of Good Practices for Contracting, for events of natural origin.

Notes

1. This methodology may be consulted at the website of the Ministry of Finance, http://www.irc.gov.co/irc/es/riesgo/valoraciondepasivoscontingentes
2. This value does not include process No. 2003-02308, which is a proceeding brought against the Colombian Institute of Agrarian Reform (INCORA), currently under liquidation, by the Ministry of Agriculture and Rural Development. This process has a value of Col$594.24 billion of constant 2003 pesos (US$333.22 million), according to the claim filed by the plaintiff. Its indexation as of December 2010 amounted to Col$834.12 billion (US$467.73 million). With this value, contingent liability from legal proceedings against the nation will be Col$414 billion.
3. May 2011 figure reported by DNP IDB-ECLAC (2011) Presentation: "Assessment of damages (or loss) resulting from Rainy Season (La Niña) 2010-2011". The collection and processing of information on the impact comes from official sources, mayors, and municipal, provincial and government which was facilitated by the Risk Management Division (DGR), Ministry of Interior and Justice, the Administrative Department of National Statistics (DANE), the Codazzi Institute (IGAC), and the National Planning Department (Departamento Nacional de Planeación, DNP).
4. The population belonging to strata 1 and 2 correspond to groups of the poorest people of Colombia.

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This chapter presents the French experience for collecting and managing data on natural disasters and for developing adequate risk financing strategies. It describes the French CAT/NAT regime, providing effective coverage against damages from natural disasters for nearly 30 years. A draft bill has very recently been finalized to address two weaknesses which have emerged over the past decade: a lack of clarity in the legal framework and insufficient incentives for risk prevention. To build a more comprehensive and robust risk information system, the public authorities and the insurance market are working hand in hand to establish the Observatoire National des Risques Naturels, to deliver homogenized and tallied nationwide information locally. This is expected to be an excellent example of public-private partnership and integration.

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CHAPTER 8:

The French Experience on Disaster Risk Management

*This chapter is a submission of the Government of France**

Introduction

Natural disasters regularly cause large numbers of human and economic losses throughout the world. While their magnitude and impact are not the most severe in France, some events have shown that human and material damage can nevertheless be considerable and induce consequences on the local or national economy. Thus, France has developed its expertise in understanding and prevention of natural hazards and in natural disaster risk management.

The current Catastrophes Naturelles (CAT/NAT, or Natural Catastrophes) insurance regime was established by law on July 13, 1982. Since then, disaster risk management in France relies on a dual approach. First, it ensures efficient financial coverage for natural disasters through a properly designed insurance scheme to mitigate the consequences on the local or national economy. Second, it seeks to decrease the vulnerability and exposure of people and property by pursuing three main objectives: (a) preventing damage and reducing its impact, (b) keeping citizens better informed with a view to increasing their ownership, and (c) managing crises and disasters more effectively when they occur.

Managing Disaster Risk Consequences: The French CAT/NAT regime

Before the law of July 13, 1982, natural catastrophes (flood, earthquake, drought, volcanic eruption, and so forth) were traditionally excluded from insurance policies. There were three main reasons for this lack of coverage: (a) absence of reliable statistics regarding this type of phenomena, (b) serious accumulation risk wherein a single event can affect large numbers of insureds, and thus insurers' exposure is hard to assess, and (c) anti-selection risk in which only those exposed are willing to purchase insurance. Initial deliberations on the creation of a public facility, that is, relying solely on an ex post government response, started in the early 1980s. Corresponding draft bills were submitted to Parliament to this end. However, the occurrence of serious floods in 1981 increased public awareness and contributed to a shift in the design of the policy response. The initial project was turned into an ex ante mixed system, relying on both the insurance industry and the state—the French CAT/NAT regime.

In light of the magnitude of this flooding, the cost-effectiveness of the ex post compensation model was questioned, because its targeting was weak. With thousands of properties damaged, delays for compensation delivery would have been extremely long while the fiscal burden to the state would have been hardly predictable and sustainable over the medium to long run.

*Sébastien Raspiller, French Ministry for the Economy, Finance and Industry, Directorate-General of the Treasury

A Regime Designed to Meet the Need for Large Coverage While Ensuring Affordability, Consistency, and Financial Sustainability

The CAT/NAT regime, a public-private insurance scheme, was a preferred option. All insurance coverage against fire or against any other type of damaged goods must include a provision for natural catastrophe coverage. Hence, buildings and moveable property (including motor vehicles) are eligible. This category includes, among other things, domestic properties and their contents; industrial and commercial installations and their contents; buildings owned by local authorities and their contents; agricultural buildings; and vehicles, car accessories, and equipment as long as they are covered by the basic insurance (for example, basic household insurance for domestic property).

The purchase of the basic property damage insurance being voluntary in France, coverage against natural catastrophes is sold on a voluntary basis as well. But this automatic bundling to a basic coverage ensures a very high penetration rate: estimates show that household insurance is subscribed to by 97 percent of the French population, as is the natural catastrophe coverage.

France is exposed to a variety of natural disasters, and the natural catastrophe insurance guarantee covers all "uninsurable damage" caused by natural phenomena and thus enables risk pooling. In practice, the French CAT/NAT regime covers floods and mudslides, earthquakes, landslides, geotechnical subsidence (differential landslides following drought and rehydration of the soils), tidal waves, water flows, mud or lava, moving masses of ice or snow, and so forth. It covers neither wind damage from storms because they were considered "insurable" by the law of June 25, 1990, nor damage from hail, weight of snow, or frost.[1]

The damage must be "direct," arising solely as a result of the action of a natural phenomenon of "abnormal" intensity to the property insured (for example, the loss of goods in a freezer will be included only if the machine itself was damaged, thus excluding a simple power cut). The CAT/NAT guarantee covers the cost of direct material damage to the property up to the value in the basic insurance policy. The guarantee is subject to the policy's terms and conditions at the time the risk first occurs. The CAT/NAT coverage is also extended to include all business interruption policies. In this case, it covers loss of gross profit and additional operating costs during the indemnity period specified in the policy.

A compensation procedure that ensures consistency and equality of treatment throughout the territory

All compensation under the regime is subject to two prior conditions being met: the damaged property must be covered by a basic insurance policy and a state of natural disaster must be declared by interministerial decree. A causal link must exist between the natural disaster declared in the decree and the damage suffered by the insured.

The process of declaring a state of natural disaster is initiated by local authorities and submitted to the government representative (the prefect). The decision to qualify a situation as a natural disaster as defined by the law (a natural phenomenon of "abnormal" intensity) is made by an interministerial commission composed of representatives of the Ministry for the Interior, Overseas Territories, and Local and Regional Authorities; the Ministry for the Economy, Finance, and Industry; and the Ministry for the Budget and Public Accounts. The commission is advised by meteorological or geological services, and it bases its decision on objective data. The decision-making process guarantees consistency throughout the territory and ensures that two neighbors living on the same street are treated the same way, regardless of their insurance company.

The claims procedure is also easy to use and transparent. The insured must file a claim with his usual insurer as soon as he or she becomes aware of the damage. This must be no later than 10 days (for direct property damage) or 30 days (business interruption) after the interministerial decree is published. The insurer must then disburse the claim payment within three months of (a) the submission by the insured of an estimate for damage or lost items or (b) the publication of the decree, whichever is the later. Moreover, the law of July 30, 2003, requires insurers to make a first deposit within two months of either of these two dates.

A setting of premiums and deductibles that ensures affordability and reflects the national solidarity dimension of the regime

The government sets the level of both premiums and deductibles by decree. Since the launch of the current regime, the premium for the CAT/NAT guarantee has been established as a supplemental premium to the premium of the basic insurance policy. The rate of this supplemental premium is determined by a flat pricing mechanism. Today, the rate is set at 12 percent of the premium for property other than motor vehicles and at 6 percent of the premium for fire and theft of motor vehicles.

Deductibles are also set by the government and are structured as follows:

- Property for domestic use, motor vehicles, and other objects not intended for professional use: €380, except in the case of damage from differential landslides following drought and rehydration of the soils, where the deductible is €1,520;
- Motor vehicles: €380 for each damaged vehicle (even if the insurance policy covers several vehicles), except in the case of vehicles intended for professional use, where the deductible contained in the basic coverage shall apply if it exceeds the statutory deductible;
- Property for professional use: 10 percent of the direct property damage loss for each and every location and each and every loss occurrence, subject to a minimum of €1,140, except (a) in the case of damage from differential landslides following drought and rehydration of the soils, where the deductible is €3,050; or (b) if the basic coverage contains a higher deductible, then this higher deductible shall apply;
- Business interruption: three working days subject to a minimum of €1,140, unless the basic coverage contains a higher deductible.

These deductibles apply to any case, any time. They are compulsory, that is, they apply even when the basic insurance policy does not include them. To foster risk prevention, they cannot be covered by any other policy.

Furthermore, since January 1, 2001, a sliding scale has been introduced to allow these deductibles to vary with the implementation of prevention measures. In practice, in districts where a prevention plan for foreseeable natural risks (plan de prévention des risques naturels prévisibles, PPRN) is not in place, the level of deductibles rises significantly when natural disasters tend to occur frequently. The increase in deductibles is linked to the frequency of declarations of natural disaster issued in response to the same type of phenomenon during the preceding five-year period as shown in the following:

- One to two declarations: normal application of the deductibles set out above;
- Three declarations: doubling of these deductibles;
- Four declarations: tripling of these deductibles;
- Five or more declarations: quadrupling of these deductibles.

CAT/NAT regime that provides for a public reinsurance scheme as part of its financial sustainability

Natural catastrophe insurance is subject to significant cost volatility. For example, the cost of direct damage from a flood that would occur every 100 years in the Paris area is estimated at about €11–12 billion, and an earthquake occurring on the Côte d'Azur could reach €15 billion. The insurance market may not be able to cope with such costs without putting at risk its own viability. By offering its sovereign guarantee to the CAT/NAT regime, the French government gives insurance companies clarity on the maximum potential cost to which they are exposed. In doing so, it protects citizens by ensuring their full compensation, and it contributes to the solvency of the regime by containing the liabilities of insurance companies.

Caisse Centrale de Réassurance (CCR), a French state-owned reinsurance company, offers unlimited reinsurance coverage in the framework of the CAT/NAT regime. However, CCR is not the only player in this market, and any insurer may seek coverage from the reinsurer of its choice and may even choose not to underwrite reinsurance. The reinsurance scheme offered by CCR is a twofold coverage combining two basic reinsurance mechanisms. Under the first mechanism, known as *quota-share*, the insurer cedes an agreed proportion of the total premiums collected to the reinsurer, while the latter, in return, commits to covering the same proportion of losses. This proportion is called the *cession*. Conversely, the part of the premium that is kept by the insurer is called the *retention*. Quota-share reinsurance ensures that the reinsurer truly shares the overall riskiness of the insurer's portfolio, because the latter has to cede a percentage of each of the accounts in its portfolio to the reinsurer. Thus, the risk of anti-selection is avoided. The second solution, known as *stop-loss*, covers the portion not ceded on a quota-share basis by the insurer, that is, the insurer's retention. Unlike the quota-share system, this part is non-proportional because the reinsurer intervenes only if and when the total annual losses exceed an agreed-on figure, expressed as a percentage of the premiums retained. In particular, this type of reinsurance enables the insurer to protect itself against the frequency risk, that is, the risk of many claims occurring at the same time (as in the case of subsidence, for example).

In light of the magnitude of potential losses linked to natural disasters, building financial reserves is just as essential a precaution as risk prevention. This is why the natural disaster branch is allowed to fund specific reserves known as *equalization reserves*, supplemental to ordinary underwriting reserves. Insurance and reinsurance companies are allowed to set aside up to 75 percent of their annual profits tax free, provided that the total amount of the equalization reserves does not exceed 300 percent of their annual income. This provisioning is released after 10 years.

The financial sustainability of the CAT/NAT regime was questioned in the late 1990s and early 2000s as a result of a strong deterioration in the loss record caused by a constant increase in the cost of subsidence claims that was reinforced by the occurrence of serious floods. The situation peaked in 2003. However, the French government did not have to operate its sovereign guarantee thanks to the equalization reserves of CCR, which played their buffer role well. Had this trend continued, the long-term stability of the scheme would have been threatened. The government and the insurance market worked together to create a wide range of provisions to restore the financial stability of the regime, to contain costs, and to encourage risk prevention. The agreed measures entered into force in 2000 and 2001 and enabled the regime to come back to balance. Today, the CAT/NAT regime has sufficient provisioning to cope with major natural disasters—for instance, the two serious floods that occurred in France in 2010—without triggering the financial intervention of the state. Nevertheless, the results of these measures can be assessed only over the medium to long run.

A Regime Under Reform to Increase Transparency and Incentivize Risk Prevention

The French CAT/NAT regime was designed nearly 30 years ago. Since then, it has demonstrated its efficiency for the insured, the insurers, and the government, providing very broad coverage against damage caused by natural disasters as follows:

- Ensuring affordability for insurance policy holders. The average premium amount of a basic household insurance policy is about €220 per year. Hence, the average additional premium amount of the CAT/NAT guarantee is about €25 per year for dwellings. On

aggregate, the global amount of CAT/NAT premiums was approximately €1.3 billion in 2011. The global amount of CAT/NAT claims has shown great volatility: it was as high as €2.4 billion (in 2011 euros) in 2003 and as low as €120 million (in 2011 euros) in 2004. The main CAT/NAT perils in France are floods (55 percent of the amount of claims, on average, over the past two decades) and subsidence owing to drought (41 percent).
- Ensuring a swift delivery of compensation, even with thousands of claims.
- Preserving the integrity of the relationship between insured and insurers.
- Protecting public monies. The very high penetration rate of coverage is achieved without any subsidies to premiums, and public intervention is now contained to a few very serious catastrophes (for example, a flood that would occur every 100 years in the Paris area).

Over the past decade, severe natural disasters in France, such as the drought of 2003 and the Xynthia windstorm and subsequent flooding in the Var in 2010, have revealed two weaknesses of the regime: a lack of clarity in the legal framework, detrimental to the transparency and fairness to policyholders, and insufficient incentives for risk prevention. A draft bill has very recently been finalized to address these shortfalls, without undermining any of the strengths of the CAT/NAT regime.[2]

The current legal framework does not establish a list of what would be considered a natural hazard covered by the regime. Despite a step-by-step clarification process since the launching of the regime, the notions of *uninsurable damages or hazard of abnormal intensity*, which legally trigger the mobilization of the CAT/NAT regime, entail a part of judgmental appreciation. These notions were judged not operational enough to ensure full consistency in the declaration of a state of natural disaster. Thus, they were not clear enough to preserve fairness and equity of treatment among citizens. In response, the draft reform clearly defines the scope of the regime, establishing a list of eligible natural perils and clarifying its articulation with construction insurance for the management of subsidence risks. It also clearly defines how the intensity of natural perils is assessed—through scientific expertise based on objective data. Today, few people know how the decisions are made. In the near future, that will not be the case thanks to the creation of a list of eligible natural perils and the definition by decree of the methodology to be used by scientific experts to assess the intensity of those perils. As a result, predictability will be significantly improved, strengthening transparency and fairness to policyholders while incentivizing the insurers to develop the still embryonic market for natural perils of normal intensity.

The weakness of incentives for risk prevention was highlighted as a second shortfall and the draft bill proposes several improvements.

The flat pricing mechanism for setting the CAT/NAT premium, without consideration of either risk exposure or efforts made to reduce vulnerability to risk, contributes to the affordability of the system. However, it does not encourage policyholders to implement any preventive measures. In this respect, it could also be seen as a missed opportunity to incentivize the main stakeholders through a pricing signal. While preserving the framework of national solidarity that characterizes the CAT/NAT regime, the reform aims to shift the current equilibrium toward greater incentives by introducing an option for a risk-based pricing mechanism within a range to be defined by decree. This option will be offered to large businesses and local authorities only—the stakeholders that are reasonably able to implement transformational prevention works and can engage in a dialogue with the insurers on the matter.

Today, compensation under the CAT/NAT regime may be granted even for properties knowingly built in breach of the administrative rules for prevention of natural hazards. This provision has been questioned because national solidarity should not bear the costs induced by irresponsible behaviors. Therefore, the draft bill includes revisions to the framework to ensure that the benefits of the CAT/NAT compensation will no longer be granted to properties built in breach of the law, that is, properties built without any authorization on lands that are classified as unbuildable by a PPRN.

The draft bill also introduces measures to prevent risks associated with drought for new buildings, aimed at significantly reducing or even eliminating such risks by appropriate construction standards.

There is so far no provision within the CAT/NAT regime for a disciplinary device aimed at incentivizing risk prevention against damage from subsidence owing to drought. Moreover, to be effective, prevention measures must take place during the construction phase. Therefore, the draft bill introduces major changes in the insurance treatment of such a risk. First, during construction and the following period of 10 years, coverage will be ensured through a construction insurance scheme to empower all builders and building owners; coverage will be provided through the CAT/NAT insurance regime only after 10 years. Second, any new construction in clay areas will have to be grounded on a soil study determining the presence of clay. If so, specific building standards will have to be followed. This measure will slightly increase the cost of construction, but it will help avoid damages and, thus, losses. Everyone is better off by paying a little more at the beginning of construction than by risking a large loss at the end.

The reform is based on a shared vision among all stakeholders—victims, consumers, local authorities, companies, the insurance market, the construction market, scientific organizations—and grounded by a large consultation process. A public consultation, organized in the summer of 2011, showed strong support for the main objectives and a broad consensus among stakeholders. The draft bill has greatly benefited from their inputs.

Strengthening Disaster Risk Assessments: The Project of the National Observatory for Natural Hazards

By strengthening incentives to prevention efforts and encouraging responsible behavior, the draft bill described above will consolidate the French CAT/NAT regime over the long run. But building resilience to natural disasters also requires a risk-management strategy based on robust risk information, analysis, and modeling. In France, such a strategy was developed gradually by the public authorities and the insurance market independently, benefiting from the lessons learned from nearly 30 years of experience with compensation through the CAT/NAT regime.

Various public and private organizations have gathered a wealth of information serving different purposes: knowledge of natural perils, prevention, crisis management, and so forth. For instance, ministries and other government bodies, linked to the Ministry for Ecology, Sustainable Development, Transport, and Housing among others, have gathered data and mapped natural perils and their magnitude.

Exposure data have also been collected from diverse sources. A specific data collection system is used within the CAT/NAT regime by CCR, which contracts with many insurers. As part of the reinsurance contract signed with CCR, insurers are requested to provide CCR with information on the risks insured—risk by risk, for each building insured—as well as on the claims filed. The confidentiality of these data is protected. Each insurer has online access to the vulnerability of its mapped portfolio against different natural perils with an estimate of potential claims and a benchmark of its exposure against the market average. Data collection continues, and estimates show that the data collected represent approximately half of the market. Thanks to this data collection exercise, CCR has developed models for the main perils (flood, subsidence owing to drought) with a deterministic view as well as a probabilistic approach.

French insurance companies have also built their own data collection system. After the 1999 flood and storm episodes and following a decade of increasing losses owing to subsidence, the two business associations of the French insurance market—the French group of insurance companies, Fédération Française des Sociétés d'Assurance (FFSA), and the group of mutual insurance companies, Groupement des Entreprises Mutuelles d'Assurance (GEMA)—launched a task force for natural risks, Mission Risques Naturels (MRN, or Natural Risks Mission). Because there was no centralized public information system for gathering the wealth of partial data, the insurance market developed its technical interface that provides more transparent and structured access to public data and projects.

The MRN acts as an agent and often as a conductor for the members of FFSA and GEMA. The principal activities of MRN include the following:

- Support for risk knowledge management by contact groups set up between the MRN and the public authorities that contribute to the dialogue on activities of common interest with public authorities, both local and national;
- Provision of professional online services that provide access to public data for hazard zoning and regulatory zonings;
- Monitoring of asset exposure for the main categories of insured assets (dwellings and professional buildings);
- Ranking of tools that assess collective vulnerability at the local level and that help assess the adequacy and efficiency of risk prevention plans;
- Development of practical guidelines to address each category of hazards.

The main challenge remains to gather and homogenize data collected from various sources locally or nationally. To address the challenge, terms need a common definition, data need a shared methodology on the collection and gathering on a meta-basis perspective, and data aggregation needs a standard. Also, the data and resulting indicators need qualitative assessment. But the heterogeneity of sampling used by the various sources may remain an impediment to data cross-combination, even with a common framework, especially because perils ignore administrative zoning boundaries. Integrating public and private data is just as demanding because the private sector's willingness to share could be limited by considerations of competitive advantages.

Based on these needs and constraints and with a view to strengthening and standardizing available data, the creation of a public-private platform, ruled by soft law— the Observatoire National des Risques Naturels (ONRN, or National Observatory for Natural Hazards)—is under development.[3] The ONRN will be tasked with delivering homogenized and tallied nationwide information on a municipal basis, with indicators derived from different sources. Public authorities, private insurers, and CCR are working hand in hand to establish this institution, which will be hosted by the Ministry for Ecology, Sustainable Development, Transport, and Housing. This outcome is expected to be an excellent example of public-private partnership and integration.

Notes

1. This clarification process began in 1984 with the promise of windstorm coverage by insurers, a measure that proved insufficient because a large number of insureds, particularly industries, refused to purchase the coverage. The law of June 25, 1990, made it compulsory to cover wind damage from storms when covering fire damage or any other damage of property in France. This was an important step. By definitively excluding damage caused by wind from the scope of the CAT/NAT regime, the law also contributed to a better definition of natural risks considered "insurable," such as storm, hail, weight of snow, frost, and so forth.
2. See Sénat, http://www.senat.fr/dossier-legislatif/pjl11-491.html.
3. The agreement to launch the ONRN and establish its goals was signed May 3, 2012, by the Ministry for Ecology, Sustainable Development, Transport, and Housing, CCR, and MRN.

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:

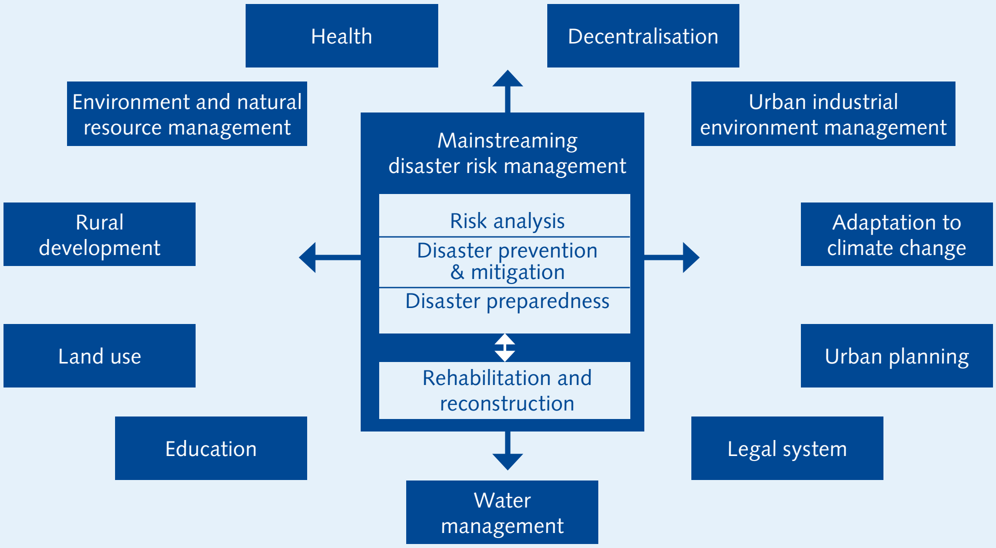
*Edited by: Florian Neutze (Federal Ministry for Economic Cooperation and Development); Wolfgang Lutz (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH)

- 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

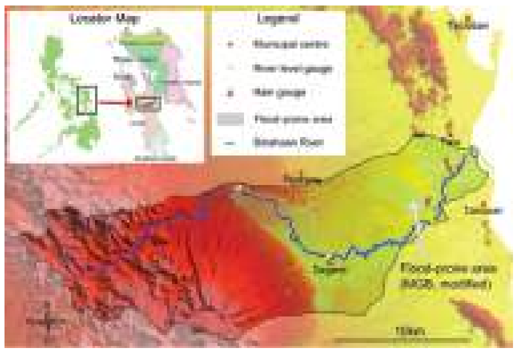
In the Philippines, sizable catchments quickly drain large amounts of rainwater in downstream areas. The country is affected annually by two monsoon seasons, and on average, nine typhoons make landfall. While typhoons can lead to exceptional rainfall, local flooding is also frequent during monsoon season.

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

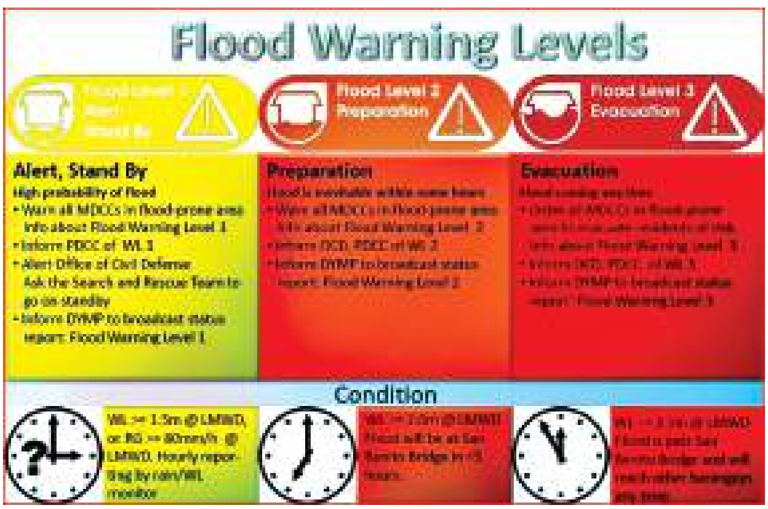
Source: Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH.
Note: LFEWS = Local Flood Early Warning System

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 cooperation 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)

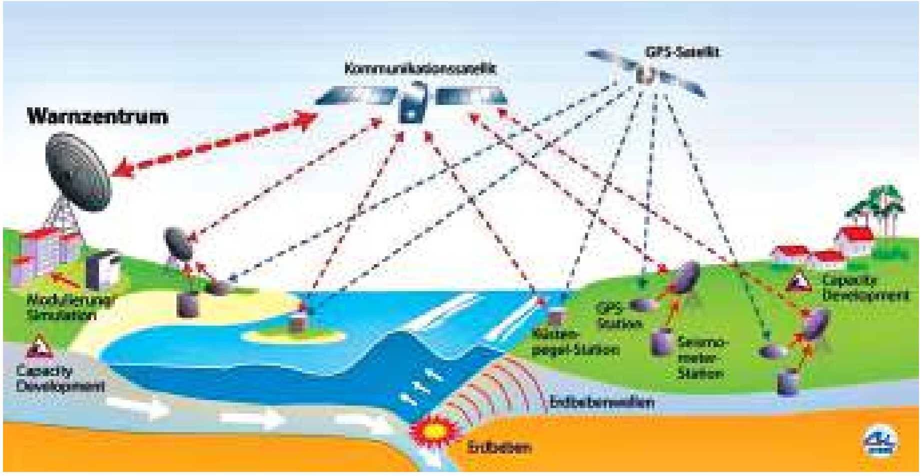
Indonesia is located along the most prominent active continental margin in the Indian Ocean, the Sunda Arc, and is one of the most threatened regions of the world in terms of natural hazards such as earthquakes, volcanoes, and tsunamis. On December 26, 2004, the third-largest earthquake ever instrumentally 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.

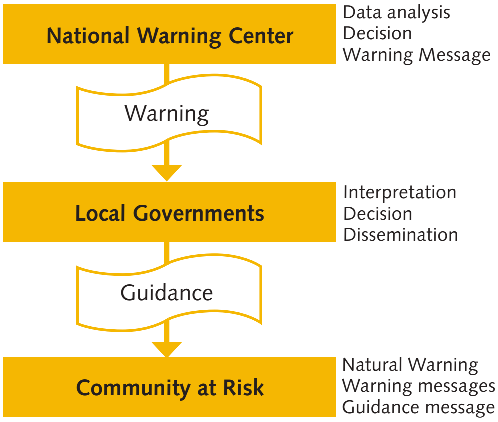
in January 2005 to make a substantial contribution to this extensive EWS through the German Indonesian Tsunami Early Warning System (GITEWS), based on the long cooperation between the German Federal Ministry of Education and Research (BMBF) and the government of Indonesia (see figure 9.3).

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)

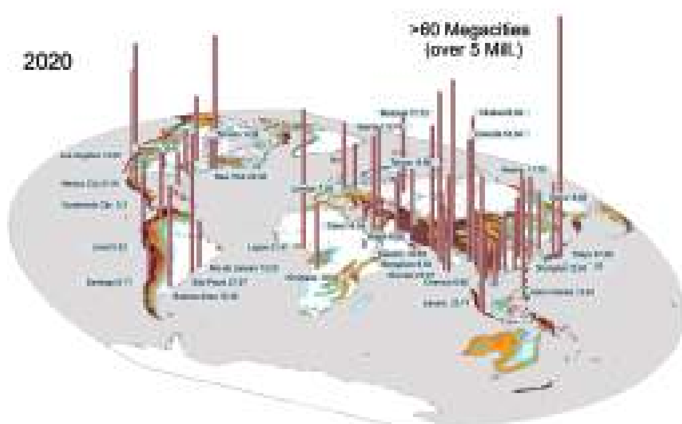
A major issue in the quantification of the risk associated with the full spectrum of natural hazards is the highly dynamic, dramatically increasing, and globally interdependent nature of the phenomenon. However, such characteristics are not yet accounted for in conventional risk models, where researchers, 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 semiquantitative 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)

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

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.

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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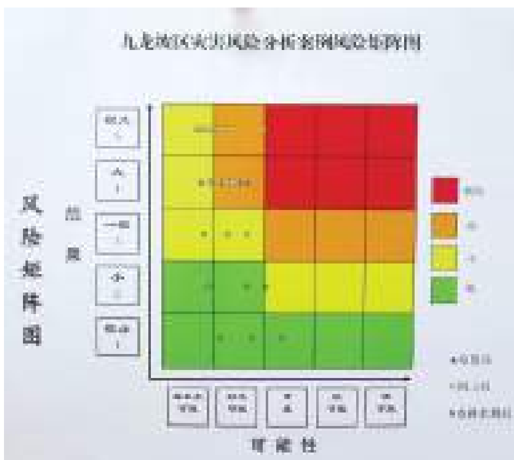
Figure 9.7 Risk Assessment Matrix, Jiulongpo District, Chongqing Municipality



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:

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

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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Protecting life, property, settlements, and the environment from disasters is costly and complex. A proper institutional framework is needed to coordinate actions, and a clear definition of critical processes and infrastructures is essential to guarantee business continuity. The latter is particularly important for the financial market and payment infrastructures where operational risk and coordination failures have systemic implications. Since 1992, Italy has relied on the Civil Protection Department, a complex system organized by the central government. For the financial sector, the Committee for Service Continuity, established in 2003 and chaired by Banca d'Italia, is a pilot organization for crisis management and prevention coordination among different economic agents; it merges private and public stakeholders' interests in a flexible structure.

CHAPTER 10:

From *Business* Continuity to *Service* Continuity: The Case of the Italian Financial System

*This chapter is a submission of the Government of Italy**

Introduction

The list of natural disasters that have had serious economic impacts in the 21st century is long. They include the severe acute respiratory syndrome (SARS) outbreak (2003), Hurricane Katrina (2005), the South Asian tsunami (2004), the swine flu pandemic (2009), the earthquake in Abruzzo, Italy (2009), and Japan's earthquake and tsunami (2011). Disruptions from these and other disasters have rippled across supply chains; shaken entire industries; and taken their toll on employee, customer, and partner relations.

As a result of these dramatic events, governments and economic agents now consider crisis preparedness and crisis management key components of policy and business planning. For governments, the first step is to identify a set of essential and critical infrastructures whose disruption would have major consequences on the functioning of the economy and the well-being of citizens. Although the types of organizations usually included in these lists vary, the most common sectors and activities classified as critical include utilities, communications, transport, finance, and public administration.

Disruption of critical infrastructure exposes industrial economies to negative cascade effects because the infrastructures are interdependent. As the Organisation for Economic Co-operation and Development (OECD) underlined in its recommendations, national legislation and regulations should identify the roles and responsibilities for effective business continuity planning. The legislation and regulations need to identify critical components of the business and public sectors and to determine measures that ensure the functioning of critical infrastructures in the event of natural disasters or other national crises.

Business continuity planning focuses on the so-called operational risk: the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events. Business continuity planning covers events with low statistical probability and events with uncontrollable and unforeseen timing that may have a sizable impact on organizations and society. Business continuity is particularly important in the area of payment and securities settlement systems (checks, commercial paper, bills, transfers, and so forth) because of their network externalities and their relevance for monetary policy operations. A problem arising in a component of the market and payment infrastructures can trigger a systemic crisis. The disruption of an individual participant can have wide-ranging effects beyond its immediate counterparties; at the same time, all financial firms have a role in improving the overall resilience of the financial system.

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In 2008, the European Commission adopted a directive on critical infrastructure to create a consistent framework, one that would also apply to the management of major disruption. Taking into account the different local *critical* factors within the perimeter of general principles, the directive introduced the concept of *service continuity*, which moved the focus from *business needs* to *social functions*. The full exploitation of the directive continues; in the meantime, given the differences among the member states, cooperation in sharing the best national practices is essential.

In Italy, major critical infrastructure providers or lifelines are among the structures involved in the Italian National Civil Protection Service, created by law in 1992. As a national service, the Italian civil protection is a complex system that includes all the structures and activities put in place by the state to protect the life, property, settlements, and the environment from damage or the danger of damage resulting from natural or man-made disasters. All local and central resources necessary for managing a calamity are part of the system, including voluntary organizations; these resources ensure that their specific competences and capacities are implemented in an integrated manner during intervention activities. To ensure the functioning of the critical infrastructure in disasters or other crises, the Italian Civil Protection Department (Dipartimento della Protezione Civile, DPC) manages the coordination of the National Civil Protection Service and the promotion of civil protection activities in case of a national emergency.

Another important initiative in Italy was the 2003 creation of Committee for Service Continuity (Continuità di Servizio. CODISE), chaired by Banca d'Italia. Their mandate is to ensure proper coordination among various economic actors in crisis management and prevention at regional and national levels. CODISE includes private and public stakeholders in a flexible structure. The focus is on minimizing the immediate systemic effects of wide-scale disruption on critical financial services, defining—and periodically exercising—a crisis-management structure together with business continuity for those financial services.

The European Framework for Critical Infrastructures

In December 2008, the Council of the European Union adopted Directive 114/08/EC, "on the identification and designation of European critical infrastructure and the assessment of the need to improve their protection," which gave rise to the European Programme for Critical Infrastructure Protection (EPCIP). The EPCIP objective is to enhance the protection of critical infrastructure in the European Union (EU). This task will be achieved through implementing EU legislation as directives and recommendations released by the European Commission. The legislative EPCIP framework consists of the following elements:

- A procedure to identify and designate European critical infrastructure and a common approach to assess the need to improve safety;
- Measures to facilitate the EPCIP improvements that include an action plan, a warning system on critical infrastructure, the creation of boards on critical infrastructure protection (CIP) at the EU level, procedures for sharing information about the CIP, and the identification and analysis of interdependence;
- Assistance for member states to improve the security of critical national infrastructure and intervention plans;
- Financial procedures to make available new financing measures for critical infrastructure protection.

All of these efforts have been designed to assist and support the individual national efforts.

The directive includes the following definitions:

- "Critical infrastructure" means an asset, system, or part located in member states that is essential for maintaining vital societal functions, health, safety, security, economic, or social well-being of people, and its disruption or destruction would have a significant impact in a member state as a result of the failure to maintain those functions.
- "European critical infrastructure" means infrastructure in member states that, if disrupted or destroyed, would have a significant impact on at least two member states. The significance of the impact shall be assessed with cross-cutting criteria. This includes effects resulting from cross-sector dependencies on other types of infrastructure.

The directive does not distinguish between different scenarios or root causes of risks (natural events, terrorist attacks, incidents, and so forth), but focuses on two concepts: loss of service and impact of service unavailability. The EU approach to critical infrastructure protection is developed and implemented by taking into account sector specificities and existing sector-based measures, including those already existing at European, national, or regional level, and, where relevant, cross-border mutual aid agreements between owners and operators of critical infrastructure already in place. Given the very significant private sector involvement in overseeing and managing risks, business continuity planning and postdisaster recovery, the EU approach encourages full private sector involvement. The directive constitutes a first stage in a step-by-step approach and, as such, it concentrates, for the moment, on the energy and transport sectors. The directive will be reviewed with a view to assessing its impact and the need to include other sectors (such as the information and communication technology sector and the financial sector) within its scope.

In Italy, under the prime minister's offices, a secretariat has been created to coordinate national and international activities and manage relationships with Italian critical infrastructure, including those designated as EU critical infrastructure.

The National Civil Protection Service

In Italy, the civil protection is the National Civil Protection Service, or National Service, a complex system that includes all the local and central resources necessary for managing a calamity, particularly through the activity of voluntary organizations. Compared to other European countries, Italy is vulnerable to many risk factors throughout its territory and, for this reason, has developed an intervention system that starts from a local level and involves all levels of government.

In particular, the National Service includes the following:

- **The Civil Protection Department:** a special member that heads the National Service, directs and coordinates the activities, and intervenes directly in the management of the events that require greater resources because of their extent and duration.
- **Other components:** the local and central authorities like municipalities, provinces, regions, and ministries. They also include all the subjects involved, for various reasons, in civil protection (for example, public authorities, institutes and groups of scientific research, private institutions and organizations, associated citizens and groups of civil volunteers, and professional memberships and boards).
- **Operational structures:** the organized state corps such as the fire brigade, the armed forces, the forestry corps, the mountain rescue team, the Italian Red Cross, and health service structures. Among these, the voluntary organizations of the civil protection service have played a particularly important role, and they have grown in all regions of the country in numbers and skills.

The National Service intervenes to provide relief to the population, to help overcome the emergency, and to aid a return to normality. The mayor is the first person responsible for civil protection in the territory and must cope with the initial moments of a calamity and provide relief to the population, coordinating the local structures (including the civil protection volunteers).

If the municipality cannot cope with the emergency alone, the provincial council and the government's territorial offices intervene by activating all available resources for the areas affected by the calamity. In the most serious situations, the central government intervenes: the President of the Council of Ministers (prime minister) assumes direct responsibility operating through the DPC.

The Coordination of the National Civil Protection Service

For the civil protection system to function effectively, the appropriate level of authorities (municipal, regional, or national) need to take charge of operations according to both the seriousness of the event and their respective areas of competence. In an emergency, the first step is to clarify who decides and assumes operational responsibility for all the activities to be carried out. In cases of a national emergency (as defined by the law), this role rests with the DPC, whereas the prime minister assumes the overall political responsibility. In such cases, Italy has established a clear chain of command for disaster management. The coordination of the National Civil Protection Service and the promotion and development of civil protection interventions and activities are entrusted to the prime minister through the DPC. The National Civil Protection Service is able, in a very short time, to define the event's significance and assess whether local resources are sufficient to handle it. However, the first emergency response, irrespective of the nature, scale, and effects of an event, must be guaranteed by the local structure.

Over the years, the responsibility of civil protection has progressively moved from the state to local governments. Currently, the legislative power, except for the determination of the fundamental principles, lies with regional governments.

The Department of Civil Protection

The Italian DPC is a structure of the prime minister's office that—in collaboration with regional governments and local autonomous bodies—orients, organizes, and coordinates civil protection projects and activities. The main tasks of the DPC are (a) promoting and coordinating the whole system, (b) intervening directly in the event of national disasters, (c) defining common intervention and action procedures for the whole system, (d) submitting guidelines for legislation relative to risk prevention, (e) directing the setting up and management of information networks necessary for risk prevention, and (f) producing and managing regulations—the official orders—needed to conduct emergency interventions and deal with natural disasters. An early warning system has been created that covers the entire emergency cycle phase: forecast, monitoring surveillance, risk prevention, emergency management, and recovery. The DPC, together with regions, has the role and responsibilities to coordinate this system. In case of natural disasters, catastrophes, or other events that, because of their intensity and extent, must be tackled using special means and powers, the DPC functions through an Operational Committee.

The DPC is also involved in international interventions, within the European Civil Protection Mechanism or according to bilateral agreements, and promotes initiatives such as exercises, exchange of experts, organization of training activities and programs, and activities to improve risk forecast and prevention. The European Civil Protection Mechanism is the instrument of the EU activated to respond in a timely and effective manner to emergencies occurring on an international scale. All interventions are based on the principle of subsidiarity: the actions of the EU must always be undertaken on request of and in coordination with the authorities of the affected state. In particular, the DPC at the international level

- participates in technical-scientific knowledge exchange and sharing of projects and interventions in Europe and internationally;
- belongs to monitoring networks for preventing and forecasting risks;
- maintains permanent relations with research centers, specialists, and structures organized by the civil protection departments of the other countries;
- promotes, coordinates, and participates in international exercises;
- shares its own organizational model with the other countries, also through guided tours to international delegations interested in furthering their knowledge of the Italian civil protection system; and
- participates in meetings and events whose objective is to improve coordination and promote the civil protection culture at an international level.

The Operational Committee and the Declaration of the State of Emergency

In case of the most severe types of national emergency, the head of the DPC convenes the Operational Committee, which defines intervention strategies, guarantees a coordinated deployment of national resources, and ensures a unified direction and coordination of all emergency activities. The committee, led by the DPC head, comprises representatives of all components of the National Civil Protection Services, including ministries, agencies, institutes, organizations, and infrastructure providers. All representatives remain in the DPC headquarters during the event to work together in the National Operation Room, equipped with technical and communication systems to house and to provide assistance for the meetings held during a national emergency. This room is designed and operated to keep pertinent information online at all times, and it provides an integrated picture of unfolding events through monitoring surveillance and telecommunication systems. A case study on critical infrastructure crisis management (L'Aquila earthquake) is described in annex 10A.

Vulnerabilities, Threats, and Operational Risks in Financial Systems

In the financial sector, operational risk has wide-ranging systemic implications given the increasingly large size, interconnectedness, and complexity of financial institutions that increase the possibility of errors and fraud. Techniques aimed at identifying worst-case scenarios for operational risks must take into account the inherently unpredictable nature of extreme events.

Disruptions to the flow of financial services because of impairment of all or part of the financial system may give rise to systemic risk and possible spillover effects to the real economy. The magnitude of such disruptions depends on asymmetric information and network externalities. System and process failures are particularly dangerous if they occur in the clearing and settling of financial transactions as well as in the trading and pricing of financial instruments.

The fallout from the recent financial crisis has illustrated that many sources of systemic risk were triggered or at least propagated by vulnerabilities in operational risk management of market and payment infrastructures. Financial institutions are connected directly and indirectly to their customers, to other financial institutions, and to their service and utility providers; accordingly, operational risk may be imported from connected entities. In addition, operational risks may be exported by a financial institution to other entities. As a consequence, global leaders recognized a greater role of operational risk. The policy resolutions of the Group of Twenty (G-20) Summit in Pittsburgh, Pennsylvania, in September 2009 mark a shift of financial sector regulation from internal controls and sound risk management practices to macroprudential regulation for systemic risk and contingency planning.

The identification and management of market, credit, and other financial risks can rely on reasonably reliable data and statistics. To analyze the relations between operational risk and other types of risk and to make them credible and relevant, internal database systems become crucial.

For banking supervisors, operational risk is inherent in all banking products, activities, processes, and systems, and the effective management of operational risk has always been a fundamental element of a bank's risk management program. Sound operational risk management greatly depends on the effectiveness of the board and senior management in administering its portfolio of products, activities, processes, and systems. In the wider context of globalization, the governance of operational risk must deal with more ubiquitous computing and Internet-related technologies that enable transactions and services to occur at any time, instantaneously, with no barriers, and at decreasing prices. Increasing reliance on outsourcing work and entering into partnerships with banks and nonbanks, especially those that are Internet-related, entail new aspects of operational risk that needs close attention. To improve industry and supervisory knowledge and to foster the emergence of sound industry practice, financial institutions must perform loss data collection exercises and quantitative impact studies and review governance, data, and modelling issues.

Crisis Coordination in the Italian Financial System

Before 2003, the business continuity management for financial and monetary institutions (FMIs) was mainly driven by business sectors, given their incentives to ensure continuity of service to their customers and value generation. Following the dramatic events of 9/11, Banca d'Italia realized that a new approach was needed to overcome the coordination failures that emerged in those days. In February 2003, almost six years before the EU directive, Banca d'Italia undertook a series of initiatives in cooperation with the main banking groups, market infrastructures, payment system operators, and technical service providers. The purpose was to introduce a public dimension in the scope of continuity management of Italian FMIs. A committee on service continuity, CODISE, was created in 2003 to define actions for reducing systemic risk factors. The group is coordinated by the Banca d'Italia in agreement with CONSOB (the Italian stock exchange commission) and consists of representatives of the leading banking groups and the companies that manage infrastructure essential to the orderly working of the financial system.

The rationale for the direct involvement of the Banca d'Italia derives from the risk of coordination failures in case of a large-scale operational crisis of the financial sector because of the huge number of actors involved and their level of interdependency. Experimental studies of banks' behavior during crisis show that there is no endogenous drive to efficient equilibrium in the financial system. In this regard, CODISE allows the Banca d'Italia to react quickly once coordination failures start emerging, Coordination is easier in a heterogeneous market where there is a clear leader in size. This is one reason to restrict CODISE participation to systemically important operators only. In addition, because tests show that small frictions in coordination can be autonomously absorbed, CODISE is another tool for the Banca d'Italia to use in closely monitoring of the financial system and preventing friction.

CODISE is the coordinating committee for all activities, both within and outside the Banca d'Italia, relating to the handling of operational crises in the national financial system. In the event of a crisis affecting domestic operators, the CODISE coordinator provides the necessary liaison with the Banca d'Italia's crisis management units, other domestic financial operators, and the European Central Bank.

Currently, CODISE performs a number of functions:

- Coordination of the handling of operational crises involving the infrastructure and participants in the Italian financial system;
- Representation of the Italian financial market in Eurosystem coordination activities;
- Interface with the other sector authorities (civil protection; CONSOB; and Ministries of the Interior, Defence, Health, Economy, and Finance);
- Contact point for Italian operators in an emergency;
- Running of simulations, including those coordinated by the Eurosystem, and evaluation of the results and the impact on emergency management plans for business continuity.

CODISE's first tasks included the following:

- Determination of which services were vital to the financial marketplace;
- Development of risk scenarios;
- Planning of integrated tests and trials;
- Drafting of business continuity rules and standards for important infrastructures.

Accordingly, CODISE identified the financial services that were vital to the orderly functioning of the system, laid out risk levels, and evaluated the interdependence among the main participants in the domestic financial marketplace. It developed strategies for action and methodologies for testing. The group's analytical work highlighted several factors:

- The essential role of some vital services in meeting economic agents' fundamental liquidity requirements whose interruption, even for a very brief interval, would have a severe impact on the operation of the financial markets (above all, the real-time gross payment and settlement system);
- The key role of reliable communications;
- The need to give banks a sufficient amount of time between the resumption of activity after an interruption and the end of the business day.

In addition, CODISE set the principal service resumption objectives for operators, which were then codified as part of the Banca d'Italia's guidelines on business continuity, issued in the second half of 2004. The intermediaries' business continuity plans are regularly examined by Banca d'Italia's units responsible for banking supervision, payment system, and market oversight.

CODISE is responsible for designing and coordinating integrated test exercises among participating institutions. A multi-year program of exercises has been drawn up with verifications of increasing degrees of complexity. Four trials have already been conducted at the national level to assess the adequacy of participating institutions for handling severe disruptions of operations.

In 2011, the fourth national business continuity simulation exercise took place with extensive participation.[1] The scenario, simulating widespread social incidents, analyzed the impact on communication, liquidity management, logistics, and staff. At the end of the test, participants asked for simulations of increased complexity coordinated at the European System of Central Banks level and an even greater involvement of the boards. The next simulation will be in autumn 2012.

Similar exercises have been conducted at Eurosystem level to determine the following:

- The role to assign to international committees in the event of a global operational crisis, the shortcomings of their action, and possible areas for improvement;
- Specific strategic information to provide to committee members in the event of a global operational crisis;

- Internal and external communications procedures, including what to do in case of the absence of one or more committee members.

Methodologies and Tools for Crisis Coordination

Since January 2012, after a testing period, the 12 members of CODISE have used a secure website managed by Banca d'Italia to share their yearly test and change plans. In this way, critical financial players increase their awareness of interdependency risks related to change and test phases, notably those most vulnerable to operational problems. Critical players use this repository to manage and mitigate their risks by asking their peers to stand ready when they perform major changes and to reciprocally participate in testing activities.

Crisis management and coordination in the financial sector cannot be effective without a close coordination among financial sector authorities. Actually, all of them (banking supervision, markets and payment systems oversight, and stock exchange commission) are active members of CODISE, strongly enforcing CODISE's decisions on banks, technical service providers, and market infrastructures. Nevertheless, a wider network of cooperation is needed both in the prevention and in the crisis management phases. Banca d'Italia, as chair of CODISE, cooperates with the Italian Ministries of Interior and Defence in working groups aiming at analyzing national vulnerabilities, promoting a culture of national continuity, contributing to international initiatives, and sharing information on incumbent threats. In 2009 during the swine flu pandemic alarm, CODISE cooperated with the Italian Ministry of Health to define a list of staff members vital to the financial system for priority vaccinations. In 2011 in the aftermath of the attack on security tokens produced by RSA, a United States–based computer and network security firm, CODISE cooperated with the Postal and Communication Police Services[2] to analyze the impacts on the Italian financial system and possible countermeasures. In other words, CODISE provides a direct, high-level channel for coordination between the financial system and public authorities when a crises is not declared.

When a crisis is declared, CODISE establishes a direct link with the DPC. In case of national crises, the DPC calls the CODISE emergency number (available 24 hours a day) and the CODISE chairperson (or his or her delegate) contacts—at any time—CODISE members to manage all the crisis issues relevant for the financial system. In the same way, there may be situations in which the financial sector needs external support, as happened during an extensive transportation industry strike that affected Italy for more than one week. In that case, the DPC was ready to support major banks to ensure cash distribution throughout the country.

In case of local or regional crises, the DPC oversees crisis management but leaves the responsibility for implementing the urgent interventions to regions, provinces, and towns. In these cases, the director of the local branch of Banca d'Italia acts as an entry point for communication between the local financial community and national authorities; he or she informs the CODISE chairperson, who ensures, if necessary, coordination with the DPC.

Conclusions

Recent years have witnessed a significant increase in the occurrence and severity of natural disasters, very often of international dimension, resulting in the loss of human lives and property including cultural heritage, the destruction of economic and social infrastructure, and damage to the environment. An effective international cooperation and a robust national system of civil protection are needed to tackle the global dimension of disasters. A number of tools are to be in place to facilitate adequate preparedness for and an effective responses to global disasters.

These tools include a monitoring and information center, an emergency information system, and advanced training programs. A key enabling factor is highly skilled national and local resources with teams and experts that are available for intervention or that can be organized and dispatched at very short notice. This is the case of Italy's National Civil Protection Service, a complex system in which voluntary organizations play a crucial role.

A well-founded system of civil protection should rely on strong sectorial expertise and procedures. In Italy for the financial sector, CODISE—created in 2003 and chaired by Banca d'Italia—represents a pilot program for coordination among different economic agents in crisis management and prevention at regional and national levels; it merges private and public stakeholders' interests in a flexible structure. CODISE focuses on minimizing the immediate systemic effects of wide-scale disruptions on critical financial services. It defines and periodically exercises a crisis management structure together with business continuity expectations for critical financial services.

Annex 10A

Critical Infrastructure Case Study: L'Aquila Earthquake

On April 6, 2009, at 3:32 a.m. (local time), the city of L'Aquila was hit by a main shock measuring 5.8 on the Richter scale, with a seismic focus at 8.8 kilometers of depth, that was also felt in the bordering regions. Following the public communication of the event carried out by the Istituto Nazionale di Geofisica e Vulcanologia[3], at 3:57 a.m. the central and territorial operational rooms of the structures represented in the Civil Protection Department's operational room were immediately contacted to obtain the first information available on the effects of the earthquake.

After the first assessments were carried out on the territory, information about collapsed buildings in the historical center of the capital of the region was released. Collapsed buildings were reported, particularly in the minor villages near L'Aquila such as Paganica, Fossa, and Poggio Picenze. Later on, information was released about the total destruction of the historical center of the village of Onna. Technical surveys and registration of the damage were carried out immediately. In the first hour after the news of the earthquake, the DPC headquarters in Rome, through the use of a simulator, began to estimate the magnitude and geographical position of the earthquake and to establish the expected number of victims, collapsed buildings, and buildings declared unsafe and severely damaged.

Immediate analysis did not reveal problems on the power network because, despite the damage registered, the continuity of the service was guaranteed; on the contrary, problems were immediately reported to the mobile phone networks, which the experts attempted to resolve by installing several mobile plants. Furthermore, the seismic event resulted in a reduction of the water supply in many municipalities of the area caused by damaged pipelines. The gas network supply was promptly interrupted for safety reasons following the fire brigades' dispositions. The technical experts of all the different road and highway companies assessed roads and highways and proceeded to forbid access to all vehicles weighing more than 7.5 quintals on the stretch of Highway A24 from Rome to L'Aquila. The experts forbade all traffic from Tornimparte and Assergi to facilitate access to the crisis areas for emergency relief vehicles. A series of measures were adopted to assess the safety of the railway system: preventive interruption of the stretches affected by the seismic event, temporary suspension of traffic on the Apennine axis, and speed limits imposed on the coast line.

The people of Abruzzo who felt the earthquake evacuated their homes and moved to the streets, while the operational structures (firefighters, members of police forces, volunteers, health-care operators, and so forth) arrived at the territory to begin the first urgent technical operations aimed at rescuing people in collapsed buildings. The President of the Council of Ministers immediately declared a state of high risk for the primary needs as provided by art. 3 of Law 286 of 2002 and appointed the head of the DCP to coordinate activities for managing the state of emergency.

On the same day, the Council of Ministers issued the first civil protection ordinance establishing the most urgent operations required to face the emergency. At the same time, the DPC activated the internal operational structure by summoning the Civil Protection Operational Committee, a national decisional body that involves the participation of all the administrations interested in the emergency management. This committee established itself no later than one hour following the seismic event. The DPC's technical experts on seismic risk immediately set off to carry out macroseismic surveys aimed at defining a first report of damage suffered by the structures and infrastructures hit by the earthquake. Other teams of experts dealing with the emergency management were transferred to L'Aquila to support the local authorities in the first phase of the event and to begin the necessary operations to guarantee national coordination on site.

At 9 a.m. on April 6, the Direction of Command and Control Headquarters were established at the Revenue Guard Corps School in Coppito, a village near L'Aquila. In the course of the morning, the DPC's teams already present in the territory were joined by more experts in emergency management, logistics, health, voluntary work, telecommunications, and protection of cultural heritage. The Fire Brigade Corps' mobile columns from all the Italian regions except Sicily and Sardinia, the civil protection mobile columns of the regions and autonomous provinces, and the National Volunteers' organizations were all immediately alerted and ready to intervene. One of the first response operations carried out was the evacuation of L'Aquila's San Salvatore hospital that was seriously damaged. The evacuation lasted eight hours with the transfer of 250 patients (150 by medevac aircraft) while the hospital continued to assist the population.

Twenty-four hours after the earthquake, eight regional mobile columns and a provincial one were already operational at the Inter-Municipal Operating Centers; the 13 relief areas assigned to the evacuated population were being set up, tents were being put up with 5,000 beds, and hotels were making 15,000 accommodations available. The railway station of L'Aquila also set up eight sleeping cars to accommodate the homeless. Meals for 18,000 were distributed to those affected by the emergency, and 165 toilet cabins were brought in.

Following the first 24 hours of activity, more than 8,000 operators were already at work involved in search, relief, and assistance to the population; 130 people died; 60 people were pulled from wreckage alive; and 1,500 people were injured. Activities continued without interruption, and 48 hours following the earthquake, the assisted population amounted to 28,000, among which 18,000 were sheltered in 3,000 tents set up in 30 different areas and 10,000 were transferred by bus to hotels in the coastal areas of the Abruzzo provinces of Teramo, Pescara, and Chieti. To guarantee full medical assistance, 13 advanced medical posts and one field hospital were activated. At the end of the second day, the number of deaths increased to 251 (a month after the seismic event, the number of victims rose to 298).

Restoration of Essential Services

Electrical power. From April 6 to April 21, 2009, ENEL provided power to 130 relief areas by carrying out 287 urgent emergency operations and installing equipment for a total power of approximately 20 MWe (megawatt electrical), a quantity of electrical power sufficient to supply a city of 40,000 inhabitants. Despite the difficulties encountered, electricity was supplied to almost all the camp sites with work carried out by the military arm of the Civil Engineering Department.

Gas supply. To restore the supply of methane gas in the areas hit by the earthquake, ENEL Rete Gas (a gas distribution company) tested nearly 400 kilometers of pipelines as its first operation, supplying gas to strategic structures during the emergency phase.

Water supply. The Gran Sasso Acqua (a water supply company) provided the water supply and sewage system for the displaced people camps. The company repaired 120 leaks, allowing the camp water supply to be continuous, and carried out 50 operations to restore the functioning of the hydraulic system.

Post offices. Poste Italiane opened 15 mobile post offices throughout the territory. Ten were equipped with ATMs (automatic teller machines) so people could obtain cash at any moment as well as perform other transactions. The ATMs worked 24 hours a day.

Road and highway system. A few hours following the earthquake, the highway company's technical experts were working on Highway A24 to reinstate light vehicle traffic in the stretch between Assergi and L'Aquila. Light traffic was also readmitted to Highway A25 in the Bussi Popoli–Pratola Sulmona stretch. ANAS[5] announced that the 20 most urgent emergency operations were carried out to ensure road safety and that 20 more extraordinary interventions were planned following the seismic event.

Telecommunications. Telecom Italia reported that, following the earthquake, many urgent telephone emergency operations were accomplished. At L'Aquila telephone central, an important network connecting most of the communication basin of Abruzzo, many operations were carried out to bypass the central office, both to avoid problems related to its recovery and to provide new services without access to L'Aquila telephone central. In particular, many ways to access the regional telecommunication transportation network were set up without the possibility of accessing the center of L'Aquila city. They were created by building and opening new optical fiber transmission nodes and rings. Radio relay systems and optical fiber cables servicing the keep center of L'Aquila were recovered. Finally, a telephone central was established in Rome to substitute for the central in L'Aquila with the reactivation of all the commutation plants of the district affected by the seismic event. Moreover, operations were carried out to ensure backhauling safety of those GSM (Global System for Mobile Communications) Base Radio Stations considered strategic for the radio coverage of the area. The damage reported in the minor center of the area affected by the event (Paganica and Valle Cupa) also required different emergency relief operations like the construction of a new transmission ring and the installation of temporary road equipment to reinstate the telephone service.

Public offices. The public offices in L'Aquila that were damaged or rendered unsafe by the earthquake were moved a few days later to new offices at the Officers School of the Revenue Guard Corps in Coppito. A government town was established that hosted bodies such as the prefecture, the police headquarters, and the social security office, which were directly available to the public and guaranteed services for them.

Notes

1. The estimated global cost for the design, preparation, and implementation phases was about 600 day's work by one person.
2. Italy's Postal and Communication Police Services investigates all crimes that involve the use of communications such as computer hacking, online child pornography, credit card fraud, spreading of computer viruses, or software copyright violations.
3. The Istituto Nazionale di Geofisica e Vulcanologia gathers data from all Italian scientific and technical institutions operating in geophysics and volcanology and creates a permanent scientific forum in the earth sciences. The Istituto cooperates with universities and other public and private institutions, as well as with many research agencies world wide. The new institution, currently the largest European body dealing with research in geophysics and volcanology, has its headquarters in Rome and facilities in Milano, Bologna, Pisa, Napoli, Catania, and Palermo.
4. ENEL is an Italian electric utility company, the third-largest in Europe by market capitalization.
5. ANAS is an Italian government-owned company appointed to the construction and maintenance of Italian motorways and state highways under the control of the Ministry of Infrastructure and Transport.

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The earthquake and tsunami that struck Japan on March 11, 2011 generated a mega earthquake and tsunami that went far beyond any of the pre-disaster expectations. These events have demonstrated the fundamental role of understanding the risks faced by society from natural hazards as the basis for building countermeasures to extreme events. Through developing damage scenarios decision makers and the public are better aware of the potential effects of natural hazards on human and economic assets. Recognizing that the Great East Japan Earthquake vastly exceeded all levels of damage considered, this chapter shows the importance of accurate risk and damage information to inform prevention and preparedness planning.

CHAPTER 11:

Lessons Learned from the Great East Japan Earthquake: Hazard Information and Damage Scenarios to Inform Effective Countermeasures to Extreme Events

Excerpt from Report of the Committee for Technical Investigation on Countermeasures for Earthquakes and Tsunamis Based on the Lessons Learned from the "2011 off the Pacific coast of Tohoku Earthquake, (September 28, 2011)

This chapter is a World Bank abridged version of the submissions of the Government of Japan

Introduction

The Great East Japan Earthquake has brought unprecedented damage in Japan. As the full picture and the dimensions of the damage gradually become revealed, local residents, communities, businesses, local governments, and the national government are unifying their strength in a determined effort toward reconstruction.

However, the bitter experiences and tough lessons encountered in this disaster must be permanently passed on as a testament linking the past, the present, and the future and as wisdom for building a disaster-resilient nation and resilient communities.

The 2011 off the Pacific coast of Tohoku Earthquake generated a mega earthquake and tsunami that went far beyond any of the predisaster expectations. It incurred vast damage, including the greatest loss of human life in a single disaster in Japan since the Second World War, and posed enormous challenges for the nation regarding the way earthquake and tsunami countermeasures have been developed so far. Therefore, the Central Disaster Management Council decided to establish the Committee for Technical Investigation on Countermeasures for Earthquakes and Tsunamis Based on the Lessons Learned from the 2011 off the Pacific coast of Tohoku Earthquake[1] to investigate and analyze the recently experienced earthquakes and tsunamis and examine countermeasures for future earthquakes and tsunamis.

The tragic events have demonstrated the fundamental role of risk information and understanding of natural hazards and the way these affect human and economic assets as the basis for developing all countermeasures to extreme events. The following is an excerpt of the committee's report focusing on the importance of understanding hazards and risk to better inform risk mitigation and preparedness measures.

The magnitude of the earthquake, the height and strength of the tsunami, the extent of the inundated area, the occurrence of subsidence across a wide area, and the extensive human and material damage experienced in this disaster all vastly exceeded the levels of damage previously envisaged by the technical committees convened by the Central Disaster Management Council. Although disaster management measures had been promoted according to various disaster management plans based on predisaster assumptions and their implementation, these measures possibly exacerbated the damage in some districts. We have to humbly concede the difficulty of predicting natural phenomena and conduct a fundamental review of how to conceptualize earthquakes and tsunamis for hazard assumption in the future. For tsunami countermeasures in particular, we must urgently conduct across-the-board reviews and thoroughly prepare for mega earthquakes and tsunamis in the Nankai Trough, where, we fear, they may occur in the near future.

Characteristics and Verification of the Damage Caused by the Earthquake and Tsunami

The tsunami and the earthquake exceeded predisaster assumptions and overcame mitigation measures. From this, we must learn the importance of careful hazard assumptions and preparedness measures to respond to all events, including extremely high-impact, low-frequency events. The fact that such events were not envisaged is the result of basing assumptions on the earthquakes and tsunamis experienced over the past several hundred years and means that there are limitations to the hazard assumption methods used before this disaster. The predisaster assumptions of earthquakes and tsunamis were far removed from the earthquake and tsunami that actually occurred, gravely highlighting the importance of principles for selecting earthquakes and tsunamis for future hazard assumptions.

The tsunami that occurred in this disaster was of a scale that vastly exceeded predisaster assumptions. An enormous earthquake with a magnitude of 9.0, a size that could not be envisaged from the history of earthquakes in Japan that stretches back several hundred years, erupted with a wide epicentral area that interlocked several regions. The reasons such enormous tsunamis occurred include the fact that the mechanism causing the tsunami consisted not only of a slipping movement at the deep plate boundaries that lead to a normal ocean trench earthquake, but also a considerable simultaneous slipping movement at the shallow plate boundaries.

Phenomena that particularly exceeded any predisaster assumptions included an enormous tsunami height and extensive inundation area, penetration of the inundation area to a considerable distance inland, inundation caused by tsunami run-up overflowing river banks, and widespread occurrence of subsidence. The level of subsidence remained unchanged six months after the disaster, and secondary damage from this earthquake and tsunami disaster is occurring in the form of flooding in the affected regions because of storm surges and precipitation.

Predisaster Principles in Selecting Earthquakes and Tsunamis for Hazard Assumptions

In addition to estimations for trench-type earthquakes in the vicinity of the Japan and Chishima Trenches that are expected to occur in regions that include the epicentral area of the 2011 off the Pacific coast of Tohoku Earthquake, the committees convened by the Central Disaster Management Council have conducted estimations of expected hazard levels of earthquakes and tsunamis for the Tokai Earthquake, Tonankai and Nankai Earthquakes, Tokyo Inland Earthquakes, and Chubu and Kinki Regions Inland Earthquakes. In the committees' efforts at replicating the earthquakes and tsunamis experienced over the past few hundred years in those regions, those earthquakes and tsunamis that have repeatedly occurred and are likely to occur in the near future were selected as the impending earthquakes and tsunamis to be used for hazard assumption and were considered for examinations of seismic movement and tsunami hazards.

The 2011 off the Pacific coast of Tohoku Earthquake was a magnitude 9.0 earthquake caused by the interlocking of several epicentral areas in the Japan Trench, an earthquake that could not be found in the earthquake literature of Japan stretching back several hundred years. The fact that such an earthquake could not be envisaged is the result of basing assumptions about Japan Trench earthquakes and tsunamis on this data. This approach means that there are limitations to the hazard assumption methods used before this disaster.

Reflections on the Differences between the Pre-disaster Assumptions and the Actual Disaster

We must gravely accept the fact that the results of the predisaster assumptions of earthquakes and tsunamis were far removed from the earthquake and tsunami that actually occurred. Therefore we must undertake a fundamental review of the principles regarding selection of earthquakes and tsunamis for future hazard assumptions.

Until now, the earthquakes considered to be impending from among the very largest earthquakes experienced in Japan over the past few hundred years have been used for replication of seismic intensities and tsunami heights recorded in the past using seismic source models. The results of these replications have been treated as the hazard assumptions for the next largest-scale earthquake to occur. As a result, if the seismic intensity or tsunami heights of an earthquake were not reproduced by the model, the earthquake was regarded as having a low probability of occurrence, even if such an earthquake may have occurred in the past, and was disregarded from the hazard assumptions. With regard to this disaster, there is a need to deeply reflect on the fact that earthquakes such as the Jogan Sanriku Earthquake of 869, the Keicho Sanriku Earthquake of 1611, and the Enpo Boso Earthquake of 1677 were all disregarded when developing the hazard assumptions.

These earthquakes were disregarded despite knowledge of them because of the difficulties in reproducing the complete picture of the earthquakes, including their intensities and tsunami height, which are necessary as the basis for examining concrete disaster management measures. In the future, the use of these earthquakes in hazard assumption must be examined, regardless of the inadequate understanding of their complete picture. Despite the probability of their occurrence being low, earthquakes in which earthquake and tsunami damage occurred on an overwhelming scale must be adequately examined.

Because the actual earthquake and tsunami differed from the predisaster hazard assumptions, the scope of the seismic movement, the tsunami height and extent, and the inundation area all exceeded expected levels by far. In particular, although the estimated inundation area was used to prepare disaster management material including hazard maps, the fact that the tsunami inundation area and tsunami height were far greater than the estimated levels led to the proliferation of damage. It is possible that the hazard maps that were prepared on the basis of the predisaster hazard assumptions led to a false sense of security among people and that the tsunami that exceeded these assumptions led to an expansion of the damage.

Looking at the construction of coastal protection facilities suggests that, although these are effective against tsunamis with heights within the scope of their design, the massive tsunami and colossal damage witnessed during this disaster exposed the limitations of disaster management measures that rely excessively on coastal protection facilities.

Gravely acknowledging that this disaster event caused damage greatly exceeding the predisaster damage estimate, the former principles for hazard assumption need to be fundamentally reviewed and thorough reviews need to be conducted for all procedures from the selection of earthquakes and tsunamis for hazard assumption to the development of individual measures. Disaster management measures can then be rebuilt entirely.

Selection of Earthquakes and Tsunamis for Development of Disaster Management Measures

Assumptions about natural hazards underlie all risk assessments and risk mitigation measures. The magnitude of the event expected directly dictates and guides the various disaster management measures. Adequate understanding of prevalent hazards must be obtained, and the selection of events for future hazard assumptions must be as comprehensive as possible. Countermeasures need to take into account low-frequency, high-impact events as well as medium- and high-frequency events that can be better mitigated. Comprehensive preparation and planning should always include the possibility of actual damage exceeding the damage expected by the hazard assumption.

Significance of Earthquake and Tsunami Hazard Assumptions

Since before this disaster, earthquake and tsunami countermeasures have been developed by national and local governments by first selecting earthquake hazards to be assumed. Next, government formulates and promotes various disaster management measures based on the results of hazard assumptions of seismic movement and tsunami. Though the earthquake and tsunami experienced in this disaster greatly exceeded the predisaster assumptions, this does not necessarily mean that the exercise of hazard assumptions for earthquakes and tsunamis is pointless. Governments need to: (a) adequately investigate and analyze the reason phenomena far beyond the predisaster hazard assumption occurred, (b) continue to revise assumptions for earthquakes and tsunamis, (c) reexamine future damage scenarios, and (d) proceed with disaster management measures.

Meanwhile, governments need an adequate understanding that natural phenomena are inherently uncertain and there are certain limitations to hazard assumptions.

Principles for Conducting Earthquake and Tsunami Hazard Assumptions for the Future in Consideration of the Great East Japan Earthquake

For selection of earthquakes and tsunamis for hazard assumptions, the historic occurrences of the earthquakes and tsunamis need to be investigated going back as far as possible. Then investigations can proceed on the basis of scientific analysis of ancient documents and other historical material as well as surveys of tsunami deposits and coastal topography. These investigations must be implemented with the continued collaboration of the Headquarters for Earthquake Research Promotion's Earthquake Research Committee, which has been undertaking a long-term evaluation of seismic movements.

If one bears in mind that forecasting earthquakes is difficult and that there are uncertainties with long-period assessments, earthquakes and tsunamis must be examined considering all possibilities, including the actual damage exceeding the damage expected by the hazard assumption.

In other words, when one conducts earthquake and tsunami hazard assumptions in the future, the largest-possible mega earthquakes and tsunamis should be considered from every possible angle. Furthermore, even when it would be difficult to develop the facilities needed as disaster management measures against the earthquakes and tsunamis based on a hazard assumption, such an assumption must be adopted without hesitation.

Research and analysis explaining the mechanisms that trigger earthquakes and tsunamis will become even more essential. For verification of the occurrence of mega tsunamis over several thousand years, enhanced research must include the areas of seismology, geology, archaeology, and history, as well as tsunami deposits on land and the ocean floor, the geology of coastal terraces, and biological fossils, among others.

In addition, to ascertain accurately the state of the ocean trench that is thought to have been the source of the mega tsunami, researchers need to include direct observations of not only inland movement but also ocean bottom crustal movement. They also need to study interplate coupling and make further efforts to promote seismology-based research to improve the precision of earthquake and tsunami hazard assumptions.

The mega tsunami generated by the magnitude 9.0 earthquake occurred because the so-called "interlocking of a normal ocean trench earthquake" and a "tsunami earthquake" simultaneously occurred. This kind of earthquake could occur not only in the Japan Trench where the 2011 off the Pacific coast of Tohoku Earthquake erupted, but also in other regions such as the Nankai Trough. Therefore, research and analysis of the tsunami earthquake mechanism and the multisegment rupture of normal ocean trench earthquakes and tsunami earthquakes are vital so that their generating mechanism can be adequately explained and tsunami scenarios can be created for future mega ocean trench earthquakes.

In the event of the 2011 off the Pacific coast of Tohoku Earthquake, a massive tsunami was generated together with tremendous shaking. However, if a tsunami earthquake, not accompanied by a large quake, erupts by itself, there is a possibility that the tsunami will reach the coast before the residents become aware of the need to evacuate. Because tsunami earthquakes, including such disasters as the 1611 Keicho Sanriku Earthquake and the 1896 Meiji Sanriku Earthquake, have repeatedly caused extensive damage, special measures are needed to warn and evacuate the population in the event of tsunami earthquakes.

Because the impact is enormous when damage is caused in regions where facilities such as nuclear power stations are located, earthquake and tsunami hazard assumptions must be based on more elaborate research about and analysis of epicentral areas and tsunami source areas. This research and analysis must consider the viewpoint of ensuring safety.

Principles for Future Tsunami Hazard Assumptions and Development of Tsunami Countermeasures

Developing future tsunami countermeasures requires the assumption of two levels of tsunamis. On the first level are the largest possible tsunamis envisaged on the basis of developing comprehensive disaster management measures, which focus on the evacuation of local residents as the main pillar. Such tsunamis would be determined by ultra-long-term tsunami deposit research, crustal movement observations, and so forth. Although the frequency of their occurrence is extremely low, when such tsunamis do occur, the damage would be enormous. The tsunami triggered by the 2011 off the Pacific coast of Tohoku Earthquake belongs to this group.

On the second level are tsunamis envisaged on the basis of constructing coastal protection facilities such as breakwaters to prevent tsunamis from penetrating inland. These tsunamis occur more frequently than the largest possible tsunamis and cause major damage despite their relatively lower tsunami heights.

Damage Scenarios

Damage scenarios serve as the foundation for formulating disaster management measures. There is a need to continuously review and improve damage scenarios according to new scientific insight and lessons learned from damages sustained. Because natural phenomena are inherently uncertain, there are certain limitations to assumptions and scenarios. Therefore, multiple damage scenarios need to be examined, including a worst-case scenario. Improvements to the damage estimation system must be sought along with review of damage scenarios to prepare for future catastrophic events.

Significance of Damage Scenarios

In promoting earthquake and tsunami countermeasures, the Central Disaster Management Council has envisioned the seismic movement and tsunamis from the target earthquake. Using damage scenarios based on these, various disaster management measures to be implemented by the government such as Policy Frameworks for Earthquakes, Earthquake Disaster Reduction Strategy, and Guidelines for Emergency Response Activities have been developed. Necessary countermeasures have also been promoted.

With damage estimates calculated and a clear picture of the potential damage provided, damage scenarios help widely inform the society about the necessity for disaster management measures. At the same time, damage scenarios serve as the foundation stones for formulating wide-area disaster management measures.

Therefore, in response to the colossal damage caused by the Great East Japan Earthquake, there is a need to meticulously research and analyze the nature and state of the damage. Once the methods and content of scenarios are reviewed, the council will continue working on creating future damage scenarios.

Predisaster Damage Scenarios and the Actual Damage Caused by the Great East Japan Earthquake

The damage scenario published in 2005 by a committee of the Central Disaster Management Council anticipated trench-type earthquakes near the Japan and Chishima Trenches. The report contained quantitative estimates of physical damage (building damage, earthquake fires, and disaster waste), human damage (deaths, people forced to live in evacuation centers, and so forth), lifeline damage (electricity, communications, gas and water supplies, and so forth), transportation damage (roads, railways, and ports), and economic damage (direct and indirect). However, the height of the tsunami, the inundation area, and the human and material damage caused by the 2011 disaster far exceeded anything envisaged in predisaster damage scenarios.

In addition, enormous damage was caused by factors for which qualitative but not quantitative scenarios had been created. These factors included tsunami fires; missing people; and destruction caused by the shaking of the earthquake and the tsunami to substations and power lines, water intakes, water purification and sewage treatment plants, and oil storage tanks.

Although many buildings were damaged by the shaking of the earthquake, the damage was not as extensive as expected, and an examination of the suitability of the estimation methods used in predisaster damage scenarios is required. Research and analysis also is needed about the relationship between the length of the earthquake cycle and the damage caused, with examples that include indoor damage such as ceiling collapses from short-period seismic movement and damage to high-rise buildings and other large structures caused by long-period ground motion, a cause for concern in the event of a mega ocean trench earthquake. Particular attention must be paid to shaking resulting from long-period ground motion during a future

Tokai Earthquake. Such an earthquake is estimated to be at least twice the size of what was experienced in the Great East Japan Earthquake.

Future Damage Scenarios

The majority of the damage witnessed in the Great East Japan Earthquake far exceeded any predisaster damage estimates. In response to this, the causes must be adequately investigated and analyzed and, after a clear identification of the issues in the scenario methods, the requisite improvements should be made. Furthermore, sufficient investigation and analysis is essential with regard to the phenomena for which the actual damage fell below the predisaster estimate, the reason this was the case, and the relationships between regional characteristics and the shaking generated by the earthquake.
Disaster management measures must be examined and drafted on the basis of a more concrete damage scenario. This needs to be done after minutely researching the matters that were only qualitatively considered in the damage estimation scenarios used before the disaster, the matters that have become apparent following the Great East Japan Earthquake but were not considered in predisaster scenarios, and the matters that should be considered in future damage scenarios.

Because natural phenomena are inherently uncertain, one must bear in mind that there are certain limitations to assumptions and scenarios.

In a review of the methods used in developing damage scenarios, quantitative assessment should be conducted for damage mitigation by future countermeasures, such as reducing human damage by promoting early evacuation of residents or construction of earthquake resistant buildings.

During the Great East Japan Earthquake, regional differences in the evacuation distances and evacuation procedures became apparent for the lowland plains and rias costal area. A means to consider regional characteristics needs to be devised when future scenarios are developed.

The 2011 off the Pacific coast of Tohoku Earthquake occurred during daytime and not in the middle of winter. Had it occurred under other seasonal conditions, or at a different time of day or under different meteorological circumstances, the damage could have been even greater. Therefore, multiple damage scenarios need to be examined, including a worst-case scenario. In doing so, the scenarios need to consider that the damage differs greatly in the urban and rural districts and that the areas outside the disaster zone are subject to secondary effects of the disaster.

There was a considerable discrepancy between the rapid damage estimates conducted by the Cabinet Office immediately after the earthquake and the damage caused to people and buildings by the Great East Japan Earthquake. Improvements to the damage estimation system must be sought along with review of damage scenarios to prepare for future mega ocean trench earthquakes.

Countermeasures to Mitigate Tsunami Damage

Better hazards assumptions and damage scenarios should inform counter-measures against largest possible events based on a disaster risk management policy that focuses on minimizing damages. All measures rely on as comprehensive an understanding of risk as possible. This is crucial to inform structural and nonstructural measures. In the planning of countermeasures, it is necessary to consider all possible scenarios including worst-case scenarios. Risk information also needs to be communicated effectively to adequately inform the population about effective prevention and measures to take if a disaster strikes.

Countermeasures must be enacted against the largest possible tsunamis according to a disaster reduction philosophy that focuses on minimizing damage. To do so, tsunami damage should be mitigated as much as possible not only through structural measures such as coastal protection facilities, but also through nonstructural measures centering on evacuation with thorough disaster education and hazard maps preparation. These measures will help prepare for tsunamis that exceed the protection levels of the structural facilities.

Easing tsunami evacuation requires, in addition to the construction of coastal protection facilities, a combination of measures such as (a) construction of secondary barriers using transportation infrastructure to prevent tsunami waves from penetrating further inland, (b) land raising, (c) construction of evacuation sites, (d) tsunami evacuation buildings and evacuation routes and stairs, and (e) land use and building regulations that account for the risks of inundation. These steps must be implemented in a manner appropriate to local circumstances. To achieve swift and assured evacuation from tsunamis, town planning should allow evacuation within the shortest possible time—about five minutes in the case of communities where tsunamis arrive quickly—while placing evacuation on foot as the basic principle for response in local circumstances. In communities where topographical conditions or land use make such responses difficult, measures for tsunami evacuation must be thoroughly examined considering factors such as the tsunami arrival time.

From the perspective of securing the safety of residents and mitigating damages to livelihood and industry, the basic and vital countermeasures to tsunamis are the swift and assured evacuation of residents, promotion of land use that mitigates inundation risks, and construction of coastal protection facilities to prevent tsunami penetration inland. There is a need to combine all of these nonstructural and structural measures and to build systems and mechanisms for integrated efforts taking local circumstances into account.

Development of Resilient Communities

With regard to the newly envisaged largest-possible tsunamis, potential inundation risks for different communities need to be shown. These risks need to take into account assumptions of a worst-case scenario of impact from tide levels and damage to facilities. In addition to securing the safety of residents and obtaining local consensus with this scenario, community development efforts to mitigate the scale of the damage caused to livelihood and industry need to proceed.

In the regions devastated by the recent disaster event that have often been exposed to tsunamis, old inscriptions on stone monuments warned of the dangers of tsunami damage. History shows that when houses have been rebuilt on low-lying land, they have repeatedly suffered damage. These stone monuments need to be left standing and their meaning needs to be correctly passed to future generations to avoid the repetition of such calamities.

When considering land use in the future, planners need to reflect on changing social conditions, such as the advent of an aging society and a declining population. They also need to consider measures to coexist with the oceans that at the same time protect human life, lifestyles, and industry and tie in with community revitalization.

By incorporating a perspective of gender equality, realistic and practical measures that reflect the diverse viewpoints of those living in the communities will be achieved. It is also conceivable that a community's ability to manage disasters will be improved. Therefore, when concrete evacuation procedures and development of communities are explored, female perspectives that have not been adequately considered in the past will be incorporated, through means such as enthusiastically promoting the inclusion of female members in disaster management councils.

Measures need to combine land use planning, including designation of residential districts in the areas less prone to tsunami inundation risks, with educating residents about the inundation risks from largest-possible tsunamis. In addition, a local consensus needs to be sought for these measures.

By adequately verifying the causes of the earthquake and tsunami devastation in the recent disaster and disaster management measures introduced before the disaster and by using the lessons learned, facilities such as evacuation sites, tsunami evacuation buildings, evacuation routes, and stairs should be developed or designated in a planned manner. These facilities should account for local circumstances such as the risk of tsunami inundation and the time it takes for tsunamis to arrive. It is particularly important that the designation of tsunami evacuation buildings and development of evacuation sites, routes, and stairs, are incorporated in the whole of community development to ensure complete evacuation. Besides the attempt to make tsunami evacuation buildings resistant to earthquakes and waves, responses need to be examined in cases where the inundation height exceeded the controlled height in local zoning regulations.

Raising Disaster Awareness about Tsunamis

Although tsunami disasters occur only about once every 10 to 15 years, when they do occur the damage can be devastating. Local residents need to be adequately informed that a tsunami can hit at any point along the coastline of Japan, disaster management measures need to be continuously promoted, scientific understanding of earthquakes and tsunamis needs to be deepened, and disaster awareness needs to be improved among residents and others. In addition, raising awareness with the cooperation of mass media such as television, radio, and newspapers will be effective.

Earthquakes and tsunamis are natural phenomena, and there should be an adequate understanding that they might exceed our assumptions. Examples were witnessed during the recent disaster where, although the hazard level went far beyond the scope of scenarios envisaged, appropriate evacuation actions helped prevent or mitigate damage. Gaining a shared awareness of risk through disaster education—so-called risk communication—is vital to encourage an understanding of the precise meaning of the numerical values used in tsunami scenarios and to enable people to evacuate flexibly according to rapidly changing circumstances in the midst of an impending tsunami whose scale and nature is unknown.

Passing down disaster-related culture over generations based on the earthquake and tsunami damage that has occurred across history is very important. In response to the investigations conducted into the recent disaster, people's understanding of earthquake and tsunami disasters and their management needs to improve. In addition to school education, comprehensive education programs need to be developed that examine various scenes with participation of experts and practitioners on the ground.

Improvements to Hazard Maps

The results of a post-earthquake survey in the damaged areas show that the residents' awareness of hazard maps was low. Because the maps were prepared on the basis of former scenarios, they led to providing a false sense of security among people. Therefore, the hazard maps may well have exacerbated the damage caused by the tsunami. Continued investigations and analysis into the deficiencies of hazard maps are necessary, including the manner in which the maps are used.

For assurance that hazard maps are effectively used by residents in evacuation, the way that hazard maps are created must be examined, including clarifying the relationships between tsunami warnings and evacuation advisories and instructions, envisaging multiple hazard levels of tsunamis, and indicating ground elevations on hazard maps. Furthermore, because tsunamis are natural phenomena with a great deal of uncertainty, an emphasis must be placed on risk communication, including the continuous and regular communication that the inundation areas for a largest-possible tsunami shown on the hazard maps may actually be exceeded. Because there are limits to raising residents' awareness merely by handing out hazard maps, systems and mechanisms need to be built to communicate the message of hazard maps thoroughly. For example, include them in city planning books and use them to explain important matters contained in the Building Lots and Buildings Transaction Business Act.

Preparations for the Future

Earthquakes can occur anywhere in Japan, not only in the Nankai and Tokyo metropolitan areas where intense concerns exist for a mega ocean trench earthquake in the Nankai trough or Tokyo Inland earthquakes. For areas that have not yet experienced a major earthquake or tsunami, full preparations need to be made for the possibility of an earthquake or tsunami.

First, the seismic movements, tsunami, and subsidence that are to be expected should be estimated. Then estimations should be made for human and material damage based on damage caused by the 2011 off the Pacific coast of Tohoku Earthquake and newly available scientific and technological knowledge. Based on these estimates, all possible measures should be taken to improve future disaster management measures, such as formulating earthquake and tsunami countermeasures that fully reflect the lessons learned from the Great East Japan Earthquake.

Because a worst-case scenario may not necessarily ensue if Tokai, Tonankai, and Nankai earthquakes all occurred at the same time, consideration must also be given to scenarios in which earthquakes occurred in these areas at different times. For example, if earthquakes occurred in these areas within a few minutes to a few hours of each other, the height of the ensuing tsunami would increase owing to the overlapping of the tsunamis; accordingly, if the time until the next earthquake occurs is longer than this, there is the danger that facilities that have been or are being recovered and reconstructed will be damaged again, causing an aggravation of social anxiety. Moreover, one must also consider complex disasters that may occur if these coastal earthquakes occurred at the same time as an inland earthquake, typhoon, or other natural disaster.

In the case that key Japanese industries are affected by a large-scale earthquake, recovery will require a substantial amount of time and domestic economic activity may stagnate. For these reasons, business continuity plans for times of disaster are necessary.

In addition, investigation and research on earthquakes and tsunamis that could occur in Japan should be promoted on the basis of the latest scientific knowledge. The investigation and research findings should be used to strengthen disaster management measures.

Preservation of Records of the Great East Japan Earthquake and Information Dissemination on Future Disaster Management Measures

To make good use of the lessons learned from the Great East Japan Earthquake, a disaster that took the greatest number of lives in a single event in Japan during the postwar period with extensive human and material damage, and to strengthen countermeasures against earthquakes and tsunamis that may occur in Japan in the future, we must firmly pass these lessons to the next generation so that the experience and memories of the Great East Japan Earthquake do not fade and are not forgotten.

Preservation of Records of the Great East Japan Earthquake

Firm efforts are needed to pass these experiences to the next generation, such as making a broad range of materials available to the public, including the results of investigations and analyses conducted by relevant government ministries and agencies, universities, and private research institutions as well as the visual images taken by relevant government ministries and agencies and the mass media. Availability should be made through the Internet and other channels in addition to being stored in the National Diet Library and National Archives of Japan.

Furthermore, Japan also needs to make a collective effort to carry out an investigation and research of the mechanisms that generated the massive tsunami in the 2011 off the Pacific coast of Tohoku Earthquake and summarize the results of this research so that they can be used in formulating earthquake and tsunami countermeasures for the future.

Information Dissemination Regarding Future Disaster Management Measures

Following the Great East Japan Earthquake, Japan received wide-ranging support from the international community, with many countries, regions, and international organizations sending rescue and specialist teams to Japan and providing food, water, blankets, and other relief supplies.

Through the investigation and discussion by this committee, new knowledge and valuable lessons about earthquake and tsunami countermeasures have been gained. This knowledge and experience will contribute to the strengthening of disaster management measures not only in Japan but also in other countries. For this reason, this information needs to be widely disseminated to other countries through international conferences and other forums.

Conclusion

Because of the extensive damage brought by the mega tsunami in the Great East Japan Earthquake, the report of this committee focuses on tsunami countermeasures. However, it is highly possible that a mega ocean trench earthquake in the Nankai trough—which is feared will occur in the near future—would cause not only damage from a mega tsunami but also extensive damage from strong shaking by earthquakes. Accordingly, countermeasures against both earthquakes and tsunamis need to be strengthened more than ever before.

For this reason, the lessons of the Great East Japan Earthquake need to be thoroughly reviewed. Accordingly, detailed investigation and analysis of the 2011 off the Pacific coast of Tohoku Earthquake, the mechanisms that generate mega tsunamis, and the status of damage caused by these events need to continue. A system needs to be established for compiling materials such as summaries of investigation and analysis results and visual images and for presenting them to the general public as well as using them to formulate disaster management measures for the future.

Furthermore, for support for the recovery of the disaster-affected areas, surveys of the process of recovery and reconstruction in the devastated areas need to be carried out in real time so that the power to recuperate from disasters can be scientifically surveyed and analyzed.

We cannot simply mourn the losses and damage inflicted by the Great East Japan Earthquake. While mourning the damage, we must stand and face whatever catastrophic disaster may occur and do all that we can to protect human life. On the basis of this conviction, we must further strengthen earthquake and tsunami countermeasures while carrying through with the recovery and reconstruction of the devastated areas. We must systematically build a nation and cities that are even stronger against earthquakes and tsunamis as we educate and raise awareness of the public about earthquake and tsunami disasters. Moreover, there is a need for disaster management–related fields of science and engineering, humanities and social science, and life sciences to join forces in a collective effort to carry out scientific surveys examining the reasons for the occurrence of disasters and comparing local characteristics, such as whether or not damage was inflicted, as well as to strengthen the research system.

Based on the report of this committee, the national government can be expected to perform necessary revisions of Japan's overall earthquake and tsunami countermeasures and pour every effort into enhancing disaster management measures for the future, thus liberally fulfilling the fundamental government role of protecting the lives and property of the nation's citizens.

Notes

1 The 2011 off the Pacific coast of Tohoku Earthquake refers to the earthquake of magnitude 9.0 that occurred March 11, 2011, and was named by the Japan Meteorological Agency based on a standard naming convention. The Great East Japan Earthquake, named subsequently by the Cabinet Office of the Government of Japan, refers to the earthquake and tsunami disaster and the accompanying nuclear accidents.

The Central Disaster Management Council, one of the councils that deal with crucial policies of the cabinet, is established in the Cabinet Office based on the Disaster Countermeasures Basic Act. The council consists of the prime minister, who is the chairperson, the minister of state for disaster management, all other ministers, heads of major public institutions, and experts. The council promotes comprehensive disaster countermeasures including deciding important issues on disaster reduction according to requests from the prime minister or minister of state for disaster management.

This chapter presents the Republic of Korea's disaster management system, collecting and analyzing techniques of fundamental data and disaster risk financing strategies. The National Disaster Management System (NDMS) is the one-stop, comprehensive disaster management system in Korea. To better assess and respond to disaster risks, several systems and measures are in place, including (a) the Comprehensive Plan for Storm and Flood Damage Reduction (CPSFDR), (b) the Preliminary Assessment Consultation of Disaster Impacts (PACDI), (c) the Flash Flood Forecasting System (FFFS), and (d) the Typhoon Committee Disaster Information System (TCDIS). Finally, disaster risk financing strategies, including insurance and government support for disaster recovery, are presented.

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CHAPTER 12:

Strengthening Disaster Risk Assessments to Build Resilience to Natural Disasters

*This chapter is a submission of the Government of Korea**

National Disaster Management System

The National Disaster Management System (NDMS) includes disaster management support systems that are installed in the central and local governments to take action against both natural and human-made disasters. The NDMS is jointly operated by the national government, local governments, and related authorities. It is a nationwide information system to prevent dangerous factors that can threaten human lives and properties, to promptly respond to emergency situations, and to support recovery and restoration.

The NDMS consists of a central system at the National Emergency Management Agency (NEMA) and local systems that are installed in 16 cities and provinces nationwide. The NDMS includes the system for data collection from the National Meteorological Administration (NMA) and Flood Control Offices (FCO), which are located at major rivers. The NDMS is a web-based system. The central system collects data from the 16 cities and provinces and constructs an integrated information database. Using the database, the NDMS processes and produces relevant data for users in the central government. The local systems are for users in the local governments in 231 cities and provinces nationwide.

Collecting and Analyzing Disaster Risk Data

Comprehensive Plan for Storm and Flood Damage Reduction

The Comprehensive Plan for Storm and Flood Damage Reduction (CPSFDR) was introduced in 2005 to establish realistic and effective prevention and mitigation measures in cities and provinces where risk factors were identified. This plan sets the priority for investments by estimating approximate costs to prevent potential disasters and helps local governments establish comprehensive disaster prevention plans as well. In general, storm and flood disasters include river disasters, slope disasters, mud flow disasters, ocean disasters, and wind disasters. The goal is to complete the CPSFDR within ten years. Once the CPSFDR established, the feasibility will be examined every five years to revise the plan as appropriate.

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Flash Flood Forecasting System

Regional torrential rains that frequently occur in Korea are a serious problem. They can lead to serious disasters in mountainous areas, as proven by recent cases. The pattern of these rainfalls becomes a direct cause of flash floods, resulting in severe damages in both urban and mountainous areas. The National Disaster Management Institute (NDMI) established a plan to minimize casualties in the mountain valleys by estimating flash floods that occurred during the previous three hours and by operating an early warning system within 20 to 40 minutes before the flood.

The Flash Flood Forecasting System (FFFS) can forecast 3-hour-long rainfall data on 4,272 unit basins. The FFFS identifies disaster-prone areas and rainfalls in those areas that are monitored and checked by the Flash Flood Guidance Rainfall for warning. The accuracy is checked by a separate specialized system in which predicted rainfalls are compared with measured data and the properties of warning criteria are regularly checked.

Typhoon Committee Disaster Information System

During the 38th session of the United Nations Typhoon Committee in 2005, the members of the Working Group on Disaster Risk Reduction (WGDRR) agreed to establish an efficient data-sharing tool for various tropical cyclone-related disasters. The members agreed that the objective of this initiative was to acquire an accurate and rapid system to assess damages through prediction, survey, and recovery support functions.
The members also agreed to establish an integrated information system to share disaster data and information. The WGDRR implemented its first project in 2006 and established a website (http://www.tcdis.org), the Typhoon Committee Disaster Information System (TCDIS). The TCDIS contributes to tropical cyclone-related disaster risk reduction in the region by promoting a timely and efficient way of communicating information through its website. As chair of the committee, Korea has actively engaged in collecting data and developing ways to strengthen its functions.

Preliminary Assessment Consultation of Disaster Impacts (PACDI)

The Preliminary Assessment Consultation of Disaster Impacts (PACDI) predicts and analyzes disaster risk factors that can occur in various administrative plans and development projects. The list of administrative and development plans that should be given the preliminary assessment consultation of disaster impacts are as follows:

- Land and city development;
- Industry and distribution complex construction;
- Energy development;
- Transportation facility construction;
- River use and development;
- Water resources and ocean development;
- Tourism complex and athletic facility construction.

Disaster Risk Financing Strategies in Korea

Storm and Flood Insurance

The Storm and Flood Insurance (SFI) is controlled by NEMA and operated by a private insurance company. In the SFI, the central and local governments support part of insurance premiums for the customers so that they can readily cope with unexpected storms and floods.

Agriculture and Fishery Disaster Insurance

Law for Agriculture and Fishery Disaster Insurance (AFDI) was introduced in 2010 to compensate for crop, aquacultural products, livestock, and facility damages caused by agriculture and fishery disasters. The AFDI is one of the disaster insurances controlled by the government to enhance the stability of agriculture and fisheries and to increase production. It aims to contribute to the balanced development of the national economy.

Government Support for Disaster Prevention and Restoration

The Korean Government decided to redirect investment from restoration to prevention to minimize damage and reduce the burden of restoration. Using the stability assessment for vulnerable areas and facilities, the government sets the priority by the degree of danger and the urgency to increase the effectiveness of investments. For the flood control facility project this year, the government mandated in the beginning of the year that the project should be completed before the summer monsoon season, which spans June through July.

Investment in disaster prevention will be included in the midterm financial plan and the national financial management plan to secure sufficient financial resources. The 2012 financial investment plan secured approximately W 6.7 trillion (US$6 billion), a 21 percent increase from the previous year. According to the 2012 budget under the midterm financial plan, approximately W 35 trillion to W 40 trillion (US$31 billion to US$36 billion) was secured for five years.

This chapter shares Mexico's experience in developing disaster risk management models. It describes both the benefits and challenges of moving from a "response-to-disaster" approach, to an integrated approach including preparedness, prevention investment, and financing the costs of reconstruction. The first part describes the evolution towards a system focused on prevention. The second part outlines the efforts towards quantifying, managing, and financing risk. The third part describes how the results of disaster risk management models have been used to design new financial strategies. Finally, the chapter concludes by looking at future tasks to strengthen resilience and to consolidate a national DRM strategy. It emphasizes how these experiences, namely designing an integrated national strategy focused on risk quantification, should be shared with other countries to create international standards.

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CHAPTER 13:

Disaster Risk Management in Mexico: from response to risk transfer

This chapter is a submission of the Government of Mexico

Introduction

Mexico is highly susceptible to a number of natural hazards that may cause death and destruction as well as have serious impacts on public finances, potentially affecting long term investment and economic growth. It is therefore essential for the country to have a comprehensive and integrated disaster risk management strategy such that, through the continuous improvement of data and analysis, people and assets are better protected.

Since the occurrence of a dramatic earthquake in 1985, which caused 6,000 human deaths and approximately US$11.4 billion[1] in material losses, Mexico's authorities have promoted various initiatives to build resilience to natural disasters. The first step was the creation of the National Civil Protection System (Sistema Nacional de Protección Civil, SINAPROC) in 1986. In order to assure financing for SINAPROC´s activities, the Natural Disaster Fund (Fondo de Desastres Naturales, FONDEN) was created in 1996, followed in 2003 by the Natural Disaster Prevention Fund (Fondo para la Prevención de Desastres Naturales, FOPREDEN). These funding mechanisms have moved the national disaster risk management strategy from a system based on response, recuperation, and reconstruction to a system focused on preventive action with the objective of protecting human integrity and the nation´s material wealth. Even though these schemes have achieved good results, authorities have recognized the need to continue to improve disaster risk management, and have invested significantly to develop capabilities to quantify risks nation-wide on the basis of probabilistic estimations of material and human losses.

To obtain probabilistic quantifications of natural disasters, the academic and financial literature has proposed an analytic process centered on fundamental data collection and risk models. Disaster risk quantification is complex and requires a high degree of coordination to gather information from governmental institutes, process and analyze substantial amounts of data, and develop vulnerability and risk models capable of producing useful information to design financial risk transfer strategies.

Once the government has a good understanding of its disaster risk, a financial risk management strategy can be designed and existing funding mechanisms can be improved. The basic financial strategies can be grouped into two main categories: (a) retention, in which the government decides to assume and manage disaster losses through the creation of budgetary reserves to restitute material damages, and (b) transference, in which the government transfers potential future disaster losses to financial or insurance markets by paying a premium. For both strategies it is essential to have appropriate databases and risk measurements, since the variety of financing alternatives increases with the quality of information presented to the reinsurance and financial markets.

Mexico's Risk Management Model

Hazard Context

Natural catastrophes are usually associated with phenomena that affect a large number of people and assets, and jeopardize the economic stability and development of a region, state, or country. Disasters may be generated from hazards that are classified into two major categories: (a) geological (earthquake, volcanic eruption, tsunami, and landslide) and (b) hydrometeorological (flood, tropical cyclone, drought, and hail).

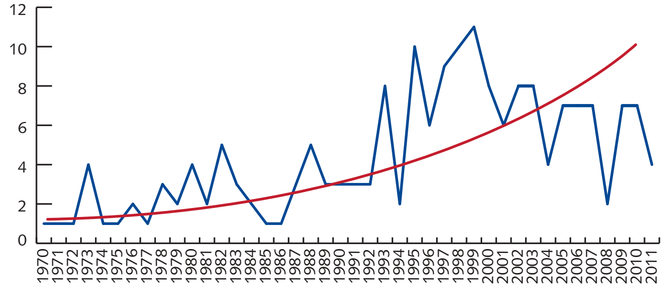
Because of its geographic situation, Mexico is highly susceptible both to hydrometeorological and geological events. Statistics show that, similar to a worldwide trend, the occurrence of these events has been increasing during the past five decades (figure 13.1).

With regard to geological phenomena, Mexico is among the countries with the most seismic activity in the world; this is due to the interaction of five major tectonic plates in its territory as well as important regional faults. Mexico has more than 90 earthquakes each year with a magnitude higher than four degrees on the Richter scale—the equivalent of 6 percent of all earthquakes occurring in the world. Areas prone to strong earthquakes include the entire territory of 11 states, and parts of 14 other states, in all covering more than 50 percent of the nation's territory. Demographic trends and the mobility of population settlements have significantly increased the country's exposure to seismic risk (areas with greater exposure generate about 60 percent of the gross national product and contain a similar proportion of the population). It is also important to consider that earthquakes represent the main cumulative hazard, capable of affecting large groups of assets per event, because of their intensity, extensive coverage and, in some cases, because of infrastructure that is not designed to withstand them.

Tropical cyclones and floods represent the most dangerous hydrometeorological events for the country, particularly in the regions of the Gulf of Mexico and the Caribbean Sea, where the annual hurricane season begins in June (because of the increased heat from these bodies of water in the summer), and extends until the end of November, although with the exception of March hurricanes can occur throughout the year. It is important to note that population and coastal infrastructure have grown at a faster rate than the average of population growth, suggesting that in relative terms, there is a greater concentration of assets and people in these areas. Over time, this may result in an increasing negative effect from tropical cyclones.

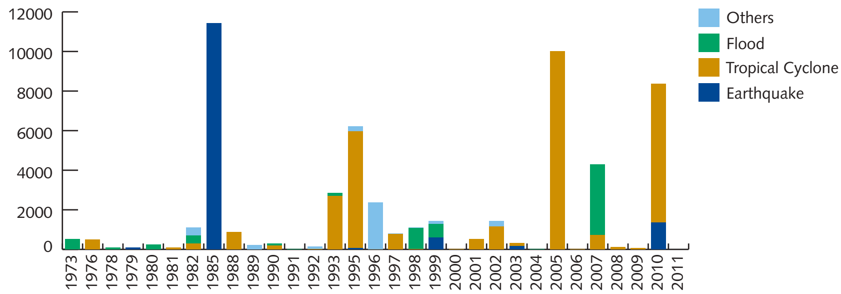
Disasters may have various adverse impacts on the development and welfare of the affected areas, directly destroying the assets of individuals and indirectly affecting economic relations. The cumulative cost of disasters between 2000

Figure 13.1 Number of Natural Catastrophes, México 1970-2010.



Source: Center for Research on Epidemiology of Disasters, Catholic University of Louvain. The blue line indicates the number of events occurred every year from 1970-2010. The red line is an exponential regression used to show the trend.

Figure 13.2 Economic Losses Per Event in Mexico, 1970–2010 *(In million US dollars of 2011).*



Source: Center for Research on Epidemiology of Disasters, Catholic University of Louvain.

and 2010 is estimated to amount to more than US$ 25.1 billion[2], with a ratio of direct and indirect losses of 60 percent to 40 percent respectively. 2005, 2007, and 2010 stand out for the magnitude of damages observed, representing 52 percent of the costs. As shown in figure 13.2, the three events of greatest magnitude in terms of damages, in order of importance, are (a) the 1985 earthquake, (b) Hurricane Wilma (2005), and (c) Hurricane Alex (2010).

Earthquakes, because of their characteristics, usually generate higher housing losses, as well as larger numbers of victims. For cyclonic and flood phenomena, human losses are typically lower because the time gap between detection and occurrence makes it possible to implement protective actions for the population. However, it is revealing that there is no direct relationship between the number of affected people and the economic damage in the event. The number of deaths by natural disaster has been decreasing in the last decade while a similar trend is not clear in terms of material damages.

Previous Efforts

The Mexico City earthquake of September 19, 1985, of magnitude 7.8 on the Richter scale, marks a shift in disaster risk management in Mexico. Damage to infrastructure accounted for approximately 87 percent of direct losses, with the remaining 13 percent caused by loss of income or production, increased costs for providing services and emergency response, and temporary rehabilitation. Nearly 1,700 schools were damaged, and 30 percent of the hospital capacity in Mexico City was destroyed. Approximately 250,000 people became homeless, and nearly 900,000 residents were left with damaged homes.

Following the 1985 earthquake, Mexico managed to support postdisaster reconstruction needs, as well as to strengthen the Civil Protection System, and its building codes. A National Commission for Reconstruction was established in October 1985 as an initial step to address the needs of the affected population. The commission was also asked to establish the necessary mechanisms, systems, and organizations to better assist populations that would be affected by future disasters.

The decree for the creation of the National System of Civil Protection (Sistema Nacional de Proteccion Civil, SINAPROC), published in 1986, defined the mandate of civil protection for the individual and society in the event of a natural or human-made disaster, by reducing or preventing the loss of human life, destruction of property, and damage to nature and by minimizing the disruption of lifeline public services. SINAPROC was created as an organized group of structures, functional relations, and methods and procedures involving all levels of government as well as engaging with the private sector and nongovernmental and civil society organizations. In 1988, the Executive Coordination of SINAPROC was instituted within the Ministry of Interior, which became responsible for managing the mechanisms and policies for prevention of hazards, post-disaster response and reconstruction activities. Its mission is to coordinate and supervise SINAPROC to extend disaster prevention and rescue and recovery to the entire population, property, and the environment.

Based on SINAPROC, disaster risk management in Mexico has been broadly defined as the process of planning, participation, intervention, decision making, and implementing sustainable development policies aimed at (a) understanding the causes of risks, (b) controlling and reducing risks, (c) reversing the social causes for associated risks, and (d) strengthening the resilience of government and society against natural disasters. This entails a multidisciplinary approach and a strong commitment from all levels of government and society as a whole.

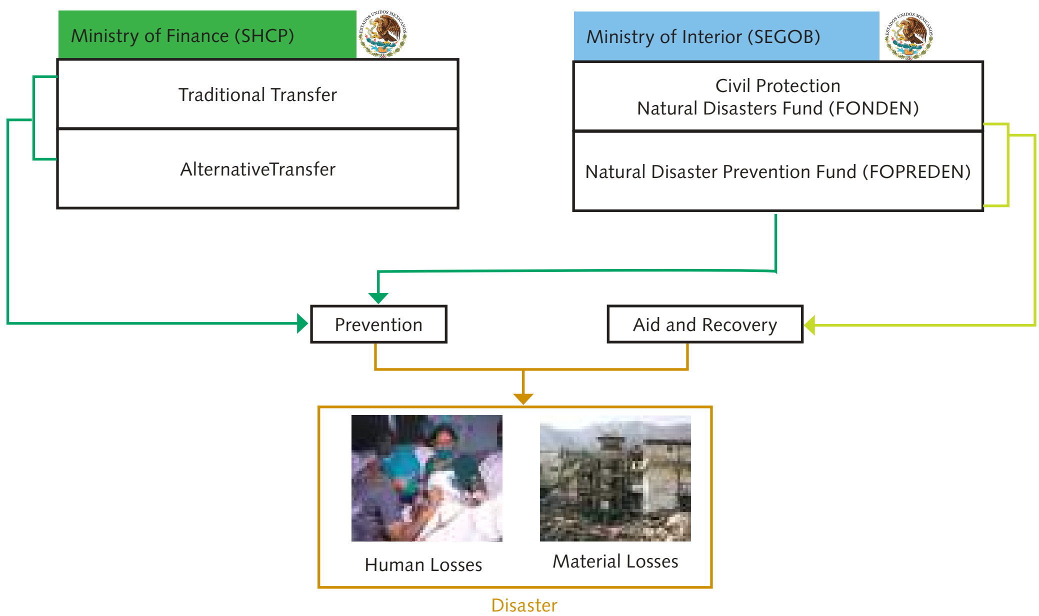
In 1996 FONDEN was created to provide real execution power to SINAPROC. Its mandate is to ensure that sufficient financial resources are immediately available in the aftermath of a natural disaster. As an interinstitutional financial vehicle, FONDEN was established as a line item within Mexico's federal budget to finance damaged public infrastructure and low-income housing.

By 2006, observed budget shortfalls for postdisaster reconstruction activities led to a new law that required the Ministry of Finance to make an annual budget allocation to the FONDEN Program for Reconstruction, assigning an annual budget of a minimum of 0.4 percent of the federal budget (approximately US$800 million every year), and mandating the fund to also provide resources for reconstructing federal and local infrastructure.

Mexico´s Disaster Management Organizational Structure

Two main branches of the Federal Government are involved in dealing with the consequences of natural disasters: the Ministry of Finance (Secretaría de Hacienda y Crédito Público, SHCP) and the Ministry of Interior (Secretaría de Gobernación, SEGOB) (figure 13.3). They both have clear roles within the SINAPROC/FONDEN organizational structure:

Figure 13.3 Current Mexican Risk Management Model.



Source: Secretaría de Hacienda y Crédito Público (SHCP).

- As previously mentioned, the Ministry of Interior, through SINAPROC and FONDEN, has been entrusted with civil protection activities that involve designing strategies for prevention, aid, and recovery in case of disaster. For prevention, FONDEN has used mainly federal funds while FOPREDEN aims to finance local and federal initiatives to generate information or tools for coping with disasters. For aid, SINAPROC is the national coordinator of civil protection activities promoting strategies at the local and federal levels to protect human life.
- In turn, the Ministry of Finance has been in charge of the design of financial risk transfer mechanisms and therefore has been especially aware of the necessity and importance of risk valuation, understanding of potential losses (feasible losses observed with a given probability), and to design and contract financial instruments that provide cover against disasters. Due to its role as the regulatory authority of insurance markets in Mexico, the Ministry of Finance has first hand information on the primary insurance in place for infrastructure, a useful source of information for fulfilling its mandate under FONDEN´s framework.

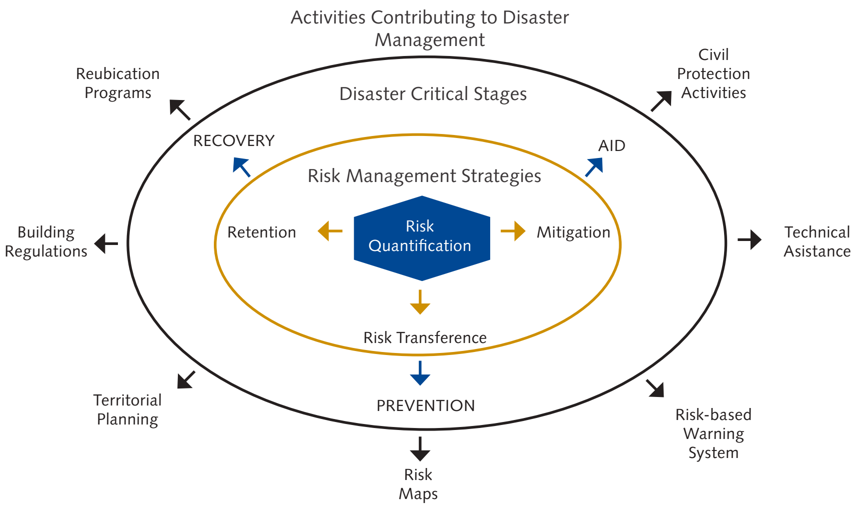
Being able to measure and manage risk led to a new way of thinking about the current risk management model, supported by a new paradigm on risk assessment that relies on newly available information generated as a consequence of the efforts to quantify risk (figure 13.4).

Under this framework, all government institutions exposed to recurrent disasters must use risk quantification to inform their decisions, and to ensure that all elements of the risk analysis process rely on homogeneous measures. Therefore, risk measurement has led to the design of specific tools that allow hazard identification and vulnerability analysis, focused on measuring exposure, their characteristics, and their potential for causing losses.

Measuring risk adequately has resulted in a number of advantages in terms of thinking about financing the costs of disasters:

- **Cost- retention levels and limits** can be designed considering "the return periods" of probable losses;
- **Risk transfer mechanisms** can be designed for different "risk layers", defined also by the return periods of natural catastrophes.

Figure 13.4 New Mexican Risk Management Model.



Source: Secretaría de Hacienda y Crédito Público (SHCP).

Traditional insurance, alternative financial products, and contingent capital mechanisms are all available as the markets open to risk transfer possibilities;
- **Mitigation strategies** can be more precisely targeted to reduce potential impacts of disasters on key infrastructure, for example, through asset relocation;
- **Civil protection plans**, territorial planning, construction regulations, and prevention projects may be categorized and prioritized by using return periods with associated levels of losses attached to them.

Mexico has worked on different initiatives to achieve risk quantification, and, as will be described in the rest of this chapter, the elements to define and implement a new risk management model based on these characteristics are already in place.

Quantifying and Managing Risk

The main difficulty for disaster management is at the quantification stage, because the small amount of historical events with a great impact prevents the use of traditional statistical tools to analyze and measure risk accurately. Therefore, it is necessary to make use of simulations based on probabilistic hazard models.

The main effort made by Mexico towards probabilistic risk assessment, has been through the design of financing mechanisms to protect the financial resources of the FONDEN against seismic, flood and tropical cyclone risks. By aiming to fulfill the requirements of reinsurance and capital markets, a strong drive to identify and quantify the vulnerability present in major federal assets led to risk transfer schemes. This required a high degree of coordination among institutions in order to collect precise data and cooperation between various experts (scientists, public officers, advisors).

Collecting Fundamental Data

The effort to collect high quality information resulted in the creation of a physical inventory of assets for each of the government institutions that manage public assets: roads and bridges, water distribution, hospitals, schools, and others. The physical inventory was the first step towards building the capability of estimating each agency's assets vulnerability, an exercise that also required:

- **Location data.** This is particularly important to determine damages from hazards such as floods, for which information about terrain and nearby water bodies is vital for the accuracy of estimations. Generally, these data were requested in geographic coordinate format. Zip code, address, locality, or municipality were also requested whenever geocoding was not available.
- **Structural type and original design.** This is key to modeling the resistance of each asset to different intensities of hazards (vulnerability). Materials, structure, use, and contents of structures included in the asset inventory contribute to estimation of losses and resistance of structures to the impact of natural elements (ground acceleration, wind speed, water depth, and so on). This information is also useful for estimating human exposure inside the assets, such as statistics of occupation, demand of services, and working personnel.
- **Replacement or reconstruction cost.** To obtain economic losses derived from damages to assets, it is important to have an economic valuation of the infrastructure. Information about the cost of reconstructing the asset to replace it with similar characteristics is crucial for insurance based risk transfers.
- **History of Losses.** Whenever possible, data for historical losses were requested to calibrate loss modeling or verify accuracy of estimations. Institutional records from government agencies on loss history from pre-existing insurance policies were also collected.

Once information was gathered, the next process was to identify the fundamental variables necessary to generate useful loss estimates. In general, it was very difficult to gather complete information for the categories mentioned above; therefore, the first step was to identify inconsistencies or errors in data and return corresponding observations to dependencies for correction. The second step was to identify missing data or missing variables. This required developing methodologies to estimate necessary information. Once this was completed, a thorough process was instrumented across government agencies to validate the final information and the assumptions and methodologies used to estimate missing data.

It is worth mentioning the importance of spreading the nature and objectives of the project throughout government agencies, in order to make them aware of the relevance of complete and accurate information, and to guarantee full cooperation from the areas that own and manage the information. Agencies must be made aware of the benefit of sharing their information to build financial risk management strategies that may improve their own risk transfer options, as well as increase nationwide benefits derived from national schemes. It may also be helpful if requests involving numerous dependencies be sponsored by one or more top ministries within the country to support timely information gathering. In Mexico, recent risk measurement initiatives have been sponsored and promoted by the joint efforts of the Ministry of Finance and the Ministry of Interior.

Developing Risk Models

The first step in developing loss models capable of estimating damages to infrastructure, considering all hazards, is to guarantee the availability of technical and human resources. For such purpose, the Federal Government of Mexico drew on the national scientists devoted to researching natural hazards and structural engineering. In particular, the National Autonomous University of Mexico (Universidad Nacional Autónoma de México, UNAM), through its Engineering Institute, was engaged to construct the risk models. An ample body of research was made available for this purpose, holding more than 40 years of papers on natural hazards (particularly earthquakes), probabilistic simulation hazard models, and vulnerability functions all focusing on Mexico.

The second step was to catalog enough information on natural phenomena to feed the models in order to simulate a range of natural hazard events. Event catalogs produced through the years by UNAM, SINAPROC, the National Disaster Prevention Center (Centro Nacional de Prevención de Desastre, CENAPRED), and the National Meteorological Service (Servicio Meteorológico Nacional, SMN) were compiled. In addition, these organizations provided fundamental information to develop, feed, and calibrate models for earthquakes by performing seismic sources analysis, verifying attenuation dynamics, site effects studies, and historical loss information for earthquakes. For tropical cyclones, these institutions provided a wind model, topographical effect studies, storm surge models and flood precipitation models, among others.

The third step was to develop computational tools adequate to analyze disasters. As a result of Mexico´s risk quantification projects, three main tools were developed to underpin responses to three basic stages of a disaster: (a) before its occurrence, when authorities have time to study and design prevention strategies; (b) during occurrence, when the potential negative impact of a natural hazard is imminent and tracking information of its evolution is necessary to guide aid and prepare financial assistance; and (c) after occurrence, when reconstruction support and economic aid must be as effective as possible to reestablish normal conditions in affected areas.

The main tool produced is known as R-FONDEN, a tool capable of producing probabilistic simulation, and replicating historical as well as potential material and human losses. R-FONDEN estimates losses for a single scenario or for the entire catalog of modeled events, at any geographic zone within Mexican territory, using vulnerability functions for every kind of infrastructure included in the database. For a given portfolio of assets, the system provides the fundamental financial risk measures necessary to design financial risk transfer schemes, such as the "annual average loss", the "exceedance probability curve", and identifies the scenarios that produce the highest risk. Visualization of results and information can be produced through any geographic information system (GIS), given its particular design, for which databases are geocoded, inputs are fed in shape format, and outputs are obtained in shape format as well.

The Hazard Tracking System for Tropical Cyclones, also known as R-AVISA, is a separate system specifically designed for monitoring tropical cyclone activity, from the formation of the cyclone through its likely impact. R-AVISA estimates material and human losses at potentially affected areas The information to update hazard characteristics is obtained from the National Hurricane Center of the U.S. National Oceanic and Atmospheric Administration (NOAA), and is automatically processed to estimate losses for the infrastructure exposed in the potentially affected areas. This in turn allows for a quick mobilization of disaster response and prevention resources though SINAPROC, helping the Government to minimize the impact of tropical cyclones.

Finally, the last tool developed is FONDEN´s Funding Control, Request and Validation System, also known as SICCAVA[3], which is a web tool that automates the reporting of damages by affected government agencies from the moment when disasters happen. Government officials capture basic information and loss verification activities necessary to request federal reconstruction funds. The system facilitates the reporting of losses through standardized templates, allowing the attachment of geocoding and photos from the damaged assets by using the global positioning system (GPS) equipment. As a result, FONDEN funds can be duly processed and channeled timely to reconstruct key infrastructure.

Once probabilistic measures of material and human losses from a disaster are available, and the systems previously described were in place, the alternatives to financially manage disaster risk opened a wide window of opportunities:

- It was possible to estimate economic losses before the occurrence of disasters, allowing for better budget forecasts;
- Dramatic time savings were achieved in processing funds for reconstruction and verifying losses;
- Early identification and warning systems were also improved;
- It was possible to attract reinsurance and capital markets to leverage existing funds to support disaster relief and reconstruction activities.

The next section describes how some of the opportunities for disaster risk financing strategies have materialized as a result of achieving risk quantification and helpful technological tools.

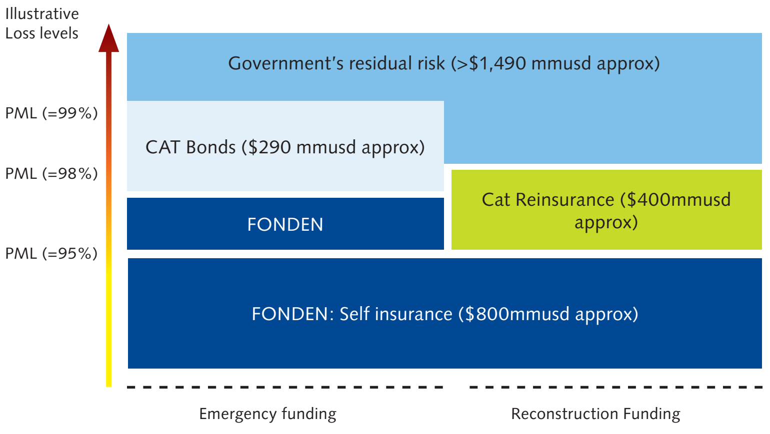
Financial Risk Management Strategy

Mexico´s financial strategy for managing the costs of disasters at the Federal level has three main components: a) a risk retention vehicle (FONDEN) that allows to budget for the costs produced by the most frequent types of disasters, b) a reinsurance program that leverages budget funds in order to purchase a layer of cover that provides funds unrelated to the public finances when severe deviations of disaster frequency arise, and c) a parametric triggered layer of cover that provides immediate emergency funds if a major and severe disaster occurs.

Risk Retention through FONDEN

FONDEN´s potential liabilities to other Federal or State agencies are the result of a well-structured process of loss validation, which not only includes damage inspection and valuation, but

Figure 13.5 Financial instruments for DRM



Source: Secretaría de Hacienda y Crédito Público (SHCP).

also takes into account the beneficiaries' obligations to insure their assets as a first level of protection. In order to manage effectively this exposure, a robust database needs to be in place, and R-FONDEN provides just that. It also provides georeferences of damages and photos, strict loss classification and registration, thorough documentation to allow for the control of undue payments, all of which is used to compute losses during the FONDEN payment authorization process.

R-FONDEN has been used to improve the insurance policies of federal dependencies, which has in turn resulted in better inventory information that insurance companies and reinsurers can use to assess and underwrite risk. In some cases, the simple fact of having better and more detailed information has reduced insurance premiums.

Although there are insurance policies for various federal and state government dependencies, there are still sectors under public administration that are exposed to disasters and that do not purchase insurance because of a lack of information. That, and the permanent risk of low-frequency, high severity natural disasters, obliged authorities to structure risk transfer mechanisms to leverage FONDEN´s yearly resources.

Transference

Reinsurance

Systems to estimate losses allowed for the development of a Catastrophic Reinsurance program for FONDEN, which aims to cover large deviations of aggregate losses to FONDEN in a given year. To determine the levels of coverage, a risk analysis was performed through the generation of exceedance probability curves, obtained from R-FONDEN, for the main assets covered by FONDEN. The information generated by the system allowed a determination of pure pricing of risk transfer layers by associating specific return periods for earthquake and hydrometeorological phenomena.

As can be seen, this analysis could only be made with available risk quantification methods. With this information and budgetary considerations, a layered structure was proposed for FONDEN. The first layer is integrated with individual dependency policies and has approximately US$ 1 billion aggregate deductible, while the excess of loss is covered by reinsurance of up to US$400 million.

Catastrophe Bonds

In addition to reinsurance, which is better suited to absorb the risk of not having enough funds in FONDEN for reconstructing assets, a catastrophe (cat) bond has been placed in order to provide cover against the risk of not having enough emergency funds quickly after a major disaster happens. As it is well known, the cat bonds are structured as a reinsurance contract between the sponsor (the party seeking protection) and a special purpose vehicle (SPV). The SPV obtains the capital necessary to underwrite and fully collateralize the reinsurance contract by selling a bond to capital market investors. Because this bond is issued directly by the SPV, it is not affected by the sponsor's credit rating and is not considered to be a debt of the sponsor. The proceeds from the sale of the bond are placed in an account specifically established to pay claims on the reinsurance contract.

The SPV thus functions like a fully collateralized reinsurer with the sponsor as its sole client, with the benefit of keeping an amount of cover ready to be immediately transferred to the FONDEN should the covered risk materialize. All under the highest credit quality available in the financial markets.

In turn, investors are compensated for their risk by receiving a spread above the risk free rate. The spread results from reinsurance premiums paid by the sponsor and the proceeds of investing the bond's principal. The spread reflects the market price of the probability, as determined by the modeling agent, that the bond will lose money in case of a catastrophic event.

In 2006, the Federal Government issued the catastrophe bond CatMex 2006, under "parametric trigger" coverage, in order to transfer part of the seismic risk of earthquakes to the international financial market. Similar to reinsurance, the Federal Government pays a fee to receive compensation if the agreed-on conditions occur. In these instruments, the conditions are referred to as specific characteristics or "parameters" that the earthquake must present to determine compensation (area of occurrence, depth of epicenter, and intensity). When CatMex 2006 ended in May 2009, a decision was made to renew and improve the coverage conditions against earthquakes and to include hurricane coverage.

For seismic risk, the new instrument (MultiCat 2009) extended the areas considered for the occurrence of the epicenter and improved the depth and intensity conditions the earthquake must meet to activate the coverage. Figure 13.6, panel a, shows the geographic boundaries of the areas covered for earthquake. MultiCat 2009 also provides coverage against hurricanes affecting the Pacific and Atlantic coasts (considering the hurricane category and its path as conditions of compensation). For the Pacific coast, two separate areas were selected by considering historical experience and asset concentration. In a similar way, an area in the Yucatan peninsula was selected for coverage. Figure 13.6, panel b, shows the geographic boundaries of areas covered against hurricanes.

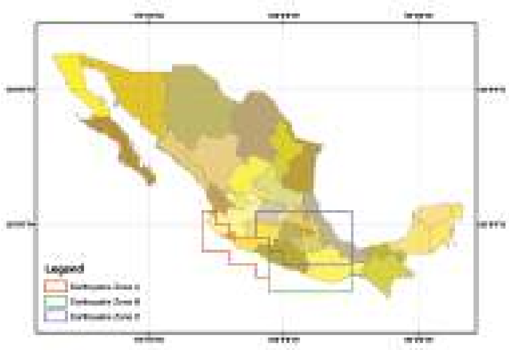
This instrument provides resources to deal with emergency losses of up to US$140 million if conditions for earthquake coverage are met. In the case of hurricane coverage, MultiCat 2009 provides up to US$50 million in each of the outlined areas in figure 13.6 (a total coverage of US$150 million).

Challenges ahead

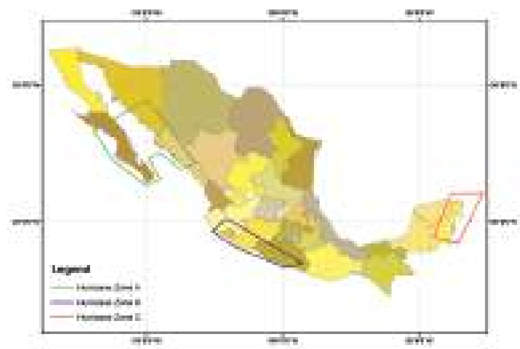
Mexico is already working on several initiatives to strengthen our DRM framework, including the enlargement of the database to include not only exposed values at a federal level, but also down to state and municipal level; expand the catalogs of natural hazards that Mexico is exposed to, in order to improve our loss estimation models; enhanced monitoring tools in order to alert the potential occurrence of additional hazards for which tracking is feasible; new tools to increase efficiency of the

Figure 13.6 MultiCat 2009 Coverages.

a. Seismic coverage.



b. Hurricane coverage.



Source: Secretaría de Hacienda y Crédito Público.

reconstruction process and risk analysis are also being designed; and institutional arrangements are being improved in order to support a nationwide DRM framework.

A crucial step towards future success in this initiative is the cooperation and interaction between the Federal Government with States and Municipal governments. To achieve such cooperation, tools to help local governments design their own risk management strategies are already available. Local government databases are being produced under federal criteria, so as to have the consistent information, and are intended to be used in the design of risk transfer pools for several states within each infrastructure sector (mainly roads and water).

Sharing experiences with other levels of government has proven very valuable to enrich Mexico´s DRM strategies. But because many of the hazards that Mexico faces are also affecting other countries within the region, and similar types of hazards are affecting many countries around the world, Mexico has come to recognize the need to extend its knowledge-sharing efforts to an international arena. This will not only result in deeper understanding of common problems, but will also allow other countries to conceptualize disaster risk management as an integral tool to better identify, measure, mitigate and transfer the risks associated with natural hazards. In time, this will also push for the reinsurance and capital markets to innovate in order to meet the needs of governments around the world, and create new markets and financing tools that will allow for a more effective response to disasters.

Notes

1. Figures in dollars of 2011.
2. Figures in dollars of 2011.
3. Sistema de Control de Recursos, Captura y Validación de Solicitudes del FONDEN (SICCAVA).

This chapter provides information about DRM practices in Turkey; including a review of the practices that the Turkish government and its relevant agencies have undertaken to manage risk (specifically earthquake risk) and measures that are available for mitigating seismic risks. It further explains the legal and institutional framework for earthquake risk mitigation and strategic action plans taken. Moreover, the Turkish Catastrophe Insurance Pool is discussed with its strengths and contributions. The chapter argues that (1) engineering measures must play a crucial role, (2) the development of a professional liability insurance market is vital for both the government and private households, (3) a well-structured and audited regulatory system must be applied through strong and sustained political will, and (4) the envisaged urban transformation projects need to be completed in the upcoming years.

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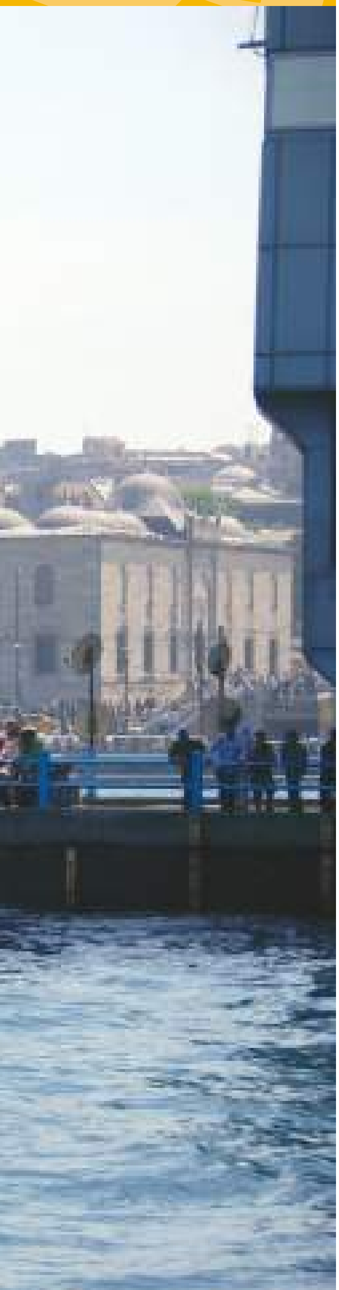
CHAPTER 14:

Disaster Risk Management in Turkey

*This chapter is a submission of the Government of Turkey**



Introduction

Because of its geologic, topographic, and climatic attributes, Turkey has frequently been confronted with different kinds of disasters. However, Turkey has managed to develop significant experience in coping primarily with earthquakes and other forms of natural disasters. During the post-1950s period, massive and rapid domestic migration to urban settlements and poorly supervised urban development have combined with an equally rapid industrialization process, thereby making cities more vulnerable to all natural, technological, environmental, and human-induced hazards. Earthquakes are the most important of these risks. In addition, landslides, floods, rock falls, snow avalanches, and forest fires are among the most destructive hazards in Turkey. The mitigation of the risk posed by seismic hazard has been the focus of governmental policies during the last half-century, especially after the devastating Kocaeli earthquake in 1999.

Following the Marmara quakes (Kocaeli and Düzce) in 1999, both the academic community and technical authorities agreed on the need to review the disaster management system and revise the related legislation and administrative structures. As a result, predisaster measures began to play a larger role in government plans. During this period, the Turkish Emergency Management Directorate (TEMAD)[1] was established under the Prime Minister's Office, and the urban search-and-rescue structure was changed with the establishment of Civil Defense Units in 11 provinces, employing up to 150 staff members each, based on the principle that effective response is one of the most crucial phases of a disaster management system.

As a response to the significant economic losses of the 1999 earthquakes, the government of Turkey launched an ambitious project to tackle this national catastrophic risk by first privatizing the risk through offering insurance through the Turkish Catastrophe Insurance Pool (TCIP, or, in Turkish, DASK -Do-al Afet Sigortalari Kurumu) and then by exporting large parts of the risk to the world's reinsurance markets. Funded by the World Bank, this program became part of a larger initiative known as the Turkish Emergency Flood and Earthquake Recovery Program (TEFER-Türkiye Acil Sel ve Deprem Iyilestirme Programi)

Additionally, important disaster risk reduction strategies and projects have been developed and implemented during the past decade. The Decree on Building Construction (Decree 595) on the enforcement of earthquake-resistant building codes, the National Earthquake Strategy and Action Plan (NESAP) to ensure earthquake preparedness, the Istanbul Seismic Risk Mitigation and Emergency Preparedness (ISMEP) Project, the Integrated Urban Development Strategy Action Plan (KENTGES-Kentsel Gelisme Stratejisi), and the regulation of building construction in earthquake zones (Afet Bölgelerinde Yapilacak Yapilar Hakkinda Yönetmelik, 1997) are some of the milestones of disaster management and mitigation in Turkey.

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This chapter outlines what the Turkish government and its relevant agencies have undertaken to manage disaster risk. In the interest of putting disasters in Turkey into perspective, especially for seismic peril, the chapter first describes the earthquake background that prevails in the country. Because mitigation is part of risk management, enhancement of the resistance of components of the built environment requires a systemic organization that ensures codes and standards, which are in fact enforced and obeyed. The chapter devotes attention to the steps taken and the problems that exist in that domain.

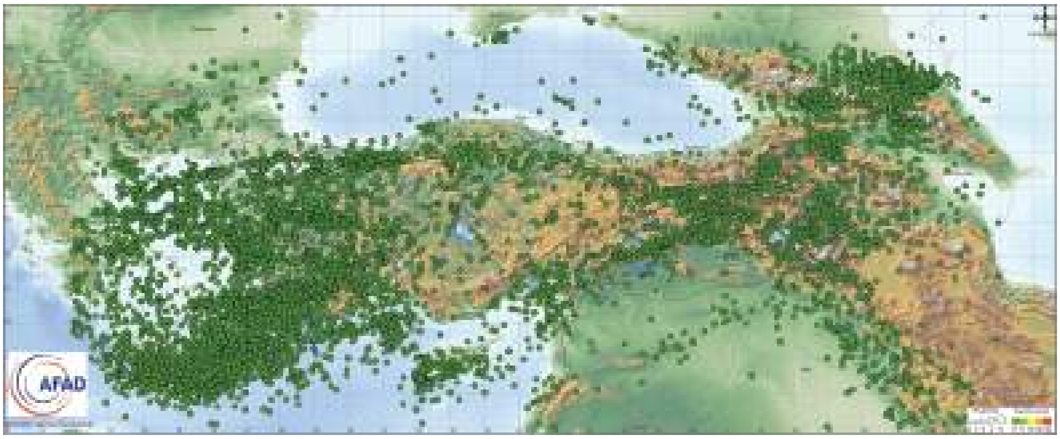
The text is organized around the experience gained from the broad range of measures—seismological, regulatory, and financial—that are available for mitigating seismic risks and containment of disaster damage on the scale of that in 1999. The remainder of this chapter considers each type of mitigation measure and discusses how successful it is. Clearly, engineering measures must play a crucial role in any risk reduction strategy, although their implementation relies on measures in other disciplines.

Earthquake Risk in Turkey

Turkey is in a seismically hazardous region of the world and is among the countries that have been materially impacted by the destructive effects of major earthquakes. According to the Earthquake Department databases (http://www.deprem.gov.tr), from 1900 to 2011 more than 10,000 events with magnitude (M) larger than 4 have occurred (map 14.1). The number of seismic events that have produced destructive effects during the same period is of course smaller but still numbers in the hundreds. The mitigation of the risk posed by the seismic hazard has been the focus of governmental policies during the last half-century, with varying consequences.

In most regions of Turkey, the seismicity is relatively well documented and major faults are often well defined. The North Anatolian Fault (NAF) zone is a 1,200-kilometer-long, seismically very active right-lateral strike-slip fault, and it accommodates the relative motion between the Anatolian and Eurasian plates. The NAF zone extends from the Karlıova triple junction in eastern Turkey to mainland Greece. At the western end of the NAF is the Marmara region, where the NAF branches into a series of subparallel fault systems, dominated by either strike-slip or normal movement. The Aegean region is one of the most rapidly moving and seismically active parts of the Alpine-Himalayan Mountain Belt, and its tectonics are dominated

Map 14.1 Earthquakes (M ≥ 4.0) in Turkey, 1900–2011



Source: Disaster and Emergency Management Presidency (AFAD).
Note: M = magnitude.

by extensional and strike-slip motions along the NAF zone and seduction at the Hellenic Trench. In the Eastern Mediterranean region, the triple junction shaped by the Arabian, African, and Anatolian plates forms a large deformational region. The tectonics of the Eastern Anatolian region are mainly characterized by the North and East Anatolian Faults, and those of the Central Anatolian region are characterized by some interpolate faults, taking up the internal deformation of the Anatolian plate.

The source zones defined on the basis of the identified active faults in the country, used in combination with the catalogue of earthquakes that have occurred in the country, have led to the seismic zone map that is currently in effect (map 14.2). Zone 1, colored in red, illustrates the highest hazard, which also shows the large proportion of Turkey prone to seismic risk.

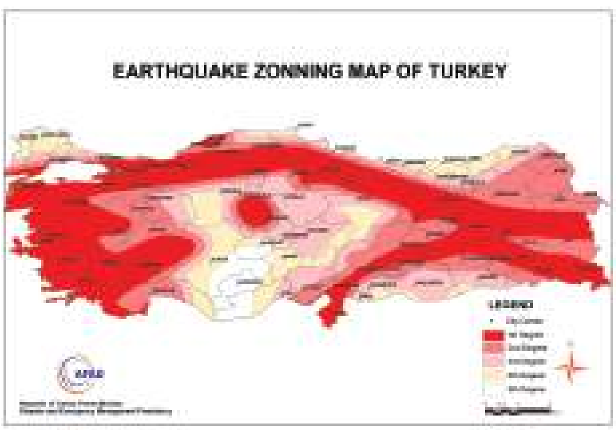
Assessment of Seismic Risk

Seismic risk at a particular location is widely understood as the convolution of seismic hazard (the possibility of ground shaking or collateral geotechnical hazards) with exposure (number of buildings and people in the area) and vulnerability (the lack of seismic resistance in buildings). Thus, it is possible to quantify seismic hazard with some degree of accuracy.

In Turkey, the focus of earthquake risk mitigation is generally on engineering measures to increase the seismic resistance of buildings and reduce their vulnerability. However, it is also possible to reduce the level of seismic risk by reducing the product of hazard and exposure, for example by relocating settlements to areas of lower seismicity. Seismic hazard maps of Turkey reflecting the seismic zonation in the current Turkish seismic design code indicate a rapid reduction of seismic hazard with distance from the North and East Anatolian Faults, implying that if settlements were concentrated away from the zones of highest hazard, risk would be reduced. Relocation of existing settlements is, however, hugely problematic, and one need not perform a cost-benefit analysis to discount this as a realistic option. Nonetheless, notwithstanding the huge number of other factors that necessarily influence settlement patterns, hazard zonation can be taken into consideration for new urbanizations.

Within existing urban areas, and particularly rapidly expanding cities such as those in the Sea of Marmara region, seismic microzonation can be a very useful risk mitigation tool. Microzonation studies have been recognized as a priority following some recent studies being performed for a number of Turkish cities such as Istanbul, Dinar, and Izmir, which are prone

Map 14.2 Current Earthquake Zones, Turkey



Source: AFAD

to high seismic risk. Comprehensive microzonation maps identify areas where soil deposits can be expected to amplify earthquake ground motions and areas susceptible to secondary hazards such as liquefaction and slope instability. Furthermore, building design can take account of the presence of these hazards, for example, by using deep-piled foundations in zones susceptible to liquefaction, thus reducing the scale of losses such as those witnessed in Adapazarı during the 1999 Kocaeli earthquake. Although microzonation may be of use in the enforcement of particular design requirements in new settlements, its usefulness in existing urban areas is limited because the earthquake response of buildings in densely built areas is usually masked by many other factors.

Hazard zonation, at macro and micro scales, can be useful in the application of structural strengthening. Those towns and cities within the highest hazard zone should obviously be the object of retrofitting programs before those in areas of lower hazard. Similarly, within these towns and cities, buildings located in areas where the surface geology or topography results in higher hazard can be similarly prioritized for retrofitting measures. A further extension of this strategy is the consideration of short-term earthquake probabilities in selecting areas for seismic upgrade programs. In addition to the seismic cycle, there is concern regarding the issue of stress transfer along fault systems, whereby stress release at one point from a large event is accompanied by an increase in stress on adjacent sections and hence heightened probability of an earthquake in the latter segment. The migration of seismicity along the North Anatolian fault from 1939 to 1999 has been interpreted in this way. In constructing an earthquake loss model for Turkey, increased likelihood of a Sea of Marmara earthquake is taken into account to give high priority to mitigation measures in Istanbul (Parsons et al. 2000).

Assessment of the Construction System

Much has been said on the quality of Turkey's building stock following the double earthquakes in 1999 in its most densely populated and industrialized Marmara region. With tens of thousands of deaths and the collapse of more than 100,000 buildings, the stark reality of endemic weaknesses in the Turkish building delivery system that needed to be corrected could no longer be ignored. The replacement cost of the housing stock and the reconstruction of the damaged infrastructure resulted in a diversion of much-needed resources from other productive areas of investment. Consequently, the 1999 earthquakes caused an economic downturn that year with a 6.5 percent contraction in gross domestic product (GDP), and in 2001 precipitated the most severe economic crisis the country had ever faced.

Mitigation of the impact of disasters, especially seismic risk posed by poor construction, must be dealt with through two distinct aspects. First, measures are needed to ensure that new construction complies with the best current seismic practice. Second, the threat posed by existing noncompliant construction must be addressed, which is potentially a much more difficult problem.

New construction. Considerable confidence exists that current procedures for seismic-resistant design and construction provide a high degree of seismic resistance at any scale of shocks. The exceptionally high percentage of buildings that suffered severe damage in the Kocaeli earthquake has been widely attributed (for example, EERI 2000, Gülkan 2005) to failure to comply with well-established seismic design procedures and not to deficiencies in published codes of practice. Development of international seismic codes will continue in many areas. However, although improvements are always possible, the current seismic codes are deemed to be quite robust in Turkey and in line with international practices. As such, the 1998 seismic code and its later revision in 2007 have received support from the international seismic community as well. Yet it is important to note that preventing another disaster on the scale of Kocaeli and attaining earthquake-resistant structures is not possible by only fine-tuning the legal framework. Training engineers and contractors and ensuring that building owners internalize its significance are also needed.

Existing construction. In the five provinces of Turkey with the highest seismic risk (which contain some major conurbations, including Istanbul), the annualized earthquake damage ratio (the ratio of the cost of repairing the earthquake damage to the replacement cost of the building) has been estimated to exceed 0.2 percent of the total value of all property in the province. The existing stock of housing in seismic parts of Turkey thus presents a threat to the safety and welfare of its citizens. As previously noted, the risk varies greatly among the building stock; some parts will protect its inhabitants well during an earthquake, whereas other parts are exceedingly dangerous. Therefore, the engineering needs are to establish cost-effective and reliable means of identifying the unsafe construction practices and then to develop means to retrofit and repair, as appropriate.

A great deal of progress has been made both on assessment and on repair and retrofitting methods in Turkey, particularly for the medium-rise reinforced concrete building structures that pose the greatest potential threat in earthquake-prone regions. Methods for assessing the stability of earthquake-damaged concrete buildings have been developed in the aftermath of the recent quakes in the Erzincan, Dinar, Adana, and Van regions. Similarly, methods developed in the United States for assessing the robustness of undamaged buildings have been widely used in a number of other countries, including Turkey. Building on these methods, large-scale building assessment and screening programs have been undertaken in various districts of Istanbul (that is, Zeytinburnu, Fatih, and B. Çekmece) as part of the ongoing ISMEP program. These methods allow relatively faster screening of buildings to categorize them according to their seismic adequacy. Admittedly, these methods require skill and training to apply, particularly for the buildings in the "gray area," which may possess limited seismic resistance.

Particularly in the past 20 years, repair methods for damaged buildings using various techniques and the addition of concrete shear walls have been developed and implemented with great success in Turkey. Although only a few buildings have actually been shaken by a subsequent damaging event, the indications from field experience are encouraging. These methods are believed to be effective. The buildings that have been strengthened were generally evacuated following the earthquake damage, so that repair work could continue unhindered by occupants. Furthermore, the strengthening of walls provided a highly visible sign of reassurance that the structures had been upgraded to provide seismic safety.

The major need in Turkey is currently to provide sound design and construction rules pushing for these highly effective procedures. One contentious issue is whether the upgrade needs to satisfy the same standards as those set for new buildings (which is the current situation in Turkey) or whether measures may sometimes be acceptable to remove the main vulnerabilities, such as soft stories, but not comply fully with the code for new building. The performance-based procedures of U.S. codes that have been incorporated in the seismic design code provide a rational basis for setting appropriate standards, but calibration of these procedures has been lacking.

The situation in undamaged but deficient buildings is different. Here, no visible signs of damage exist, and the threat comes from an event that may not occur in the lifetime of the current owners or occupiers. Moreover, introduction of concrete shear walls into existing buildings is a highly disruptive and quite expensive operation. Many alternative technologies exist, such as jacketing of members, steel cross-bracing, introduction of passive damping elements, base isolation, and so on. At present, they are not universally applicable to solve the problem, particularly as it applies in Turkey. The question as to whether standards for new buildings are appropriate is again an issue. Moreover, although undoubtedly technical advances may help produce better solutions, the problem needs to be tackled by financial and regulatory means as well. These issues are discussed in more detail below.

Disaster Risk Management and Mitigation

Disaster risk management and mitigation in Turkey became one of the most pressing issues in the agenda of the Turkish government because of the severe economic cost of the 1999 earthquakes. This milestone was followed by a series of regulatory, constitutional, and financial actions, and progress is still under way.

Legal Framework

Decree on Building Construction Supervision

The latest edition of the Turkish building code, which was issued in 1998, brings significant increases in lateral loads and in the design sophistication required from designers. The code was issued on the basis of a recognition that changes in the regulatory framework and in the practice of building control and oversight would be needed if the improved building standards envisaged in the code were to be realized. A research group was engaged by the Turkish Ministry of Public Works and Settlement (MPWS) in collaboration with the Government Housing Agency to look at issues of building and planning control and to make recommendations for change (Gülkan et al. 1999). Deficiencies identified in the present system of planning were the weakness of the local authority in implementing the development controls that the legal framework gave them, their lack of adequately qualified staff to check designs, and the unenforceability of the laws requiring owners to take responsibility for health and life safety in their buildings.

Some of the recommendations extracted from the expert report mentioned above were enacted in a series of decrees. The most important of these was the decree on Building Construction Supervision (Decree 595), which provided for newly formed building construction supervision firms, staffed by appropriately qualified engineers, effectively to assume the duties of the municipal authority in ensuring both the robustness of the design and the conformance of the actual construction to the design objectives. For each of the major administrative regions, the appointment and supervision of these firms were entrusted to a local building construction oversight commission. The building construction supervision firms were expected to take long-term responsibility for the satisfactory performance of the buildings they supervise and to buy liability insurance to cover themselves against claims in the event of "unreasonable damage" in future earthquakes. Ancillary decrees also set up the status of expert engineers and architects in the process of construction supervision.

Focusing exclusively on the poor performance of the building stock, an immediate cause could be identified: almost every collapsed or damaged building demonstrated some textbook example of poor practice and code violation. The reason the Building Seismic Code Regulations had been so grievously violated in practice was that responsibility for their preparation and enforcement belonged to different public agencies. A legally binding feature of this regulation is its final article, which states that enforcement is to be provided by the MPWS.

Ten days after the Kocaeli earthquake occurred on August 17, 1999, the Turkish parliament accorded extraordinary powers to the Council of Ministers by passing a law that effectively bestowed its own powers of lawmaking to the Council of Ministers for addressing the pressing needs during the postdisaster period. The legal instrument that accomplishes, a "Decree with Power of Law," must be voted in the Parliament within 6 months after becoming effective. The government used this privilege liberally during the rehabilitation period. One decree that later became the object of much debate was promulgated on April 10, 2000, Building Construction Supervision (Decree 595). It outlined an oversight administration for all buildings to be constructed in 27 provinces that of course included those that had been impacted by the Kocaeli and Düzce earthquakes. The MPWS was aware that a radical step was about to be taken before making the decree official. A new building quality assurance system was needed within a very short time window. Officials from the MPWS held extensive consultative meetings with professional associations, members of the academic community, consulting engineers, representatives of the insurance industry, and other relevant interest groups. These stakeholders did not agree on every stipulation of the decree, but an outline that at least represented a semblance of what the country needed was forged at the end.

Decree 595 defined four principal actors in the housing delivery process: the design engineer, the contractor, the site engineer, and the building construction supervision firm. Firms were categorized into three classes depending on the size and nature of technical staff they had on their payrolls. Better-staffed firms could be entrusted with larger and more demanding construction responsibilities. Design engineers needed to have the title of "professional," for which the requirements were later spelled out in Decree 601. The building construction supervision firm assumed the functions of the municipality in the supervisory role of checking both the design calculations and the actual construction activity at the building site. In that regard, the firm served as a public agent, ensuring that materials, workmanship, and detailing requirements were fulfilled. The firm needed to have liability insurance coverage of 10 years' duration for each job it had carried out.

A Building Construction Supervision Commission was set up in each settlement with more than 50,000 inhabitants. The commission was headed by the highest civil servant in that jurisdiction and included municipal, regional MPWS, professional association, and chamber of commerce representatives. The ministry created a central Higher Building Construction Supervision Commission whose responsibilities included keeping performance records for the firms and announcing operational guidelines.
Building owners were assessed at 4 to 8 percent of construction costs for the services provided to them by the supervision firms. Municipalities could not issue occupation and use permits for owners unless the supervision firm signaled that all design requirements had been fulfilled. The firms' insurance coverage for 10 years following occupancy also covered any unreasonable damages to the property caused by natural disasters. Having one set of professional engineers in the supervision firm check the designs of their peers in the design firms and requiring corrective action was truly revolutionary for Turkey, but the expectation of a great leap upward in building resilience turned out to be short-lived.

Decree law on the Turkish Catastrophe Insurance Pool

In Turkey, a paternalistic government approach used to be the solution to compensate for economic losses caused by disasters. The 1999 Kocaeli and Duzce Earthquakes resulted in significant economic losses of approximately US$16 billion to US$20 billion accounting for 5 to 7 percent of that year's GDP (Bibbee et al., 2000). This huge impact led to an urgent need to develop a system, that would help reduce the burden of future possible disasters on the government's budget. Because the penetration ratio of insurance and the financial strength of insurance companies were both low in Turkey, it was deemed necessary to redesign the earthquake insurance scheme and make it compulsory. As a result of this, the governmental decree No.587 regarding compulsory earthquake insurance was published in the official gazette dated December 27, 1999. With this decree, the Turkish Catastrophe Insurance Pool (TCIP) was established and it was made compulsory to have earthquake insurance for private dwellings. The obligation of the state to open credit and construct buildings that springs from the legislation concerning disasters was abolished by March 27, 2001.

For the enforcement of insurance, two checkpoints are currently applicable:

- Control at the land registry: Homeowners must present their insurance policy for the real estate registration offices to effect any procedures related to the buildings subject to the compulsory insurance;
- Control when receiving mortgage credit or a housing loan.

These check points work well and almost half of the total insurance policies go through these check points.

The new Disaster Insurance Law, which has been recently enacted by the parliament, envisages extending such control requirements to other public services, such as electricity and water service subscriptions. The enactment of the law will significantly improve insurance penetration.

The abrogation of the provision of the Disaster Law requiring the government to extend housing credit and to have buildings reconstructed after the new insurance scheme, which was waived in 2005, is reintroduced with this law. This revision in the Disaster Law is expected to change public perceptions about state involvement and support the insurance solution. Clearly, financing disasters through the public budget is not sustainable. The recent earthquake in the province of Van is the latest example supporting this conclusion.

Detailed information on TCIP is given in a later section of this chapter.

Regulatory framework for construction within earthquake zones

The planning and building regulations have evolved over time to make the structures and settlements resistant as the risks are better assessed. However, at least half the buildings in the country have been built under earlier versions of the regulations and through efforts to remediate problems. This requires a new planning approach based on risk assessments to set the priorities for regeneration efforts to make the building stock in the country effectively resistant to disasters. For those affected by major disasters, policies have been developed since the 1960s. Whereas the purpose of Law No. 7269, the Law of Precautions and Supports Related to Disasters Affecting Public Life, was to build new houses for their rightful owners, Decree Law No. 587, Compulsory Earthquake Insurance Law, aims to compensate the monetary loss of the rightful owners through a fund collected in the name of compulsory earthquake insurance.

However, the effectiveness of the approach of compensation after loss has been questioned recently because it cannot maintain the sustainability of the communities and the economy. For that reason, in 2004 the Earthquake Council was organized to discuss and apply earthquake mitigation activities. Building on the council's conclusions, new rules and regulations were set, and accordingly, new regulatory areas were proposed to strengthen construction practices.

The new Regulation about Building Construction in Earthquake Zones was prepared in collaboration with members of the academic community and members of the earthquake engineering division. This new regulation came into force on March 6, 2007. For the first time, the earthquake code includes “evaluation and strengthening of the existing buildings.” This part of the regulation provides a technical guide on assessing the earthquake resistance of buildings and strengthening subjects. In addition, to apply the regulations correctly, a training project for professional engineers was conducted for the first time in Turkey. In addition to the Existing Construction Material Regulations, in 2009 the Regulation for the Criteria of Construction Materials was published to have all construction materials certificated. New construction materials documentation processes have been developed, mostly for load-bearing walls, and control mechanisms have been applied to materials supplied to the market.

In 2010, Contractor Regulations were published. These regulations obliged contractors to be registered and regularly monitored, with a threat of debarring faulty contractors from constructing new buildings.

The Building Inspection Law, which was in force for only 19 provinces, was extended to cover the whole nation in 2011 and, among other items, sanctioned the building inspection firms that have acted under color of office. Also, geoscientific surveys (feeding into development plans) and more detailed studies for every development plot have been made mandatory by law. Geological and geotechnical survey reports consist of geology; geophysics; seismology; hydrogeology; land use; ground dynamic-elastic parameters; data on natural disasters such as earthquake, flood, and the like; and the results of analyses done at the construction area and the experiments done in laboratories. To start building in an urban area, a zone planning including the geological and geotechnical survey reports must be prepared. These surveys are aimed at determining areas of risk and taking precautionary steps.

Last, in July 2011, the Ministry of Environment and Urban Planning was established to coordinate the nationwide urban transformation facilities in addition to other duties. This ministry is given the responsibility of developing the tools and preparing the legal framework for easing urban transformation facilities. For this purpose, a Draft Law for Transformation of Disaster Risk-Prone Areas has been prepared to determine the residences that are exposed to disasters, to demolish the risky buildings, and to find ways to subsidize the households whose houses are found risky and taken down. The parliament is still discussing the draft law, and to simplify the process, some monetary tools have been developed, such as the following:

- Determining the risk conditions of structures scientifically and compensating the cost of destroying risky structures;
- Expropriating the land or real estate of the owners who cannot be persuaded with any of the alternative development models;
- Using the public areas and providing monetary support or rent subsidy to the owners to support the new construction period;
- In case of the citizens’ not applying this regulation, putting their building to an open tender.

Institutional Framework

Disaster and Emergency Management Presidency

In Turkey, disaster risk management activities used to follow a top-down centralized system until the experience of the 1999 earthquakes. Disaster risk management has three phases: before, during, and after. Predisaster, mainly mitigation and preparedness activities take place to reduce the disaster impact. In the aftermath of a disaster, the implementation of emergency procedures (the response and the search and rescue) is key to minimize the loss inflicted on society. That said, once the socioeconomic, environmental, and cultural losses materialize, it is then time for the implementation of recovery and rehabilitation strategies. In Turkey, until the August 17, 1999, Kocaeli earthquake, the focus was on the response and the recovery and rehabilitation phases. However, since then the focus has shifted to risk mitigation and investment before the fact to minimize the potential losses.

In the implementation phase, the local governments needed more authority to mobilize local expertise. The central authority was also streamlined by uniting the General Directorate of Disaster Affairs under the MPWS, the General Directorate of Civil Defense under the Ministry of Interior, and the Turkish Emergency Management Directorate in December 2009 to form a new institution—Disaster and Emergency Management Presidency (AFAD -Afet ve Acil Durum Yönetimi Başkanlığı)—within the Prime Minister's Office.

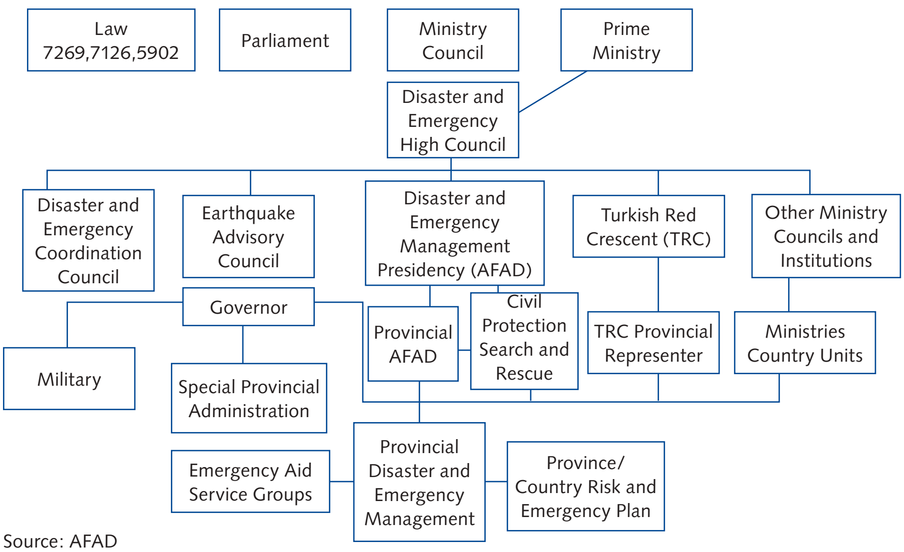
Within the new administrative structure and legislation, as seen in figure 14.1, AFAD works on disaster risk reduction (DRR) directly with the Planning and Mitigation Department and the Earthquake Department. It also conducts indirect disaster risk mitigation work through its Civil Defense, Response, and Recovery Department. In parallel with the rise of global interest in the concept of DRR, Turkey is well aware of the importance of risk reduction strategies. To this end, the country has adopted the *Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters (HFA)* (UNISDR 2005) as a key guideline for national progress in DRR.

Additionally, an important initiative, the Assessment of Principles of Risk Management Project, was launched at the beginning of 2011. This project, which will be finalized by 2013, covers the methodology and procedures for risk assessment and risk analysis studies to be performed in the provinces.

Another initiative worth mentioning is the establishment of a multistakeholder consultancy mechanism, the Earthquake Advisory Board, under AFAD. With the board's support, the Earthquake Department prepared the National Earthquake Strategy and Action Plan that was launched in August 2011.

Turkey has also recently established a National Platform for Disaster Risk Reduction, in accordance with the first priority of the HFA and in close cooperation with the United Nations International Strategy for Disaster Reduction (UNISDR). The first meeting of the platform will be held in 2012 with the participation of all stakeholders.

Figure 14.1 Organizational Structure of the Disaster and Emergency Management



Source: AFAD

AFAD is also working on the preparation of the National Disaster Management Strategy and Action Plan. The document contains the short-, medium-, and long-term DRR objectives in line with the HFA. All government institutions dealing with disaster and emergency management, as well as the academic community and nongovernmental institutions, are involved in the preparation of this document, which will be finalized by the end of 2012.

AFAD is responsible for education, training, and awareness-raising activities in the field of DRR. The target groups of these activities are decision makers, national and local officials from directors-general to experts working on disaster and emergency management, nongovernmental institutions, and the public.

Starting from the premise that well-informed populations can protect themselves better against risks and can cope more efficiently with danger in emergencies, AFAD pays special attention to publishing and distributing informative texts and visual materials on disasters and emergencies to raise public awareness. For this reason, AFAD organizes theoretical and practical education and training programs for specific topics in the field of disaster and emergency management with a continuously updated curriculum to improve the skills of managerial and technical staff members working in this field.

Housing Development Administration

A more sustainable approach to urban transformation and strengthening of the existing structures has been put into action since 2004. The method has been to adopt a new government support mechanism through the Housing Development Administration of Turkey (TOKI-Toplu Konut İdaresi Başkanlığı). This institution with local administrative units has started working on 182 projects, including converting slum houses to more than 250,000 housing units under the Urban Renewal Program, in addition to aiming to build approximately 65,000 housing units (45,000 of which have already been built) in 134 regions. Furthermore, TOKI is undertaking disaster housing projects, whereby 35,000 homes have been built since 2003.

Strategic Action Plans

National Earthquake Strategy and Action Plan

The main objective of the National Earthquake Strategy and Action Plan (NESAP) is to constitute new earthquake-resistant, safe, prepared, and sustainable settlements so that physical, economic, social, environmental, and political harms and losses that may be generated by earthquakes are prevented or their effects reduced by empowering a society that is well prepared and resilient for reduction of seismic risk and capable of coping well in the face of earthquakes.

The following three principal thematic groups have shaped the objectives, strategies, and actions of NESAP:

- Learning about earthquakes;
- Implementing earthquake safe settlement and construction;
- Coping with the consequences of earthquakes.

The periods for realization of the NESAP tasks have been based on the framework of short-term (2012–13), medium-term (2012–17), and long-term (2012–23) durations. The types of action have been considered under four principal headings: cooperation and coordination, revision of legislation, institutional structuring, and capacity enhancement. In preparation of NESAP, the fundamental principle has been approved that these actions are permanent tasks for the designated agencies. Other considerations incorporated into NESAP are public-private collaboration and compatibility with the earthquake technical acquisitions of the European Union.

Integrated Urban Development Strategy and Action Plan

The Integrated Urban Development Strategy and Action Plan (2010–23) has been published as the outcome of the Integrated Urban Development Strategy and Action Plan (KENTGES) Preparation Project for Sustainable Urban Development. With this action plan, the actions and procedures to be implemented at the central and local levels have been determined under the titles of transportation, infrastructure, housing and land provision, disaster mitigation, preservation, climate change, life quality, social policies, and participation.

Istanbul Seismic Risk Mitigation and Emergency Preparedness Project

To prepare Istanbul for a probable earthquake, Turkey and the World Bank signed the ISMEP Loan Agreement in the amount of €310 million on October 18, 2005. With additional borrowings, the total loan by international institutions such as the European Investment Bank, the Council of Europe Development Bank, and the World Bank amounted to a total budget of €969.8 million.

ISMEP, which is expected to be completed in 2015, aims to enhance the institutional and technical capacity of emergency management–related institutions; raise public awareness in emergency preparedness and response; carry out feasibility studies of the priority public buildings against seismic risks and assess reports on retrofitting or reconstruction of these buildings; support national disaster activities; inventory cultural heritage buildings, carry out seismic risk assessment of selected cultural heritage buildings, and prepare retrofitting project designs; and take supportive measures for effective building code enforcement to prepare Istanbul for a potential earthquake. Components of the project are as follows:

- **Enhancing emergency preparedness** supports (a) improvement of the emergency communications system, (b) establishment of an emergency management information system, (c) strengthening of the institutional capacity of the Provincial Directorate of Disaster and Emergency, and (d) upgrading of the emergency response capacity of the first responding agencies (Istanbul Search and Rescue Unit, Provincial Directorate of Health, Provincial Directorate of Disaster and Emergency, and Turkish Red Crescent) on the occurrence of a disaster and public awareness and training.
- **Seismic risk mitigation for priority public facilities** supports (a) retrofitting or reconstruction of priority public facilities, including hospitals, clinics, schools, administrative buildings, student dormitories, and social service facilities; (b) National Disaster Activities, development of an inventory of cultural heritage buildings under the jurisdiction of Ministry of Culture and Tourism and seismic risk assessment of these cultural heritage buildings; (c) preparation of retrofitting designs of selected cultural heritage buildings; and (d) analysis of the current land management policies and instruments for identification of the different models and methods required for mitigating earthquake risks on public buildings with improved management and generation of new financial resources.
- **Enforcement of building code** supports (a) ongoing and additional studies and activities to enhance guidelines and regulations for better enforcement of building code and land use plans, (b) voluntary training of engineering professionals, (c) enhancement of the technical and institutional capacity of the pilot municipalities to streamline issuance of building permits, and (d) assurance of transparency in the enforcement of building code and land use plans.

Within the ISMEP project, 71 schools were restructured and 413 schools were retrofitted against earthquake risk.

Insurance Solutions

Historically, earthquake insurance has existed in Turkey for a long time. Earthquake coverage has been traditionally provided as an allied peril to the fire policy and engineering policy. However, the penetration for such insurance was quite low before 2000, especially for residential buildings (5 percent on average).

Economic impacts of continuing disasters and low insurance penetration led the authorities to initiate a new study to promote disaster insurance and establish a widespread and effective earthquake insurance scheme after the Adana earthquake of June 1998. This study has been initiated by the Treasury, which is also responsible for regulating and supervising the insurance industry, in collaboration with the local insurance market and the World Bank, which has engaged in a lending program with the government after the earthquake. With the help of political momentum that emerged following the Marmara disasters in August and November 1999, as well as public and insurance industry recognition of the need for action, this compulsory earthquake scheme received immediate acceptance, and the government decided to introduce it in 2000.

The legal framework of the new scheme was established by a decree law. With this decree law, as of September 27, 2000, taking out insurance was made compulsory for all residential buildings that fall within municipality boundaries, and the Turkish Catastrophe Insurance Pool (TCIP) was created to offer this insurance. Moreover, the obligation of the government to extend credit and construct buildings for the victims in case of an earthquake disaster (a requirement of the Disaster Law) was abolished. The new insurance scheme has effectively replaced a big part of the government's obligations under the Disaster Law.

The compulsory earthquake insurance scheme has aimed to offer such insurance coverage at affordable premiums, to alleviate the financial burden of earthquakes on the government budget (particularly relating to the construction of postdisaster housing), to ensure risk sharing by residents, to encourage standard building practices, and to establish long-term reserves in financing future earthquake losses.

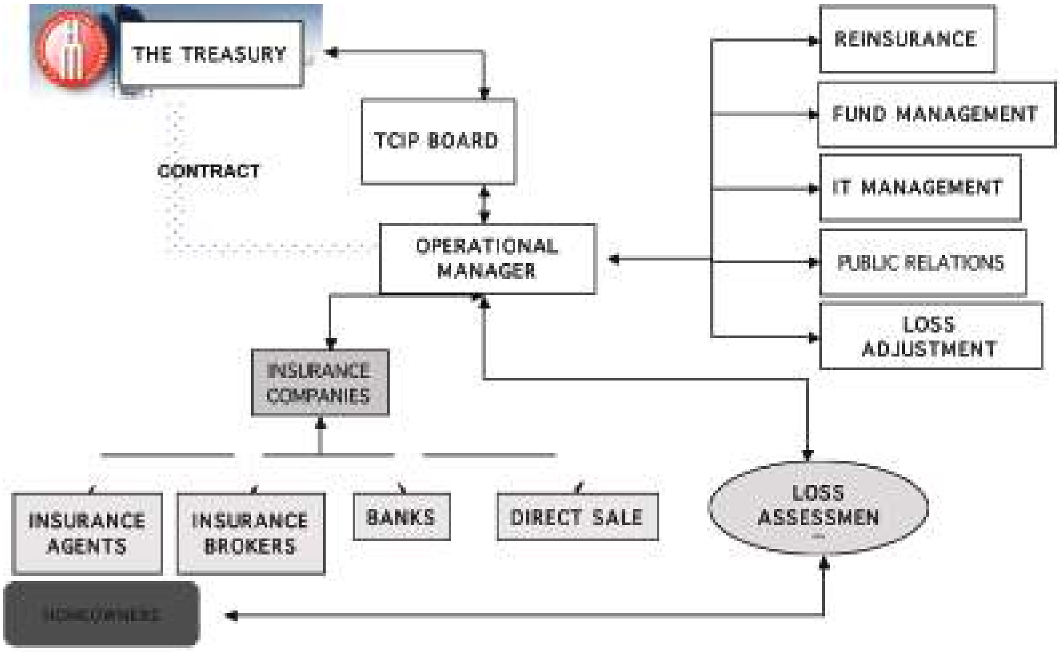
The introduction of TCIP and the new insurance scheme provides a reliable method for compensation to homeowners in Turkey without resorting to the government budget; social solidarity and risk sharing are effectively maintained through payments of affordable insurance premiums. Meanwhile, a large amount of the risk is being ceded to international reinsurance markets.

Structure of TCIP

TCIP is a legal public entity managed through the TCIP Management Board, consisting of representatives of the Prime Ministry, the Treasury, the MPWS, the Capital Markets Board, the Association of Insurers, an operational manager, and an earthquake scientist. The formation of the board and inclusion of all key parties are very important in TCIP's success. This approach has helped TCIP better coordinate works and has increased ownership of the scheme. Besides the Management Board, the Treasury is also the primary owner of the scheme. It is responsible for overseeing the whole program and auditing all operations and accounts of TCIP (figure 14.2).

Aiming to minimize administrative costs and create an efficient operational structure, TCIP relies on external service providers for most of its operations. Operational management is being contracted out to an insurance company every five years; the company receives payment depending on the overall volume of premiums received. Insurance companies and their agencies carry out the distribution of policies. Almost all non–life insurance companies are participants of the scheme. Participating insurers receive commission payments depending on the volume of premiums they have collected.

Figure 14.2 Organizational Structure of TCIP



Source: TCIP
Note: IT = information technology; TCIP = Turkish Catastrophe Insurance Pool

Public information campaigns are carried out with the help of a public relations company and other subcontractors. TCIP has been carrying out massive information campaigns to increase insurance awareness and maintain and increase insurance takeout. Likewise, independent insurance loss adjusters commissioned by the operational manager carry out loss assessments when a reported loss occurs.

TCIP and its revenues are exempt from corporate tax. Accumulated funds are kept in segregated accounts. Following the TCIP Board's investment guidelines, funds are managed by the operational manager and asset management companies.

Covered Buildings and Perils

The compulsory scheme covers only residential buildings that fall within municipality boundaries. Dwellings in small villages have been excluded from the scheme for the following reasons: villagers have a relatively lower income level to afford insurance; the insurance distribution network in these areas is weaker; and dwellings in these areas are more vulnerable, which requires high price subsidization. Therefore, state compensation under the Disaster Law for such small villages (constituting approximately 30 percent of the population) still prevails.

Compulsory earthquake insurance is a standalone product and is sold separately from fire or homeowner's insurance. It covers all material damages caused directly by an earthquake to the insured building. TCIP does not provide coverage for contents, land, loss of profit, or human injury. Coverage for such losses can be purchased voluntarily under fire or homeowner's insurance from private insurance companies.

Although the original design of TCIP was as a multiperil natural hazard insurer, products for other natural hazards are not available yet. The Disaster Insurance Law that has been recently enacted by the parliament envisages coverage of other natural perils to be provided by TCIP.

Insurance Limits and Rates

TCIP aims to provide an adequate level of protection at affordable premiums. Therefore, the compulsory earthquake insurance has a ceiling in terms of sum insured. This ceiling is approximately US$80,000. Policyholders are free to buy additional coverage in excess of this limit from insurance companies if the value of their dwelling is more than this amount. In such cases, the TCIP policy works on a "first loss" basis.

The sum insured is calculated by multiplying the gross square meters of dwellings by the relevant unit reconstruction cost. When assessing claims, TCIP takes into account market reconstruction prices at the date of event occurrence for each type of building, and any loss payment is limited to the sum insured. A 2 percent deductible is applied over the sum insured.

Insurance rates account for seismicity and construction type. The earthquake map used by TCIP divides the country into five different categories of land according to the vulnerability factors, whereas the tariff divides buildings into three categories according to their construction types (table 14.1). The aim in adopting a simple tariff is to avoid creating complexities that would confuse potential policyholders and to encourage solidarity.

Table 14.1 TCIP Insurance Rates

Type of construction	Risk regions				
	I	II	III	IV	V
	Insurance rates (%)				
Steel and concrete	2.20	1.55	0.83	0.55	0.44
Masonry	3.85	2.75	1.43	0.60	0.50
Other	5.50	3.53	1.76	0.78	0.58

Source: TCIP
Note: TCIP = Turkish Catastrophe Insurance Pool.

Financial Resources and Claims Payments

TCIP is a privately funded entity, and its funding has been primarily dependent upon premium contributions made by homeowners under the insurance scheme. TCIP has not faced any major disaster since the beginning of the program. Therefore, it could accumulate some financial resources through retained insurance premiums and investment income. However, because these resources are not sufficient, TCIP has to rely heavily on reinsurance to be able to indemnify policyholders if a major disaster occurs. However, the Disaster Insurance Law in parliament envisages state support in the form of excess reinsurance at the very top of the TCIP reinsurance program.

TCIP has successfully transferred a major part of its risks to international reinsurance markets. The current claims-paying capacity stands at more than US$3 billion, which refers to a 250-year return period, and almost two-thirds is supported by reinsurance.

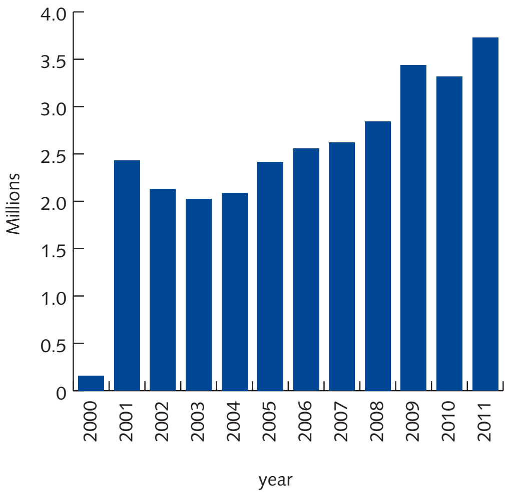
TCIP has had quite a bit of experience regarding claims payment because of several smaller earthquakes, even though no major disaster had occurred until the recent earthquake in the province of Van on October 23, 2011. Table 14.2 summarizes the claims paid by TCIP. The high frequency of small and medium-size earthquakes occurring every year is immediately evident from the table. This picture alone might indicate the importance of introducing the compulsory earthquake insurance scheme in Turkey. Obviously, the amount of payments would have been much higher if more homeowners purchased more insurance.

Table 14.2 TCIP Claims Payments

Year	Number of earthquakes	Number of claims paid	Total payment (TL)
2000	1	6	23,022
2001	17	336	126,052
2002	21	1,558	2,284,835
2003	20	2,504	5,203,990
2004	31	587	768,927
2005	41	3,487	8,118,605
2006	23	500	1,303,673
2007	42	995	1,381,599
2008	45	481	558,849
2009	37	266	497,886
2010	37	444	699,549
2011	35	6,294	77,334,631
Total	350	17,458	98,301,618

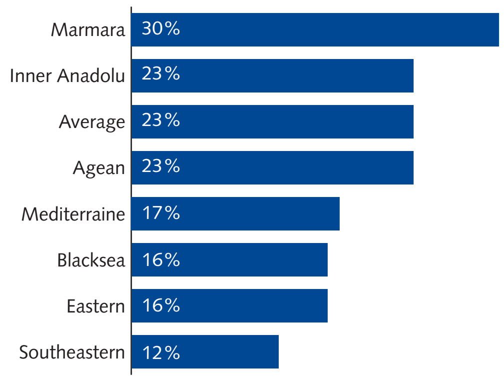
Source: TCIP
Note: TCIP = Turkish Catastrophe Insurance Pool; TL = Turkish liras.

Figure 14.3 Development of Compulsory Insurance Policies



Source: TCIP

Figure 14.4 Insurance Penetration across Geographical Regions, 2011



Source: TCIP

Market Penetration

At the end of 2011, the total policy number was 3,726,000, which is 23 percent of the total buildings that fall under the scheme (figure 14.3). This is a moderate level of penetration for a mandatory scheme and penetration definitely has not yet reached the desired level. However, it is well above the penetration of homeowner's insurance (5 percent) prior to the start of the scheme.

Insurance penetration—as illustrated in figure 14.4 varies across geographic regions and provinces. The take-up rate is obviously higher in the provinces with a damaging earthquake experience and in the economically more developed parts of the country. This implies that different regions should be treated differently in terms of marketing and public relations.

TCIP has led intensive public information and education campaigns to boost insurance sales. These include commercials and documentaries broadcast on national and local TV channels; TV and radio programs; newspaper ads; printed information and education materials distributed to the public and students; contests among cities; meetings with local individuals, academics, and press members; and an earthquake simulation trailer traveling nationwide. These campaigns have proved very helpful in maintaining and increasing insurance penetration.

Among the main reasons for low penetration are a relatively weak insurance culture; the traditional role of the state in compensating for disaster damages and the continuing expectation of the public in this direction; weak enforcement; and low income levels, especially in the eastern parts of the country. Despite various disincentives, a remarkable change has occurred in homeowner behavior, especially after damaging earthquakes. For example, insurance take-up rates increased 5 percent on average after the 2011 Van earthquake.

Final Remarks and Future Plans

Related institutions in Turkey have internalized a comprehensive disaster risk reduction and disaster risk management perspective. Nevertheless, the vulnerability of the current building stock is the most critical challenge in Turkey. Mitigation of earthquake risk in highly seismic areas requires the use of sound engineering seismology practices. Yet, these skills must be reinforced with other measures. For instance, the insurance market has a role to play by introducing financial incentives to implement sound construction practices. It can also promote economic stability by diversifying the financial risks stemming from disaster damage. The engineering measures should also be complemented by effective building controls with competent engineers to enforce them.

The multifaceted nature of earthquake risk mitigation was well recognized in Turkey, even before the Kocaeli earthquake of 1999. However, significant challenges are still ahead, as demonstrated by recent earthquakes in Afyon 2002, Bingöl 2003, Elazig 2010, Simav 2011 and Van 2011, inflicting substantial damage and triggering significant public reaction. These challenges are discussed in the following sections.

Engineering Seismology

Engineers must find ways of incorporating information about local "seismic gaps" into prioritization plans for seismic upgrading as well as the influence of recent fault breaks in neighboring portions of a fault system. Turkey's existing building code is one of the strongest in the region, but enforcement of the existing code is one of the primary challenges for the authorities.

Structural Earthquake Engineering

The more urgent need lies not in improving assessment methods, but in developing methods for repairing inadequate buildings in a cost-effective manner while limiting the disruption inflicted on the owners and occupiers of those buildings. Besides, procedures for setting appropriate levels of seismic upgrading in Turkey must be agreed on for both damaged and undamaged structures (in particular for the deficient ones).

Financial and Insurance Measures

Obviously, insurance is a mechanism to diversify the risk and does not necessarily reduce the loss itself. That said, if an insurance program is designed and implemented robustly, it may help reduce the magnitude of the losses (Mileti 1999). Such a program must be built upon four pillars (Mileti 1999):

- Education and information: to increase insurance awareness in the community;

- Involvement in the preparation processes of the legal framework: to enhance public ownership;
- Financial incentives, such as insurance premium reduction or change in the deductible amount: to encourage take-up;
- Limiting of the availability of insurance: if the construction does not comply with the standards, access to insurance should be restricted to impose sanctions on substandard construction practices.

TCIP has been a mandatory mitigation measure for individual homeowners. Thus, policy makers' cooperation with the public to increase the penetration rate of insurance is crucial for the success of this system, which can basically be achieved with proper education and information.

An important feature of TCIP is that its structure paves the way for many improvements in data quality and modeling procedures. Clearly, scope exists for enhancing the model with the addition of data on, for example, soil conditions at several locations, as well as with a better building inventory.

As described in the previous section, TCIP insurance rates are kept within affordable limits by encouraging discounts on the renewal rates of the policies compared to what a private insurance system would charge. With regard to the relative vulnerability data, risk mitigation could be enhanced through insurance.

On the other hand, the development of a professional indemnity insurance market is vital for both the government and households to transfer the disaster risk from the Turkish economy by tapping into international reinsurance markets.

Regulatory Measures

In the Turkish legal system, the Council of Ministers enforces laws, whereas individual ministries enforce regulations that emanate from them. The seismic requirements are, of course, really for the municipal governments to enforce when they issue building construction permits on the basis of project designs that have been submitted to them, but this fact is overlooked in the wording of the regulation. Because of code enforcement issues between the central and local authorities arising from this duality, necessary steps have been taken to address the legal jurisdictions.

The decree on Building Construction Supervision (Decree 595), the most important decree related to earthquake risk mitigation, was not a perfect piece of legislation, yet many of its features were still considered to be revolutionary. That said, among the issues where further progress is possible are the limited coverage, which does not capture the institutional structures, and the omission of urban planning issues. However, one should also note that at that time, urban planning was understandably conceived as a much more complicated matter to be covered in a disaster-related decree.

In line with the regulations on zone planning, geological and ground surveys became compulsory. However, too many rules and regulations have been promulgated on this issue, raising the need for harmonization of the legislative framework to have more accurate geological survey reports and hazard-proneness maps.

If the envisaged urban transformation projects can be completed in the upcoming years, the next generations will suffer less than the previous ones in a safer and more disaster-resilient environment. The government's motto is that if the building stock is strong enough, the natural events will not turn into disasters to claim human lives and inflict economic, social, cultural, and environmental losses. Achieving this end requires strong and sustained political will.

Notes

1. In 2009 TEMAD was incorporated into a combined governmental entity for disaster management called AFAD.

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There is a growing interest in the use of risk modeling and finance tools for disaster risk management. In response to the G20 call for papers, the United Kingdom's Department for International Development held a meeting in early April in London where senior-level experts from the public and private sectors and the science community discussed the opportunities and challenges for expanding the application of these tools, particularly in low-income countries. This chapter builds on the discussion at this meeting, which focused on two key components of disaster risk management: understanding risk better and using the right tools for the financial management of risk. The meeting also examined recent innovations in these two areas.

CHAPTER 15:

Building Disaster Resilience

Improving the Understanding and Financing of Risk

*This chapter is a submission of the Government of the United Kingdom**

Executive Summary

An increasing amount of expertise and resources are being mobilized worldwide to address the need for better understanding of risk and for better access to cost-efficient financing tools for disaster losses in countries vulnerable to natural disasters. However, numerous gaps and challenges remain that need to be addressed to help ensure that the most vulnerable countries—particularly developing economies—have better access and use of these tools to improve their management of disaster impacts.

Critical limiting factors in the uptake and use of disaster risk data and models include:

- a lack of available data, which is attributable to either the absence of data (including that on risks and the socioeconomic impacts of disasters), intellectual property and security restrictions on sharing data or the storing of data in inappropriate formats that inhibit sharing;
- a need to develop local capacity to build and best exploit these tools in order to engender national ownership and the imperative to use and maintain these tools locally;
- a need to ensure that these tools are well aligned with locally perceived needs and local policy frameworks; and
- a gap in local and international expertise to link better disaster risk data and models to assist decision making in disaster risk management.

A number of options for addressing these limiting factors are presented. They include building partnerships with national and international expertise from the public and private sectors to develop risk modeling and assessment tools. This is one way to build and use local technical capacity, while also stimulating local ownership. Programs of technical assistance to help integrate these tools into the processes and structures of local entities, including various government departments, are one way to ensure that decision making in disaster risk management is guided by an understanding of the risk itself. This suggested institutionalization of disaster risk data and models can also create accountability and incentives for those using the tools to ensure they are effectively used and maintained.

Additional investment in helping translate the analysis of potential physical hazards into their resulting impacts on populations and assets at risk is also a priority as the articulation of the types of impacts that disasters have beyond direct financial losses is broadly lacking. This includes understanding and quantifying financial losses from a public finance point of view and also understanding and quantifying vulnerability and exposure from a broader development and humanitarian perspective.

*Nick Harvey (UK DFID); Emily White (Disaster Risk Financing Specialist, Consultant); with support from DFID's Chief Economist, Stefan Dercon

The report greatly benefited from data and information provided by academic, private sector, donor, development institution and other partners from the international community who attended the April 2nd and 3rd resilience meeting held at DFID. Contributions and support from the Global Facility for Disaster Reduction and Recovery (GFDRR) and World Bank Disaster Risk Financing and Insurance Program are gratefully acknowledged.

Key challenges for disaster risk financing include:

- an urgent need to build the evidence base of the effectiveness of disaster risk financing tools (questions need to be answered about the demonstrated strengths and weaknesses of schemes piloted so far and the value of investment in these products compared to investment in alternative disaster risk management tools such as physical risk reduction);
- a need to share the cost of disaster response and recovery more efficiently between affected countries, donors, and other stakeholders in order to reduce dependence on international aid, to promote contingency planning, and to create incentives for all stakeholders to engage actively and invest in reducing disaster losses;
- a need to strengthen countries' capacities to deploy received funds for disaster response and recovery once these instruments are triggered; and
- a need to create and maintain demand for the use of disaster risk financing tools because at the micro level, innovative pilots have struggled to establish a significant client base, and at the macro level, the number of countries using these tools remains low.

To address the need to build the evidence base for these instruments, a stronger focus on the monitoring and evaluation of pilots is required. The benefits of insurance facilities and pools should also be evaluated, with an open discussion on operating costs.

To use disaster risk financing instruments at the national level, the first step suggested is to identify and quantify the government's contingent liabilities. There is also a need to consider how national contingency planning can be strengthened as part of the process of developing a strategy for disaster risk financing.

The role that domestic insurance markets have to play in building the resilience of vulnerable populations is also acknowledged. The public sector and development partners can help insurers reach the vulnerable populations through a number of different modes of support. These include the creation of an enabling regulatory environment, offer of subsidies,[1] injection of risk-bearing capital or investment in infrastructure, and product development. The appropriate intervention will vary depending on the country in question.

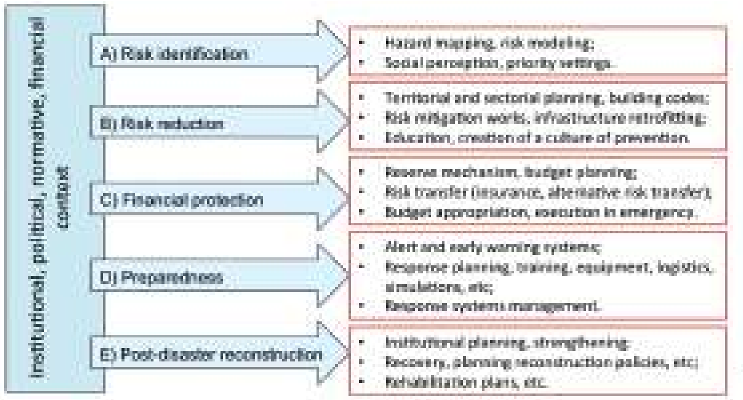
Making a case for investing in risk financing tools that may not yield payouts within a political cycle or, indeed a lifetime, can be difficult, despite the importance of these tools in the event of a catastrophe. This is particularly true in developing economies where the opportunity cost of diverting funds (potentially from the broader development agenda) is extremely high. Presenting disaster risk financing tools within a package of options is a possible way to encourage uptake of these instruments.

Introduction

The impacts of natural disasters on countries are varied, complex, and interconnected. As a result, there is no single tool or activity that can address disaster impacts and build resilience across all areas of vulnerability. A comprehensive agenda for disaster risk management (DRM) should therefore comprise multiple components (see figure 15.1).

A sound understanding of risk (risk identification) and financial strategies (financial protection) for management of the inevitable cost of disasters are critical elements within such a comprehensive approach to DRM. Without engagement in these areas, resilience cannot be built.

Figure 15.1 Disaster Risk Management Framework



Source: Global Facility for Disaster Reduction and Recovery, World Bank.
Note: ART = Alternative risk transfer

Typically, only after a significant disaster event has occurred, when directly observed impacts of the event are fresh in national and international memory, is strong interest in the DRM agenda generated. However, current tools for understanding risk can help countries avoid a recurrent cycle of only investing in DRM when an event has occurred. These tools can help identify and demonstrate the potential impacts of disaster shocks and stresses. This identification and demonstration can help create the political incentive within countries and in the international community to engage and invest in DRM before a large disaster occurs. Equally important is the role that these tools can play in helping direct decision makers to identify the most efficient interventions and investments for the most vulnerable and exposed areas, sectors, and populations. Mainstreaming disaster risk assessment into decision making in DRM is a key step in building resilience.

Interest and engagement in disaster risk financing has grown particularly rapidly in recent years. This has arisen from an understanding that while investment in risk reduction will always be at the forefront of the DRM agenda, countries and communities will never be fully isolated from disaster shocks. Therefore, financial strategies for dealing with the inevitable cost of unpreventable disaster risk must be put in place. Having access to cost-effective and rapid liquidity after a disaster can speed recovery, minimize fiscal budget disruption, and thereby reduce the total cost of the event. By helping smooth the volatility of the cost of disasters, insurance and other risk financing tools (see table 15.1) create a platform for sustainable growth.

The fields of disaster risk assessment and financing have advanced in recent years. This presents a particular challenge, because a number of tools and methodologies in use today are relatively new. Many have been brought into use within the past 20 years or more recently. As a result, evaluation of how and where these tools should be used is difficult because the body of evidence on their value is not well developed.

Table 15.1 Examples of Products Used for Financing the Cost of Disasters

Product	Features
	Risk Transfer
Traditional (indemnity) insurance and reinsurance	• Contract payout on occurrence of a defined, covered peril • Payout that reflects incurred loss • Suitability to markets with solid local delivery systems and insurance regulatory frameworks
Index insurance and reinsurance	• Contract payout on occurrence of a defined, covered peril • Payout based on some measurable event parameter that is used as a proxy for loss (for example, physical event parameters and crop yields) • Rapid dispersion of funds • Less insurance market infrastructure required
Catastrophe bonds	• Collateralized vehicle for risk transfer into capital markets • Multiannual protection (lock pricing for a period of 3 years usually) • Variety in options for triggers (indemnity, modeled loss, and parametric and industry-loss-linked products)
Weather derivatives	• Risk transfer into capital markets • Flexibility in length of contract • Payout based on some measurable event parameter that is used as a proxy for loss (typically, physical event parameters) • Rapid dispersion of funds
	Risk Retention
Contingent credit	• Prearranged credit facility • Funds that can be drawn down in the event of a disaster following occurrence of predefined conditions (for example, declaration of a state of disaster)

Source: World Bank Disaster Risk Financing and Insurance Program.

Understanding Risk

There is a need to promote the better use of disaster risk data and modeling in DRM decision making. Without a strong, quantitative understanding of the likely severity and distribution of disaster impacts, resources cannot be correctly directed to build resilience.

Catastrophe risk modeling and data are widely used in developed insurance markets where catastrophe risk models have been used for underwriting and portfolio management for the past two decades. The integration of these tools into DRM processes worldwide has not been as extensive and is a more recent phenomenon. Significant gaps in understanding risk for DRM remain, particularly in developing economies, which are the most vulnerable to disaster impacts. Therefore, there is a strong need for investment and engagement to increase the use of catastrophe risk modeling and data for DRM worldwide, and this need should remain high on the development agenda.

Challenges

A number of challenges need to be overcome to bring catastrophe risk modeling and data into mainstream use for DRM in the most vulnerable and exposed countries. Although efforts are underway to achieve this, three priority areas that require particular attention have been identified: increasing availability of data and appropriate models; building local knowledge and capacity to enhance the development and use of these tools; and ensuring the translation of risk understanding into DRM decision making.

Data availability and appropriate models

A lack of access to data, notably in developing countries, is a major inhibiting factor in understanding risk. This is partly because data are not being recorded and collected; data, therefore, simply do not exist. Investment in the infrastructure required to record, collect, and manage data is one option for improving the availability of data required to understand risk. This includes, for example, the establishment of physical recording networks for hazards and the creation or strengthening of national geological and meteorological agencies responsible for hazard data.

However, data format and a lack of openness also present problems; the data that do exist may not be accessible to DRM practitioners. A large amount of catastrophe risk data that are recorded and collected worldwide are stored in formats that make sharing difficult. For example, in a number of countries, data recorded by weather and seismic monitoring stations are not digitized. In addition, data that could be easily shared may not be for reasons of intellectual property or national and local security.

Furthermore, data on hazards need to be translated into information on the resulting impacts on population and assets at risk. The commercial catastrophe risk models that have been in use the longest focus on translating hazard into financial losses for specific assets (or interrupted income). The articulation of disaster impacts as other less direct forms is less advanced. This includes understanding and quantifying financial losses from a public finance point of view and also understanding and quantifying vulnerability and exposure from a broader development and humanitarian perspective. Data on the full socioeconomic impacts of disaster risks are lacking.

Local knowledge and capacity

As noted above, an absence of disaster risk data in vulnerable countries is often linked to a lack of data infrastructure, such as networks of weather or seismic recording stations. However, even where infrastructure is in place, there may be insufficient capacity to undertake frequent collection, transmission, and interpretation of data. Investment in physical infrastructure is redundant without an accompanying program of investment to build capacity within those institutions operationally responsible for the infrastructure.

This is particularly true for catastrophe risk models. Investment in building models will not yield results without accompanying investment in institutional capacity to use the models. Local institutions should be identified (or created) to maintain the models, so that the initial investment in model development is fully exploited. Risk is rarely stationary, and therefore, a system and institution must be in place to update models as exposure, vulnerability, and hazard change over time. This is particularly true for those climate-related perils where the possibility of severe events is likely to increase as a result of climate change and for developing economies where population growth and urbanization are rapidly changing exposure to hazards.

Investment in catastrophe risk data tools will not necessarily result in demand within relevant institutions to maintain and exploit these tools. One route will be to stimulate and sustain such demand, through incentives or systems of accountability. Promoting local ownership for sustaining these systems is also crucial, and making the available tools more closely matched with the locally perceived needs and local policy frameworks will assist in creating and sustaining the demand for and effective use of these tools.

Link to decision making

The connection between understanding risk and ensuring its translation into decision making in DRM presents perhaps the biggest challenge. There is a strong international cadre of catastrophe risk data and modeling expertise, and a growing number of initiatives to bring this expertise into local institutions through training and partnerships. However, there is limited access to both international and local expertise in mainstreaming catastrophe risk data and models into DRM decision making. As a result, countries are not making the best use of these tools to direct investment and engagement in DRM and donors and development institutions are unable to access a deep pool of expertise in this area to apply to the problem.

Overall, the cost of generating data for understanding risk (such as the creation of catastrophe risk models and recording station networks), although significant, is not the limiting factor in the development of understanding risk. The longer-term effort of capacity building in the maintenance and use of these tools in DRM decision making is the factor currently restricting the advancement of this agenda.

Financing the Cost of Disasters

Mechanisms for financing the cost of disasters can operate at multiple levels within a country. Mechanisms can be put in place to provide liquidity at the macro or national level to governments, or solutions can provide liquidity at the market and micro levels to affected businesses and households as shown in table 15.2.

The value of such mechanisms is based on the premise that governments, businesses, and individuals all have a limited capacity to absorb the cost of disasters; their budgets are finite and have limited flexibility for the contingent liabilities that arise from disaster risk exposure. Therefore, there is value in having access to additional liquidity, provided that this liquidity is cost-effective and can be quickly deployed. The volatile nature of disaster losses can exert huge pressure on fiscal and individual budgets. Disaster risk financing mechanisms can be used to reduce this volatility and prevent affected individuals and governments from resorting to expensive, adverse financial coping mechanisms in the aftermath of a disaster.

A variety of mechanisms are available for financing the cost of disasters both ex post and ex ante (see box 15.1). Experience indicates that the speed of payout of disaster risk financing mechanisms is of particular importance in creating and maintaining demand for their use. This has been demonstrated at both the macro and the micro level, where retention and growth of the client base has been strongly linked to the speed of payout.

Instruments for financing the cost of disasters are one option among many tools for managing disaster risk, and, as such, they must be considered within the broader DRM context. More work is needed to establish the effectiveness of various ex ante risk financing mechanisms. Furthermore, the costs and benefits of risk financing tools such as insurance should be carefully evaluated against expenditure on disaster risk reduction to determine where funds will generate the best 'resilience' return on investment.

Table 15.2 Products for Financing the Cost of Disasters

Solution	Current state	Value for the poor
Macro risk financing (national)	Very few governments currently make use of these tools.	Additional liquidity at the macro level helps central or local governments meet their postdisaster obligations toward low-income households.
Property catastrophe and agricultural insurance	Wide uptake is skewed toward developed economies and middle-higher-income households and middle-large size agricultural operations.	Public resources are freed up for the poor by reducing government outlay to middle-income households.
Disaster micro insurance	A number of pilots have been tested globally, but these have yet to prove that they can reach sufficient numbers and function at scale.	Vulnerable households are reached directly.

Source: Authors.

Box 15.1 Ex Post Versus Ex Ante Financing Mechanisms

Ex ante financing mechanisms are those established in advance of an event. Ex post sources of financing are those sought after the occurrence of the event.

Ex ante sources of disaster risk financing include insurance, contingent credit, annual budget allocations, or the establishment of national reserve funds. Ex post sources include other types of credit, emergency budget reallocations, international aid, and tax increases.

In the past, ex post mechanisms have dominated disaster risk responses. Disaster risk financing strategies that depend solely on ex post mechanisms carry a number of disadvantages relative to mixed strategies that include ex ante sources of financing. Although typically, using ex ante financing sources to cover the complete loss from a disaster event is not cost effective, these sources are important in providing definite, rapid liquidity in the immediate aftermath of a disaster. A mixed strategy can therefore reduce budget disruption, the potential for politicized negotiations, and delays in providing required funding (that can ultimately increase the economic and welfare costs of a catastrophe).

Source: Authors.

Challenges

Lack and use of evidence

One significant challenge presented in this area is the lack of evidence on the effectiveness of disaster risk financing tools at both the macro and the micro level. Although traditional insurance and savings mechanisms have a demonstrated track record going back hundreds of years, innovative disaster risk financing mechanisms currently being applied in developing country contexts are relatively recent phenomena. These include index-linked insurance products, contingent cash transfers and productive safety net programs, and the use of contingent financing mechanisms at the national level. Long-term data on the effectiveness of investment in these mechanisms is not available, which creates challenges for stakeholders wishing to make informed decisions on how to best invest in disaster resilience. Ultimately, the pool of resources available for building disaster resilience is limited, and expenditure on disaster risk financing tools carries an opportunity cost because funds could have been applied to disaster risk reduction.

With regard to products specifically targeted to households and firms, thought must also be given to consumer protection. A number of innovative new risk financing solutions have appeared in recent years, and efforts to educate and build awareness of these new products have struggled to keep pace. Very few countries have explicit reference to index-linked insurance in their insurance regulation. Because these products are complex and new, their strengths and limitations may not be well understood by either the end user or the entities responsible for protecting end users in the countries where these products are offered. This is particularly true for those products that target lower-income populations with limited experience with financial products and services.

For example, the increasing use of index-linked insurance means that more users are exposed to basis risk—the risk that the payout from an insurance product does not match the losses incurred. This is a complex concept to explain to consumers, but it is critical to communicate or the reputation of the product could be damaged when consumer expectations are not met by the product's performance.

Sharing of the cost of disaster response and recovery more efficiently between stakeholders

In many developing countries, the international community makes significant investments in disaster response and recovery. Dependence on international aid after a disaster remains high. However, overdependence on this support as a source of financing presents a number of disadvantages.

International aid can be uncertain. It is often impossible for countries to predict how much aid will be forthcoming, the form in which it will arrive, or when it will be made available. This unpredictability inhibits contingency planning. Risk financing tools that are established ex ante can play an important role in supporting contingency planning, by providing reliable flows of cash and goods for disaster response. They can also serve to share liabilities so that donor contributions can be balanced with retention of loss by recipient countries. Ensuring that the recipient country retains some portion of risk is important because retaining risk can help develop in-country capacity for financial management of disaster risk. This sharing of risk also ensures that strong incentives are maintained for all parties to invest in risk reduction to reduce losses in the first instance.

These principles also apply at the micro level where indiscriminate government aid to affected individuals can create a cycle of dependency by removing incentives for risk management practices, such as the purchase of insurance or even investment in disaster-resistant construction standards.

In addition to direct provision of financial resources after disasters, donors and other development partners have access to a number of modes through which they can help countries meet the cost of disaster losses (see box 15.2).

Box 15.2 Contributing to the Cost of Financing Disaster Losses

In addition to direct provision of financial resources following disasters, there are a number of modes through which donors can share part of the cost of financing disaster losses with affected countries. Governments also can share part of the cost with affected households and businesses. These areas include premium subsidies and risk market infrastructure.

Premium subsidies

In some cases, it may be efficient for donor investment to be provided in the form of premium subsidies. This can help promote the use of ex ante financing mechanisms, addressing some of the issues of unpredictability in cash and resource flows after disasters and also providing a structure for the recipient and donor to share the cost. However, premium subsidies must be applied with caution, because they can distort insurance markets, and so inhibit their development. Premiums also have an important role to play in signaling the level of risk to those exposed, and subsidies can obstruct this signal by hiding the true cost of risk transfer.

Risk market infrastructure

Part of the cost of insurance comes from administering the product itself. It can be expensive to design, price, and deliver products and then to manage and pay claims following a disaster. Furthermore, catastrophe risk insurance is capital intensive because of the potential for large, correlated losses. All these factors increase the price of risk transfer for the insured party. One way to contribute to the cost of financing disaster losses is to finance the development of risk market infrastructure such as catastrophe risk models, underwriting platforms, distribution channels, and product development. Donors (or governments) may also want to consider providing risk-bearing capital for insurance schemes.

Source: Authors.

Deployment of funds for response and recovery

Stakeholders need to consider how funds from disaster risk financing mechanisms will be used. If a recipient country lacks effective channels for deployment of disaster risk financing, the speed with which the mechanism pays out becomes irrelevant. This is an important area for further capacity building and for the translation of macro risk financing schemes into improved DRM decision making and DRM results.

Demand for disaster risk financing tools

Demand in developing countries for disaster risk financing tools has posed a particular challenge. At the micro level, pilots of innovative insurance products have struggled to establish a significant client base, with product adoption typically waning after the initial test years. At the macro level, the number of countries using ex ante risk transfer and risk financing mechanisms remains low despite the successful uptake of some parametric risk transfer mechanisms (such as the Caribbean Catastrophe Risk Insurance Facility) and recent growth in the use of contingent credit facilities among disaster-exposed countries.[2]

Stimulating demand for the use of ex ante risk financing mechanisms is difficult because they can be perceived as carrying a high opportunity cost. Reducing the cost of these mechanisms is a critical first step (see box 15.2), but will not automatically stimulate increased uptake. Disaster risk financing products need to be introduced in a way that creates a culture of using insurance among the target groups. This is particularly true of micro insurance, which targets lower-income populations whose experience with financial products and services may be limited or nonexistent.

Perhaps the most effective way to stimulate demand for a disaster risk financing instrument is by showing a demonstrated track record—a history of postdisaster pay-outs. This poses a particular challenge for insurance and other risk transfer products that tend to be most cost-effective when applied to higher layers of risk (infrequent, catastrophic events). Because events that trigger these products occur so infrequently, demonstrated payouts are few and far between.

Opportunities for Addressing Challenges

An increasing amount of expertise and resources is being mobilized worldwide to address the need for a better understanding of risk and better access to cost-efficient financing tools for disaster losses. However, as detailed above, a number of significant challenges remain that need to be overcome to ensure that the right tools, knowledge, and capacity are in place in the most vulnerable countries. Potential ways of addressing this are considered.

Understanding Risk

Build and leverage local expertise for model development

Providing access to tools and data for risk assessment is not enough; demand must be created within local institutions for the use and management of these tools and data. Without this, the investment made in model development or data collection will have a limited effect on resilience, as tools fall into disuse or become redundant if not kept up to date.

Programs that train individuals on how models are created and how to use them can create the technical capacity in local institutions required for their operation. However, more is needed to create a sense of local ownership of these models and, importantly, confidence in the models and their outputs. Both of these elements are required to sustain the use and maintenance of the tools and data.

Partnerships in model development are one solution. The use of international expertise to build local capacity in model development, rather than to undertake the model development on behalf of local institutions, can be an effective way to create trust and ownership in models (see box 15.3). Bringing local partners into the model development process gives them an understanding of both the model and its origins.

Transferring international best practice in this way can also create an in-country network of experts to take the "understanding risk" agenda forward, in the longer term.

Build flexible models with the end user in mind

Of all the model components (hazard, vulnerability, and exposure), expertise in capturing the physical hazard is the furthest advanced (see figure 15.2). A considerable amount of work remains to be done in translating what impacts—financial or otherwise—these physical hazards can have on vulnerable populations. Risk models require knowledge of how hazards affect assets, livelihoods, and the fiscal budget in different contexts.

Risk assessments in vulnerable countries must be undertaken with the end user in mind. It is critical to understand how the outputs of these exercises can be used in DRM decision-making in order to ensure that information is presented to the end user in a form that can be understood. For example, couching risk in terms of the effect on the fiscal budget may be the most compelling way to engage a minister of finance in the DRM agenda, while linking risk to increases in poverty at the local level may be more appropriate for development practitioners.

Models of disaster risk can have multiple applications in DRM, from directing investment in risk reduction to informing the purchase of insurance to disaster preparedness. It is important

Box 15.3 DFID–Met Office Climate Science Research Partnership

The UK DFID–Met Office Climate Science Research Partnership (CSRP) is a current initiative to improve both the science and the application of forecasting in Africa.

A major component of this program is a fellowship scheme allowing scientists from partner institutions in Africa to conduct research on key climate science questions for the region and to collaborate with Met Office scientists working on similar themes. The program includes a secondment to the Met Office that has helped build much greater understanding and cooperation between climate science communities in Africa and the United Kingdom.

Source: UK Met Office.

Figure 15.2 Catastrophe Risk Model Components for Insurance

Source: AIR Worldwide.

to note that the level of model sophistication required will vary depending on intended use. For example, to be valuable, risk assessment tools do not have to meet the stringent standards required for models intended for risk transfer into international financial markets.

Although the outputs of these models will be very different, they can share basic components, specifically the representation of frequency and severity of hazard. To ensure that investment in model development yields the largest effect possible, international best practice in establishing flexible frameworks for model development should be consolidated from private and public sector practitioners and shared. Model components built to give a starting point in understanding risk can then, in theory, be used for future development for additional applications.

Invest in collection of exposure data

The absence of exposure data is a limiting factor for the increased use of catastrophe risk modeling. Databases of public assets with the requisite characteristics for assessing potential damage and loss are not readily available. In addition, catalogs of private assets are sparse outside of the most developed insurance markets.

The data required to create these databases are typically spread across a number of institutions (both public and private) within countries, and consolidation of these data is both time consuming and expensive. However, an initial investment in developing an exposure database can lead to multiple applications and the creation of what is, ultimately, a public good. This is illustrated by the Pacific Catastrophe Risk Assessment and Financing Initiative (see box 15.4).

Integrate the use of models and risk assessment into the processes and structures of responsible entities

To ensure that investment in disaster risk models and data is fully exploited, relevant government entities need to institutionalize their use. This creates accountability for the use and maintenance of the models. Bringing relevant institutions into the model building process is one way to encourage use and maintenance of these tools,

Box 15.4 Pacific Catastrophe Risk Assessment and Financing Initiative

Under the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI), a disaster risk information system has been developed to help Pacific Island countries enhance their DRM agendas and build resilience.

This system is the result of a three-year effort to collect detailed information on assets, population, hazards, and risks. Physical inspections of more than 80,000 buildings and digitization and inference from satellite imagery of more than 3 million buildings and assets have been undertaken to create an exposure data set of buildings, major infrastructure, major crops, and population.

As part of the project, catastrophe risk models and a historical event database have been developed for key perils. An open-source web-based platform has also been built to provide visualization of risk through maps.

PCRAFI is a joint initiative between the Secretariat of the Pacific Community–Applied Geoscience and Technology Division (SPC–SOPAC), the World Bank, and the Asian Development Bank, with financial support from the government of Japan and the Global Facility for Disaster Reduction and Recovery (GFDRR) and technical support from AIR Worldwide and New Zealand GNS Science.

Source: World Bank. 2011

but the tools must also be integrated into the processes and structures of the responsible entities.

One of the biggest gaps identified in the understanding risk agenda is the application of disaster risk models and data to decision making in DRM. Expertise in this link between data and action is missing at both the international and the local level.

To fill this gap, programs for building capacity in the end use of these tools will be useful. As part of this approach, bringing countries together to share information will be important; the largest source of expertise in this area exists in those countries that have successfully mainstreamed disaster risk models and data into their DRM decision-making processes.

Create platforms and incentives for public and private sector stakeholders to open their data

To overcome issues of data availability, the concept of free and open data should be promoted where appropriate. By creating platforms and incentives for stakeholders to share their disaster risk data, practitioners in the field will have a stronger base of information to use in making investment decisions. Opening data in this way encourages transparency and accountability from the parties creating the data sets and models. It also allows for additional scrutiny of these tools.

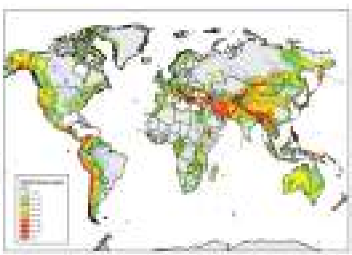
Conduct a gap assessment of model coverage

One option to direct engagement in this area would be to conduct an inventory of models available for quantifying catastrophe risk worldwide. The inventory would also need to assess both the quality and the completeness of models, because this varies significantly from country to country. An approach addressing hazard, vulnerability, and exposure components separately could be taken to identify the location of the gaps in coverage. Initial sharing of information in this area highlights significant gaps in developing countries, particularly on the African continent (see map 5.1).

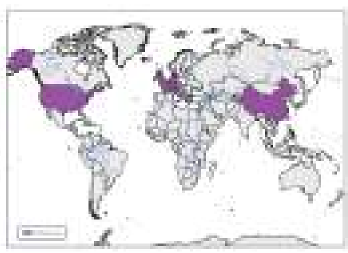
Map 15.1 Catastrophe risk model coverage by the three leading commercial model vendors

Earthquake: Model coverage

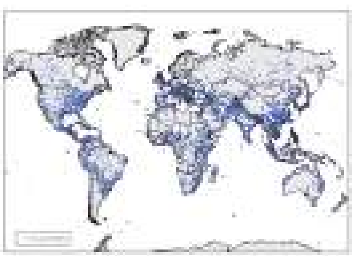
Earthquake: Hazards



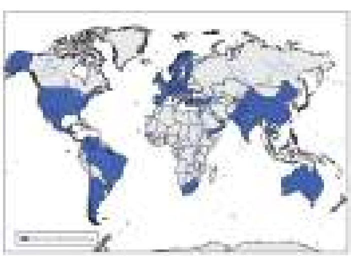
Flood: Model coverage



Flood: Hazards



Tropical Cyclone: Model coverage



Tropical Cyclone: Hazards (Southern Africa)

Source for model coverage maps: Guy Carpenter based on data from AIR Worldwide, EQECAT and Risk Management Solutions. *Source for earthquake hazard map:* Global Seismic Hazard Assessment Programme. *Source for flood hazard map*: Dartmouth Flood Observatory. *Source for tropical cyclone map:* UNISDR.

Financing the Cost of Disasters

Mainstream the use of disaster risk assessment in the management of public finances

For countries to understand how best to finance disaster losses, they must first identify and understand those potential losses. The contingent liability of a government can be difficult to assess, because a large part of it is not explicitly laid out in law. Postdisaster political pressure will often push governments to provide financial assistance to affected populations above and beyond any responsibility defined by law.

Defining these contingent liabilities is the first step in developing a strategy to manage risk (see box 15.5). An assessment of potential losses can then be undertaken to bring hazard and vulnerability into the picture. Initiatives that help governments set policies on postdisaster assistance, reducing the ad hoc nature of response, can play an important part in defining liabilities.

Quantifying the potential impact on the fiscal budget from severe disaster events can create a compelling argument for investing in disaster risk management and financing strategies. Mainstreaming disaster risk assessment data (such as modeled extreme scenarios) into management of public finances can contribute significantly to preparedness; governments will be empowered to make informed decisions on how to most effectively finance disaster losses.

Build the evidence base for the use of these tools

The past two decades have seen a number of pilots of innovative disaster risk financing instruments at both the macro and the micro level with mixed success. There is an urgent need to build an evidence base of the effectiveness of these pilots in order to guide future engagement in this area. Practitioners need to focus more on the monitoring and evaluation component of pilots, and there must be open debate on failures.

Questions must be answered about the demonstrated strengths and weaknesses of products (for example, index versus indemnity insurance), distribution channels, and models for subsidies. The benefits of insurance facilities and pools should be evaluated with an open discussion on operating costs. If one considers the sparse coverage of pilots to date, it may be necessary to supplement actual data on the utility of tested schemes with models.

Continued investment in innovative risk financing schemes must be balanced with parallel investment in generating the evidence base. By doing so, practitioners can make informed decisions on the introduction of instruments and strategies so that future schemes build on experience.

Box 15.5 Africa RiskView

The Africa RiskView software application provides an example of a regional effort to quantify part of the contingent liabilities associated with disaster response—in this case, drought.

Developed by the World Food Programme in support of the African Risk Capacity project, the tool generates estimates of food insecurity impacts and response costs across the African continent with the aim of providing information and thereby increasing financial preparedness for drought response. The tool combines satellite rainfall-based early warning models on agricultural drought in Africa with data on vulnerable populations to estimate impacts and response costs.

Source: World Food Programme.

Present disaster risk financing tools within a package of options

Experience indicates that making a case for investment in risk financing tools that may not yield payouts within a political cycle or, indeed, a lifetime can be difficult, despite the importance of these tools in the event of a catastrophe. This is particularly true in developing economies where the opportunity cost of diverting funds (potentially from the broader development agenda) is extremely high.

There are a number of solutions to this issue that ensure demand for these tools without compromising the goal of financial resilience in the face of a severe catastrophe.

- *Package instruments as part of a broader disaster risk financing strategy at the macro level.* Investment in (often expensive) risk transfer for high layers (severe, infrequent events) can be politically unpopular because of the low probability of payouts. The opportunity cost of paying the premium is perceived to be too high. This is typically the case where solutions are not in place for intermediate layers of risk and a country experiences disasters that affect the fiscal budget and trigger an emergency response, but do not trigger a payout from the product.

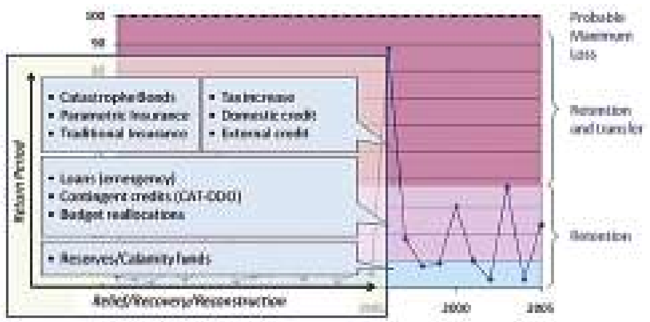
  Including the instrument as part of a layered strategy to meet the cost of disasters is one solution. Different financial strategies can be applied at the lower layers of risk (such as contingent credit or building of a national reserve fund) to ensure that the required liquidity is in place for a range of events. It will not be financially viable to cover the entire cost of postdisaster response and recovery, so international aid and other ex post measures will continue to play a role (see figure 15.3).

- *Bundle catastrophe risk insurance with other financial products at the micro level.* At the micro level, catastrophe risk insurance can be sold as part of a package of products that provides more immediate cash flow. This could include noncatastrophic insurance, credit, or even savings products.

  This is a model used in a number of insurance markets worldwide where catastrophe risk coverage is automatic or compulsory when buying household coverage. Many financial institutions (including agricultural banks in a number of countries) make the purchase of catastrophe risk coverage a condition of lending.[3]

- *Build a large pool of clients.* Increasing the pool of product users increases the probability of payouts occurring. Although individual clients may not see the direct benefit of the risk transfer product, they are able to see it contributing to the financial resilience of other participants.

Figure 15.3 Layered Strategies for Financing the Cost of Disasters



Source: World Bank Disaster Risk Financing and Insurance Program.
Note: CAT-DDO = Catastrophe Deferred Drawdown Option.

Make the most of the existing private sector

Building the infrastructure and technical and financial capacity to underwrite catastrophe risk takes decades. It may therefore be appropriate to leverage the domestic insurance market within a country, where possible, to expand access to catastrophe risk insurance products, even where the market has limited experience of offering these products (see box 15.6). The public sector and development partners can play a role in supporting the domestic insurance market in this endeavour through the creation of an enabling regulatory environment, offer of subsidies, injection of risk-bearing capital or investment in infrastructure, and product development. The appropriate intervention will vary depending on the country in question.

A significant amount of expertise exists in the international insurance and reinsurance markets on quantifying and financing catastrophe risk. This expertise is starting to find its way into developing countries, where domestic insurers seek reinsurance on the international markets. However, initiatives that seek to connect the knowledge of the international insurance and reinsurance markets with a variety of local partners should be supported.

Develop contingency planning

Financial instruments at the macro level could be accompanied by contingency planning for the deployment of funds. This could help ensure that the expense associated with having access to rapid liquidity after a disaster is fully leveraged through the rapid deployment of these funds.

There are a growing number of financial instruments for which access is linked to the existence of a credible contingency plan or framework for risk management within a country. The World Bank's contingent credit facility carries such conditionality, as will the proposed African Union and World Food Programme Africa Risk Capacity facility.

Box 15.6 The South East Europe and Caucasus Catastrophe Risk Insurance Facility

The South East Europe and Caucasus (SEEC) Catastrophe Risk Insurance Facility (CRIF) project is facilitating the development of national catastrophe and weather risk markets in SEEC by introducing low-cost insurance products, insurance business production technologies, regulatory reform, consumer education, and provision of reinsurance services.

SEEC CRIF is being implemented through the specialty government-owned catastrophe risk reinsurer, Europa Reinsurance Facility Ltd. (Europa Re), working through domestic insurers to improve access to weather risk and catastrophe risk insurance for millions of households, small businesses, and governments in the Europa Re's member states.

Europa Re is currently completing earthquake and flood risk models for the SEEC member countries. The models will be used for underwriting and pricing. It is also developing a web-based underwriting and risk pricing platform that will provide insurers with automated real-time underwriting, pricing, and reinsurance decisions.

The project is supported by the World Bank, the United Nations International Strategy for Disaster Reduction, the European Commission, the Swiss State Secretariat for Economic Affairs, and the Global Environment Facility.

Source: World Bank.

Where this link is not practical to implement, the process of developing and evaluating contingency or broader disaster risk management plans can be included in the form of technical assistance. This assistance can be part of a package of support implementing a disaster risk financing strategy.

Notes

1. A full evaluation of the appropriateness of subsidies in different situations is beyond the scope of this chapter. However, there have been, and will be, circumstances in which contributions toward the cost of coverage may be an effective option.
2. The World Bank has widely used contingent credit in Latin American countries eligible for the International Bank of Reconstruction and Development. Facilities have also been established in the Philippines (World Bank) and the Dominican Republic (Inter-American Development Bank).
3. The debate on the effectiveness of compulsory insurance is beyond the scope of this chapter, but the authors acknowledge both the strengths and the weaknesses in this model.

Reference

World Bank. 2011. "Pacific Catastrophe Risk Assessment and Financing Initiative." World Bank, Washington, DC. http://go.worldbank.org/7BXXDUVMC0.

Risk assessment and management provides a comprehensive approach for developing and implementing sustainable and effective risk policies and interventions to manage the effects of adverse natural events. For estimating potential losses from natural disasters, the U.S. Federal Emergency Management Agency (FEMA) developed the Hazus methodology. However, access to risk modeling techniques and risk models that meet international standards of best practice for valuing risk is still under discussion by governments. This chapter describes the work currently conducted by the Tropical Marine Science Institute (TMSI), within the National University of Singapore, in collaboration with a Hazus team to explore the application of the model to develop hazard data for the region.

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CHAPTER 16:

Disaster Risk Modeling Techniques: A Common Methodology for Countries to Apply

*This chapter is a submission of the Government of the United States**

Inroduction

Risk assessment and management provides a comprehensive approach for developing and implementing sustainable and effective risk policies and interventions to manage the adverse effects of accidental losses (such as those related to natural hazard impacts) and of business losses (such as speculative annexation of property). Access to risk modeling techniques and risk models that meet international standards of best practice for valuing risk is still under discussion by governments. The main purpose of the discussion is to identify common assumptions and methodologies that can be translated into a common language between governments. The Tropical Marine Science Institute (TMSI), formed within the National University of Singapore, aims to play a strong role in promoting a common approach to natural and human-made disaster risk assessment methodologies that are applicable to decision makers at national and regional levels. In the past, the government of Singapore and several other nations in Southeast Asia have called upon TMSI to produce analytical data. We anticipate that governments will continue to call on TMSI to develop hazard data for their communities. A pilot study is being conducted by TMSI in collaboration with a Hazus team from the U.S. Federal Emergency Management Agency (FEMA). Hazus is FEMA's methodology for estimating potential losses from natural disasters. The study will address data sets for Singapore and develop suitable risk assessment functions to estimate the potential economic loss. Furthermore, the study will explore the model's suitability for the entire region.

Background

The frequency and impact of disasters triggered by natural hazards have grown dramatically since the early 20th century, rising by more than 800 percent worldwide over the past 40 years alone (Munich Re 2005; CRED 2005). Moreover, the global trend is set to worsen now that climate change has become a threat, prompting an anticipated increase in the frequency and severity of weather-related disasters. For Southeast Asia, the Intergovernmental Panel on Climate Change (IPCC) has reported that the future climate is likely to be marked with increases in regional precipitation (IPCC 2007). The IPCC also reports that there is a high possibility Asian marine and coastal ecosystems are likely to be affected by heavy rainfall, temperature increases, sea-level rises, and other extremes. Disasters caused by natural hazards can have catastrophic impacts on nations and regions. These events can disrupt the social, economic, and environmental status of societies at a number of different levels.

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The present study intends to identify common assumptions and methodologies that can be translated into a common language between governments. As noted earlier, the Tropical Marine Science Institute aims to play a strong role in promoting those methodologies.

Study Area

The *Synthesis Report on Ten ASEAN Countries Disaster Risks Assessment* (ASEAN, World Bank, UNISDR, and GFDRR 2010) shows that, for human casualties, cyclonic storms are the dominant disaster risk in the ASEAN (Association of South Asian Nations) region followed by earthquakes, tsunamis, floods, epidemics, landslides, droughts, volcanic eruptions, and forest fires. During the past 40 years (1970–2009), 1,211 reported disasters have caused more than 414,900 deaths. Of these disasters, 36 percent were floods, 32 percent were cyclonic storms, 9 percent were earthquakes, 8 percent were epidemics, and 7 percent were landslides. Cyclones caused the most deaths (more than 184,000), followed by earthquakes (114,000) and tsunamis (83,600). The quantitative risk assessment performed in the study confirms that a catastrophic event with a 200-year return period (0.5 percent annual probability of exceedance) would have a major impact on ASEAN countries' economies, some of which are already fragile.

The present work is mainly for Singapore, but it can be extended to a regional risk assessment methodology. Singapore has an equatorial climate with a mean temperature of 26° Celsius (C) and an annual range of 2°C. Much of Singapore's land is less than 15 meters above sea level. The coastline of Singapore, including the offshore islands, is about 150 kilometers long. Most parts of the coastline, including many of offshore islands, have been modified through land reclamation. During periods of heavy rainfall, the low-lying areas, especially the urban center at the mouth of the Singapore and Kallang Rivers, experience flooding that coincides with the high tide. TMSI is now developing a coastal inundation and risk map for the government of Singapore with special reference to sea-level rise and other extreme events.

Risk Assessment Modeling

Risk assessment is a two-step process: hazard assessment and vulnerability analysis. Hazard assessment is designed to come to grips with the following:

- Nature, severity, and frequency of the hazard;
- Area likely to be affected;
- Time and duration of impact.

Loss assessment consists of two components:

- Identification of assets exposed to flooding;
- Vulnerability, or the degree to which assets are affected by flooding.

Assets are defined as any human-made or natural feature that has value. In the current study, land use, land cover, assets such as buildings, ports, recreational areas, and other infrastructures exposed to flooding and their degree of vulnerability because of inundation will be identified using geographic information system (GIS) techniques and flood modeling.

The risk assessment methodology being thoroughly investigated is the Hazus-MH software from the U.S. Federal Emergency Management Agency (FEMA). Hazus-MH is a powerful multihazard (MH) risk assessment platform for estimating the effects of natural disasters, including earthquakes, riverine and coastal floods, and hurricane winds (FEMA 2009). In Hazus-MH, GIS technology produces estimates of hazard-related damage before or after a disaster occurs. The software employs the Comprehensive Data Management System (CDMS) that helps update statewide data sets used in analysis. A pilot study is being conducted by TMSI in collaboration with a Hazus team from FEMA. The study will address the data sets for Singapore and develop suitable risk assessment functions to estimate the potential economic loss. Furthermore, the study will explore the model's suitability for the entire region.

Some of the region's major disasters of recent times are (a) the December 2004 Indian Ocean tsunami, (b) the May 2006 Yogyakarta earthquake in Indonesia, (c) the September 2009 Cyclone Ketsana (known as Ondoy) in the Philippines, (d) the October 2008 catastrophic flood in Singapore, and (e) the January 2007 flood in Vietnam. There are many other extreme events that have put the region's nations at risk of frequent catastrophic disasters. Climate change is expected to exacerbate disasters associated with hydrometeorological hazards. Often these disasters transcend national borders and overwhelm the capacities of individual countries to manage them. Most countries in the region have limited financial resources and physical resilience. Furthermore, the level of preparedness and prevention varies from country to country, and regional cooperation does not exist to the extent necessary.

TMSI plays a leading role as a national and regional resource center for tropical marine science research and development and education. Its current work on disaster and risk assessment is a key development in the field of risk assessment methodology development at the national and regional levels. Upon successful completion of the pilot study, TMSI plans to conduct workshops in a few of the region's nations to demonstrate the risk assessment methodology. The workshops will emphasize customizing the damage and loss function for specific countries as well as addressing multiple hazards. In addition, TMSI aims to promote not only capacity building in the region for natural disaster risk assessment but also emergency and crisis management so nations can be prepared for increasing severity of the natural disasters.

Conclusion

TMSI intends to play a strong part in promoting natural and human-made disaster risk assessment methodologies so that national and regional decision makers are encouraged to use a common approach to the issue. TMSI has a pilot study with a Hazus team underway that will develop suitable risk assessment functions to estimate the potential economic loss. Furthermore, the study will explore the model's suitability to assess disaster risk and to estimate loss for the region. Finally, TMSI aims to promote capacity building in the region for natural disaster risk assessment and management.

References

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Munich Re. 2005. "Topics Geo Annual Review: Natural Catastrophes 2005." Munich Re, Munich, Germany.

The first part of this chapter examines risk transfer and risk financing tools from a government perspective, drawing on a rich reservoir of policy experiences and lessons learned in countries of the Organisation for Economic Co-operation and Development (OECD).

To further improve and fine-tune their disaster risk financing strategies, countries need to rely on accurate and up-to-date data and information on their exposure and the effect of disaster risks and events. However, a recent review of national experiences by the OECD reveals that the quantification of disaster losses and exposures often remains a weak link in the DRM cycle. This deficiency and possible paths for improvement are treated in the second part of this chapter.

OECD

CHAPTER 17:

Policy Options for Disaster Risk Financing and Transfer and Issues in Quantification of Disaster Losses and Exposures: An OECD Perspective

Introduction

The year 2011 was characterized as having registered the highest disaster-related economic losses in history. Current estimates indicate that the direct economic costs of the series of extreme natural events occurring that year range from US$350 billion to US$380 billion, with insured losses assessed between US$105 billion and US$110 billion.[1] Earthquakes in New Zealand and Japan (followed by a tsunami in the latter country), floods in Australia and Thailand, and tornadoes in the United States were among the most severe disasters. The cost of disasters can impose a major drain on government resources, because governments are not only expected to rescue populations in devastated areas, but also often called on to cover a large proportion of the uninsured losses. In times of economic crisis, the need to manage disaster risk efficiently becomes even more pressing to preserve economic growth and national budgetary positions. From a policy perspective, therefore, governments must establish, preferably ex ante, effective risk transfer and risk financing tools as part of a broader DRM framework and a good understanding of the potential direct and indirect effects of major disaster events and how those will affect their economy in the short and long terms.

The first part of this chapter examines risk transfer and risk financing tools from a government perspective, on the basis of OECD experiences. It reviews the main options for governmental initiatives in disaster risk financing, including the establishment of dedicated disaster funds, market-based or state-sponsored disaster insurance and reinsurance programs, dedicated lending facilities or other forms of state guarantee to limit private sector exposure, and alternative risk transfer and risk financing tools such as risk securitization and contingent capital arrangements. It also explores the main institutional arrangements and modalities in support of these initiatives: for instance, the extent and form of public participation, possible existence of compulsory insurance, scope of coverage, and pricing mechanisms. It further considers incentive mechanisms for risk prevention, adaptation, and mitigation that can be promoted through well-designed risk financing and transfer tools.

The second part of the chapter examines the quantification of disaster losses and risk exposures, which provides an important basis for assessing vulnerability and improving and fine-tuning disaster risk financing strategies. Countries need to rely on accurate and up-to-date data and information on the social and economic impact of disaster risks and events. However, the analysis of national experiences reveals that the quantification of disaster losses and exposures often remains a weak link in the DRM cycle. Governments often encounter difficulties in gathering consistent and reliable data on total economic losses from disasters, with limitations, for instance, in the comparability of data that are currently available. Efforts are being made to improve the measurement of vulnerability, using databases on infrastructure that are dedicated to prevention. Possible options for G20 governments are presented for promoting the collection and dissemination of comparable data and information on disasters.

Policy Options for Disaster Risk Financing and Transfer in the OECD Area

A Governmental Perspective on Disaster Risk Financing and Transfer

General policy framework and the 2010 OECD recommendation

As witnessed by recent experience in the G20 area, in addition to the threat to human life, the economic and financial impact of extreme natural events on a country or region can be substantial, and the damaging consequences manifold: from direct damages to buildings and infrastructure—both public and private—to indirect losses arising from the interruption of business activities, decreasing tax revenues, increasing poverty levels, and other relevant long-term social and macroeconomic consequences, with cascading effects and systemic risk potentials.[2] Given these effects, governments are under strong pressure, or sometimes even under a legal duty, to provide assistance and some degree of compensation to affected parties. In times of constrained public budgets, planning ahead for the financial coverage of future disaster costs becomes, therefore, a necessary component of sound DRM strategies in both emerging and developed economies worldwide.

In 2010, the OECD Council issued a "Recommendation on Good Practices for Mitigating and Financing Catastrophic Risks," stating that governments should promote the development of efficient strategies for coping with large-scale disasters that are anchored in an integrated framework of risk assessment, risk perception, risk management, and disaster response (OECD 2010b).[3] The OECD Council acknowledged that the costs associated with natural and human-made disasters need to be properly assessed and financially managed before a major loss occurs and that governments need to take a proactive role in direct and constant cooperation with the private sector.

One of the preconditions and key components of these strategies is disaster risk assessment. For the purposes of the present analysis, the prime tasks in this respect are to assess the likelihood of possible disasters, the magnitude and distribution of their consequences across different stakeholders, and the uncertainties surrounding these estimates. For each type of risk and level of severity, governments should be able to quantify the costs they would have to bear under current programs as well as proposed strategies should one or more of these disasters occur tomorrow.

Moreover, because human-induced factors greatly contribute to direct and indirect costs of disasters and because changes in patterns of human behavior, perception, and decision making at all levels of government and society can lead to a substantial reduction in disaster risk, improving the level of risk awareness and the quality of disaster risk reduction education tools clearly stands out as another essential feature of effective DRM strategies. Principles and good practices drawn from the experience of OECD countries in this field are presented in the OECD *Policy Handbook on Natural Hazard Awareness and Disaster Risk Reduction Education* (OECD

2010a), issued under the auspices of the OECD High-Level Advisory Board on the Financial Management of Large-Scale Catastrophes.[4]

Concerning the adoption of risk prevention, mitigation, financing, and transfer measures, ex post government relief, though often necessary, may in the long run possibly deter ex ante action by potential victims of catastrophic risks;[5] moreover, inducing or requiring people to take potentially costly protective measures ex ante may be politically more difficult than providing financial assistance following a disaster. The level of ad hoc ex post government intervention for the compensation of losses caused by natural and human-made disasters varies significantly across OECD countries. Some countries still rely almost exclusively on an ex post approach, whereas other countries use ad hoc ex post compensation as a complement to other funding mechanisms, such as structural disaster funds or disaster insurance.

A purely ex post approach to the funding of disaster losses entails several limitations. In many cases, it proves to be cost-ineffective and untargeted. Delivery of compensation is often too slow, and if the hazard risk exposures are significant, the fiscal burden may be unsustainable for the public authorities in the long run. Moreover, ex post allocation of public funds to meet critical needs may divert resources from other projects, and critical decisions have to be made under political pressure—not to mention the likelihood of inequalities in treatment and possible social discontent.

The key challenge, therefore, is to take a long-term view and promote the adoption of appropriate protective measures before a disaster occurs. In this perspective, risk financing and risk transfer tools, such as insurance, reinsurance, and catastrophe-linked securities, can play a fundamental role in reducing the negative economic impacts of extreme risks, and therefore, fully acknowledging the policy implications of their use in the context of national or regional DRM strategies is very important.[6]

To this end, several governments have adopted a strategic approach to disaster risk transfer and financing, with a well-developed understanding of the appropriate roles of government, insurance markets, and capital markets in light of national circumstances and preferences. Some OECD governments have entered into partnerships with the private insurance and reinsurance sectors with the policy objective of making disaster insurance available to the general public at affordable rates and/or ensuring that private and sometimes public assets exposed to risk are duly covered by insurance. A brief presentation and discussion of their main technical features follows.

Policy and regulatory measures to stimulate supply and demand of risk transfer tools

Confronted with the growing impact of natural hazards, governments in OECD countries have sometimes adopted regulatory measures aimed at facilitating the development of sustainable private market solutions to cover disaster risks.

Regulatory measures may concern the insurance market and products, by providing fiscal incentives to the purchase of disaster insurance (for example, premium deductibility or reduced premium taxes) or by allowing special regulatory and/or tax treatment to catastrophe equalization reserves, whose main purpose is to reduce the volatility of results.[7] The future implementation of Solvency II in Europe, for instance, will introduce relevant changes concerning the insurance and reinsurance coverage of disaster risks, insofar as the new regulatory regime will increase the level and quality of capital held and is likely to stimulate the development of tailored internal models for natural disaster exposures as well as possibly lead to increased use of reinsurance and capital market risk transfer solutions.

More broadly, measures may be aimed at enhancing disaster risk awareness, preparedness, prevention, mitigation, and response and, consequently, at reducing vulnerability and exposure to natural hazards. The adoption of such policies not only diminishes the direct and indirect costs of extreme natural events, but also favors the development of market-based risk transfer tools such as insurance. An example is offered by the flood prevention and mitigation campaigns pursued in the United Kingdom to support the insurance industry's commitment to continue offering flood risk insurance to the vast majority of homes and businesses in flood risk areas.

Public disaster funds

A possible form of commitment of public resources to the coverage of future potential disaster losses is the establishment of dedicated disaster reserve funds or disaster funds. They can be funded by special appropriations made each year in the public budget toward the coverage of certain costs associated with a disaster, such as emergency relief costs and government exposures to public assets and infrastructure disaster losses. Alternatively, they may be funded on the occurrence of a disaster. Because rules on the use of such funds in case of a disaster are established ex ante, money can be disbursed promptly and a relatively consistent treatment of similar situations is ensured across time. Such rules may also limit moral hazard by restricting the scope of government compensation (for example, by strictly defining eligible damages and placing a cap on the level of public assistance).

One example in the OECD area is the European Union Solidarity Fund (EUSF), set up in 2002 to respond to major natural disasters and express European solidarity to disaster-stricken regions within Europe. Established under European Union (EU) Council regulation, the EUSF operates mainly in cases of major natural disasters with serious repercussions on living conditions, the natural environment, or the economy in one or more regions of a member state or a country applying for accession to the European Union. A natural disaster is considered "major" if it results in damage on the state's territory estimated either at over €3 billion (2002 prices) or at more than 0.6 percent of the country's gross national income. Since its establishment, the fund has been used for a wide range of disaster events, including floods, forest fires, earthquakes, storms, and drought, for a total contribution to affected countries of more than €2.4 billion. EUSF grants are financed outside the normal EU budget process through special member state contributions. Grants must be approved by the European Parliament and European Council on the recommendation of the European Commission.

The EUSF was not set up with the aim of meeting all disaster-related costs. On the contrary, compensation provided by the fund is limited in principle to uninsurable damage and does not include private losses.[8]

An example of a national disaster reserve fund is provided by FONDEN (Fondo de Desastres Naturales), Mexico's Natural Disaster Fund, established in 1996 and comprising (a) the FONDEN program, which has a budget line within the federal budget of every year and works mostly as a cash transfer to the trust; (b) the FONDEN trust, which is the financial tool through which the reconstruction costs are paid and the acquisition of risk transfer tools is financed; (c) the Immediate Fund for Humanitarian Aid, which is financed by the FONDEN program or the FONDEN trust. FONDEN covers the reconstruction costs of infrastructure belonging to states and municipalities up to 50 percent, while the remaining portion of the loss is sustained by local governments, which have access to a credit line provided by the Reconstruction Fund for local entities.

Other examples of disaster funds in the OECD area include the prearranged public funding mechanisms established in Australia (Natural Disaster Relief and Recovery Arrangements, or NDRRA)[9]; Hungary; and Norway (see OECD 2008).

Where reserve funds are set aside for future anticipated disasters, the allocation of such funds may not be cost-efficient or politically viable.[10] The problem is exacerbated if the purpose of reserve funds is to finance the expected costs of very low probability events, such as events with a return period of 100 years or more, because of the extremely long time horizon. Moreover, if public disaster funds are aimed at covering not only emergency relief costs and public infrastructure losses, but also damages to private property owned by businesses and individuals, moral hazard may arise, and incentives to take precautions could become very low (where such precautions are feasible), particularly if the disaster funds are not well designed or if the rules governing these funds are not perceived to be credible.

State-sponsored direct insurance programs

In a number of OECD countries, coverage of certain disaster losses is provided by a special-purpose entity set up by the government to act as primary insurer. Basically, the government provides insurance and responds to claims either to the fullest or up to a certain limit. The policy choice to provide primary insurance to cover disaster risks is often dictated by the fact that the private insurance sector in that particular country is unwilling or unable to provide any coverage, because of local market conditions or the peculiar risk profile of the country.

The private insurance sector sometimes contributes to the scheme by providing some operational capabilities, such as marketing of the policies, collection of the premiums, and adjustment of the claims. In the OECD area, Iceland, New Zealand, Spain, and the United States, with the National Flood Insurance Program (NFIP),[11] provide examples of such government-run programs involving a partnership with private insurers.

Catastrophic risk coverage is carried out in Spain by the Consorcio de Compensación de Seguros, a public nonprofit institution attached to the Ministry of Economy and Finance. Set up in 1941 as a provisional body to face the needs for indemnities resulting from the Civil War (1936–39), the Spanish Consorcio was given its permanent status from 1954. After that date, the activity of the Consorcio focused on coverage of so-called extraordinary risks, and it began to play a central role in the related indemnity system. At present, the Consorcio has its own assets and liabilities, separate from those of the state, and its activity is governed by private law. Thus, when doing insurance business, the company is—apart from being governed by the terms of its own charter—subject to insurance regulation and supervision, like any other private insurance company. Such regulation includes prudential rules for the solvency margin and for the setting up of technical reserves.

The aim of the Consorcio is to indemnify claims made as a result of extraordinary events, such as natural disasters or other events with heavy social repercussions, that occur in Spain and cause injuries and damage to people and assets in Spain, whenever any of the following conditions are met: (a) the extraordinary risk is not specifically and explicitly covered by another insurance policy and (b) the extraordinary risk is covered by another insurance policy, but the company that issued the policy cannot meet its obligations. In practice, the risks included in the Spanish system for the coverage of extraordinary risks are not assumed by insurance companies, even if they are legally permitted to cover these types of risks. The Consorcio, in a subsidiary manner, assumes these risks; the insurance companies underwrite and manage the policies (with the compulsory coverage attached) and collect the Consorcio surcharges along with their own premiums. The Consorcio manages claims, loss adjustment, and indemnifications. The Consorcio does not reinsure its risks and thus retains all the extraordinary risks covered. This state-sponsored system for the coverage of extraordinary risks is backed by an unlimited state guarantee, which has never been used.

Furthermore, the role of the private insurance industry in the governance of the Spanish system is highly remarkable, because 50 percent of the members of the Conscorcio's board of directors are chief executive officers of some of the most important insurance companies.

The Earthquake Commission (EQC) is New Zealand's primary provider of seismic disaster insurance to residential property owners. The EQC administers the Natural Disaster Fund, which is backed by a government guarantee. The main mechanism for promoting coverage is the provision of seismic disaster insurance to property owners who insure against fire. All residential property owners who voluntarily buy fire insurance from private insurance companies automatically acquire EQCover, the commission's seismic disaster insurance cover. EQCover premiums are added to the cost of the fire insurance and passed on to the EQC by the insurance company. Residential insurance in New Zealand has over 90 percent coverage.

The EQC's administration of the natural disaster insurance scheme involves collecting premiums through insurance companies, processing and meeting claims by insured people, administering a disaster fund, investing the fund in accordance with government directions, organizing reinsurance as a potential supplement to the fund, and accounting to its shareholder (the government). The EQC also encourages and funds research about matters relevant to natural disaster damage, and it educates and otherwise informs people about what can be done to prevent and mitigate damage caused by natural disasters.

In the United States, residential flood insurance has been provided mainly by the federally run NFIP since its creation in 1968. The NFIP was developed because private insurance companies took the position following the Mississippi floods of 1927, and continuing through the 1960s, that such peril was uninsurable. They argued in the United States that floods could not be insured by the private sector alone because (a) only particular areas are subject to the risk, and as such, adverse selection would be a problem; (b) risk-based premiums would be so high that no one would be willing to pay them; and (c) flood losses could be catastrophic and cause insolvencies of some insurers. Moreover, the level of sophistication in hazard assessment was quite limited in the 1960s compared to what it is today. The NFIP partners with private insurers and agents who sell the policy and settle claims on behalf of the federal government. They receive a fee for doing so, but they do not bear any of the risk. The program currently has 5.3 million policies in place and covers more than US$1.2 trillion in assets, mainly in coastal states.

State-sponsored reinsurance programs

In other OECD countries, the government provides reinsurance protection to private insurance companies writing disaster risk. Basically, the government protects the private insurance sector by offering special reinsurance arrangements of different types (proportional and nonproportional). Government-sponsored reinsurance programs may be mandatory or optional for primary carriers.

The option to provide special reinsurance arrangements is aimed at limiting private sector exposure to peak risks. This solution can be justified if the primary insurance carriers are able to retain a portion of the risk, but the private market does not have enough reinsurance capacity to provide the required excess-of-loss arrangements. The provision of such a limitation to private sector exposure may also be part of an institutional arrangement in which mandatory offer, purchase, or extension of disaster risk coverage is introduced by law. In this respect, this option is aimed at protecting the insurers' solvency and, therefore, the stability of the whole system. In the OECD, France (through the Caisse Centrale de Réassurance, or CCR) and Japan (through the Japan Earthquake Reinsurance Co., Ltd., or JER) have established national schemes along these lines.

In France, compensation of property damages caused by natural disasters is mostly provided by first-party insurance. Pursuant to the French Insurance Code, insurance contracts issued to any natural or legal persons other than the state to insure against damage caused by fire or any other damage to property located in France, as well as damage to hulls of motor vehicles, must also cover against the effects of natural disasters on property covered by the insurance contracts. In addition, when the insured is covered for business interruption, the cover must be extended to the effects of natural disasters in accordance with the terms of the corresponding contract.

The scheme relies on the CCR, a state-owned company established in 1946, which since the establishment of the French "Cat-Nat" (Catastrophes Naturelles) system in 1982 is allowed to offer reinsurance cover with a government guarantee for several natural disasters. CCR does not have a monopoly in natural disaster reinsurance: primary carriers, therefore, are free to seek coverage from the reinsurer of their choice and may even take the risk of not purchasing reinsurance. However, CCR remains the only company within its sector of activity that offers a whole range of reinsurance solutions with unlimited cover. CCR thus provides a guarantee of solvency and security for insured parties within the French natural disaster compensation scheme. According to current practice, CCR usually offers two types of reinsurance solutions, which are combined to provide twofold reinsurance cover to primary disaster risk carriers (quota-share and stop-loss reinsurance).

JER was established in 1966 as the only company in Japan permitted to exclusively handle reinsurance for earthquake insurance on dwelling risks. Under the Japanese earthquake reinsurance program, primary carriers sell earthquake coverage on the voluntary market and then fully reinsure their risk with JER, which, in turn, retrocedes part of the risk to the Japanese government and part of it to the private insurance market. Under this state-led system of earthquake insurance, policyholders can obtain earthquake coverage of residential buildings and household property in the amount of 30 percent to 50 percent of the sum insured under the fire policy. The insurance premiums collected by insurers do not remain with the insurers but are managed and operated by JER and the government.

Mixed risk-sharing schemes

Other OECD countries, such as Belgium (through the Caisse Nationale des Calamités); Denmark (through the Danish Storm Council); Turkey (through the Turkish Catastrophe Insurance Pool, or TCIP); and the United States (through the California Earthquake Authority, or CEA), have experimented with different forms of risk-sharing arrangements.

In Turkey, for instance, the government launched the TCIP in September 2000. In addition to the TCIP's legal framework, the parliament enacted a new code on building inspection. Earthquake insurance premiums are ceded to the TCIP, which is managed by the Natural Disasters Insurance Council. The pool provides earthquake coverage up to certain limits for a premium that varies across the country, depending on seismicity, total floor area, and type and quality of construction. The TCIP is managed through the TCIP Management Board, which consists of members from the public and private sectors and the academic community. Local insurance companies act as distributors of the TCIP policies. The TCIP operates as a disaster risk transfer and risk financing facility, ceding a large amount of its risk to international reinsurance markets until sufficient financial resources are accumulated.

Catastrophe-linked securities and capital market solutions for governments

In recent years, the transfer of the higher layers of disaster risks (that is, lower frequency but much higher losses when they occur, often referred to as *peak risks*) to capital markets has been increasingly considered by private sector participants in the OECD area. Some governments and public entities have also considered and sometimes implemented alternative risk transfer and alternative risk financing solutions—such as risk securitization, parametric insurance contracts, and contingent capital arrangements—to complement other risk transfer tools as part of a broader DRM strategy (see OECD 2011).

Catastrophe-linked securities in particular provide a mechanism for the transfer of catastrophe risks to capital markets and may supply an additional layer of protection to traditional insurance and reinsurance arrangements or serve to reduce reliance on these arrangements by permitting direct access to capital markets for the coverage of catastrophe risks. Catastrophe-linked securities may also create opportunities for the transfer of disaster risks that are currently not covered by insurance markets, thus potentially broadening the overall financial coverage of such risks. Because capital markets have a potentially large capacity to absorb disaster risks, catastrophe-linked securities may enhance the ability of the financial system and economic actors more broadly, including governments, to manage the costs of natural and human-made disasters.

The establishment of FONDEN in Mexico, for instance, was accompanied by the development of an integrated DRM framework involving risk assessment, prevention, reduction, and transfer tools. With specific regard to risk transfer, in 2006 FONDEN issued a catastrophe bond to transfer Mexico's earthquake risk to the international capital markets. More recently, in October 2009, it issued a multiperil catastrophe bond covering both earthquake and hurricane risks (see Michel-Kerjan et al. 2011).

Catastrophe-linked securities were also used in 2011 by the California Earthquake Authority, which entered into a "transformer reinsurance" deal with Embarcadero Reinsurance, Ltd., a Bermuda-based special-purpose reinsurance vehicle established for this and future CEA transactions. With the completion of a second earthquake catastrophe bond in 2012, CEA now receives 10 percent of its risk transfer cover from the capital markets.

Governments can also obtain access to international financial markets through other innovative risk transfer solutions, such as parametric insurance contracts using index-based or modeled loss approaches to quickly assess the damage on the ground, thereby securing the prompt availability of financial resources needed to cover urgent disaster relief measures.[12]

Whatever the risk transfer tools chosen, the evaluation of their costs and benefits requires a clear identification of the specific policy objective pursued by the government (for example, obtaining liquidity for immediate emergency rescue and response measures in the aftermath of a catastrophe or covering the economic losses sustained by private or public assets and critical infrastructures as a result of a disaster).

Technical Features of Public-Private Disaster Risk Transfer Schemes in the OECD Area

Mandatory nature of schemes

OECD experience shows that the government's decision to play an active role in public-private disaster risk transfer schemes by making an ex ante commitment of financial resources is often linked to the resolution to introduce a mandatory or quasi-mandatory disaster insurance regime. However, clarifying the actual meaning of *mandatory* under a given institutional arrangement is extremely important.

Some countries have made the purchase of disaster insurance coverage mandatory—for instance, Turkey (earthquake) and Iceland. The purchase of fire and natural disaster insurance is also mandatory in three Swiss cantons. Other countries have simply required insurance companies to make disaster insurance available, by introducing a mandatory offer of coverage that can be declined by the policyholder: the Japanese and the Californian earthquake schemes work this way.

In a number of countries, moreover, fire or other first-party insurance policies are marketed on a voluntary basis, but insurance companies are required by law to include coverage for disaster risks in such policies. Such rules apply, for instance, in Australia (terrorism); Belgium; France (natural disasters, terrorism, and technological disasters); New Zealand (earthquake); Norway; Spain; and Switzerland (with the exception of the three cantons where fire and natural perils coverage is mandatory). Finally, the mandatory component of the scheme may concern the participation of private insurance companies in special pooling or reinsurance arrangements, such as the Natural Perils Pool in Norway.

In this respect, one must note that different levels of compulsion reflect different policy objectives and market conditions and have different advantages and disadvantages:

- The mandatory offer of disaster insurance is consistent with the goal to ensure that disaster coverage is available on the market, so that businesses and individuals who are willing to purchase financial protection can do so. However, low risk awareness or cognitive biases that may affect the demand side could lead to suboptimal take-up rates. Furthermore, individuals and businesses with low levels of exposure to disaster risk may decline to purchase disaster coverage. As a result, the penetration rate may be low, which may generate insufficient risk pooling.
- The mandatory purchase of disaster insurance is consistent with the objective of making sure that all those exposed to disaster risks, whether willingly or unwillingly, are covered by insurance, at least up to a certain extent. Although this option—assuming that an effective enforcement mechanism is in place[13]—ensures widespread diffusion of disaster risk coverage, it may be unpopular because it limits private autonomy by forcing everyone to purchase coverage. Such a choice may be justified not only by constraints to rational decision making that may affect the demand side, but also by the risk of negative externalities or opportunistic behaviors. (The individual decision not to purchase financial protection against disasters ex ante may impose costs on the society as a whole, because it may call for postdisaster aid or translate into negative macroeconomic consequences.)
- The mandatory inclusion of disaster coverage in basic property insurance policies (for example, fire, homeowners, and auto policies) marketed on a voluntary basis can be effective if the penetration rate of such basic policies is relatively high, so that they are used as a vehicle to spread disaster insurance coverage among businesses and individuals. Compared to the mandatory purchase of disaster insurance, this option entails a lower extent of compulsion and may, therefore, be less unpopular. However, it may have negative effects on the market for the basic property policy to which the mandatory disaster extension applies. First, a risk exists that those who do not perceive the benefits of disaster insurance or who are rationally unwilling to purchase it may decide to drop the basic property coverage because of the increased cost of the "package." In some countries, the widespread diffusion of basic property policies is caused by a requirement imposed by mortgage lenders; thus, the decision to drop all insurance coverage would be inhibited by such private commitment. Second, tying different insurance products (for example, fire insurance and flood insurance) may distort competition, since policyholders would be forced to choose the same insurance company for the coverage of both risks. This outcome, of course, becomes problematic only if the price, terms, and conditions of the compulsory extension of coverage are not mandated by the law.

Scope of coverage: Perils

The institutional arrangements set up in OECD countries cover different types of perils. Some have a broad scope of application, encompassing coverage for a wide range of disaster risks. The Spanish Consorcio de Compensación de Seguros offers a good example of this approach, covering both natural disasters and sociopolitical events, including terrorist acts. Others focus instead on single perils, such as the Turkish TCIP, or categories of perils (for example, natural calamities, earthquake, terrorist acts, technological accidents), such as the schemes covering natural disasters in Belgium, France, Mexico, New Zealand, or Switzerland.

In France, three different schemes cover natural disasters, terrorist incidents, and industrial accidents, respectively. In Belgium, two schemes were recently set up to cover certain natural perils (that is, earthquake, flood, storm, landslide, and ground subsidence) and terrorism risks, respectively. In Iceland, insurance coverage is mandatory for earthquake, volcanic eruption, snow avalanches, landslides, and floods. In Japan, the coordination scheme covers earthquakes, volcanic eruptions, and resulting tsunamis. The Mexican FONDEN covers geological risks (earthquake, volcanic eruption, avalanche, tidal wave, landslide); hydrometeorological risks (atypical drought, cyclone, extreme rains, snowfall and hailstorm, atypical flood, tornado); and forest fires. In New Zealand, the scheme covers earthquake, natural landslip, volcanic eruption, hydrothermal activity, and tsunami; in the case of residential land, storm or flood; and fire caused by any of these disasters. The Norwegian pool covers losses caused by landslide, storm, flood, earthquake, and volcanic eruption. In Switzerland, the coverage of flood, inundation, windstorm, hail, avalanche, snow pressure, rock and stone fall, and landslide (but not earthquake) has been included by operation of law in fire insurance for buildings and chattels. In Turkey, although the original design of the TCIP envisaged multiperil coverage, it currently provides only compulsory earthquake insurance coverage.

A number of schemes, moreover, require an official declaration to trigger coverage, including the schemes implemented in the Netherlands (Royal Decree) and in Denmark (Danish Storm Council), the Mexican FONDEN, and the French Cat-Nat scheme. This requirement also existed in Spain until 1986, when it was removed. The official declaration requirement has the advantage of making it incontestable that a certain event is covered by the scheme, but the decision-making process may be time consuming and politically biased.

Although multiperil disaster insurance allows broader coverage, it raises complex issues related to underwriting and pricing. Setting premium rates adequate to cover all the expected costs of disaster losses caused by different perils, in fact, requires sophisticated determinations. The rate-setting process for flood insurance rates, for instance, is different from what is needed for the coverage of other perils. In some countries, multiperil coverage has been introduced to achieve a higher level of risk pooling and some degree of cross-subsidization. However, countries with very high exposures to one main peril (such as earthquakes) have often chosen to focus on a single-peril type of scheme.

Scope of coverage: Losses

The various OECD institutional solutions differ in terms of type of losses covered. Most of the schemes provide compensation for property damage, but the type of properties covered varies (commercial versus residential properties, private properties versus public properties and infrastructure, and so on). Turkey's earthquake insurance scheme, for instance, is limited to registered residential properties. In France, the Cat-Nat scheme covers commercial and residential property damage as well as business interruption loss (but not damages to state property). The coverage offered by the Spanish Consorcio includes residential and industrial property damage, business interruption loss, and personal injuries and death. The scheme implemented in New Zealand covers direct losses to residential dwellings, the land immediately around the dwelling, and most personal property (excluding some types, such as motor vehicles and art)—although the coverage of personal property is being reconsidered in light of the latest earthquake. The scope of application of the Japanese earthquake insurance scheme is also limited to residential buildings and household property. There has been movement toward including business interruption loss, as witnessed by the experience of the Spanish Consorcio. Nevertheless, in some countries, including Iceland, the coverage is still limited to property damage.

Pricing mechanisms

The pricing of disaster coverage is yet another feature of the various public sector schemes and of schemes within private insurance markets. Whereas some coordination schemes apply a risk-based pricing mechanism, others have opted for flat pricing, invoking the principle of solidarity. The impact of risk differentials across the territory of a country or region should be recognized and incorporated in the pricing mechanism with a view to providing proper incentives for risk prevention and mitigation to those most exposed to risk, while keeping coverage affordable and pricing manageable.

Risk zoning is used for pricing purposes by private insurers in a number of OECD countries. In the United States, moreover, premiums are heavily based on the prior claims experience of the insured, and discounts are available for installing specified equipment, such as storm shutters, wind-resistant glass, and fire-suppression systems. Similarly, in other countries, premiums are linked to the level of prevention measures; for earthquake insurance premiums in Japan, the application of different rates depends on the location the material used in the building (wood or nonwood), and special discounts are applied according to construction age and the installation of specific quake-resistant structures. In Turkey, premiums vary across the country depending on seismicity, total floor area, and the type and quality of construction. British insurers have adopted risk-based pricing to cover flood risks.

In France, pursuant to the applicable legislative provisions—whose possible reform is currently under discussion—pricing of insurance against natural disasters is still based on a fixed percentage of the basic premium charged for the underlying property insurance policy, without specific risk differentials. In New Zealand, the earthquake insurance premium is also calculated as a percentage of the amount for which the property is insured, without further differentiation. As a result of a change in the Spanish scheme, for property and business interruption coverage (with the exception of property coverage for motor vehicles, whose price is set at a fixed amount per vehicle), the Consorcio's surcharge is now calculated as a percentage of the sum insured rather than as a fixed percentage of the base premium.

Flat rates are easy to administer and, if coupled with mandatory insurance, may be an effective mechanism to cross-subsidize the cost of insurance across the insured pool, which is consistent with the principle of solidarity. However, this option may entail moral hazard and reduce the incentives to adopt cost-effective risk prevention and mitigation measures (where such measures are in fact feasible for policyholders). Deductibles and coinsurance may help in coping with potential moral hazard, but may not be sufficient. Risk-based deductibles, nevertheless, may be a possible alternative to risk-based premiums, even if the incentive mechanism is different for the reward for the adoption of risk reduction measures (that is, a lower deductible in case of future potential losses, instead of a lower premium at renewal) and may be perceived as too distant (timewise) or uncertain by the policyholder.

Risk-based disaster insurance, if correctly priced, affordable, and linked to actionable measures by policyholders, not only can provide coverage against damage—permitting more rapid economic and social recovery—but also signals to individuals the hazards they face, as well as financial incentives to encourage investment in cost-effective mitigation measures to reduce vulnerability, thereby contributing to the risk communication and education efforts. Although risk management incentives should be encouraged, many countries have however opted for a more pragmatic approach to pricing to enhance implementation efficiency in particular.[14]

The general shape and particular features of national disaster risk financing and transfer systems, as previously illustrated, result from a conjunction of factors: economic (for example, structure and development of the insurance market); political (for example, risk appetite of the government, short-term versus long-term policy objectives); and social or cultural (for example, degree of reliance on solidarity). As they become more developed and sophisticated, these mechanisms also increasingly rely on a comprehensive analysis of the risks and exposures to be covered.

Quantification of Disaster Losses and Exposures

Tracking the Social and Economic Effects of Catastrophic Events

The availability, accuracy, and reliability of data and information on the social and economic effects of catastrophic events play a fundamental role in the design of DRM strategies. The measure of the current state of national disaster risk is a prerequisite to the design of policy measures that can lead to the adoption of efficient disaster risk financing and transfer solutions and to the reduction of the costs to the government in the aftermath of a major event. The quantification of disaster risks is based on the analysis and assessment of past direct and indirect disaster losses, as well as of evolving hazards and risk exposures (assets, populations, and economic activity) (see, for example, Muir-Wood 2011).

For catastrophe risk assessment, past loss experience alone proves to be insufficient to determine either the underlying geography or the cost of risk. Rather, one must evaluate risk from a probabilistic perspective, in which a very wide range of potential disaster events are considered according to their respective probabilities. The calculation of the risk cost should then take into account all those future losses expected to be incurred according to their probabilities (see, for example, Muir-Wood 2011).

Over the past two decades, computer-based risk models for measuring catastrophe loss potential have been developed by linking scientific studies of natural hazard measurements and historical occurrences with advances in information technology and geographic information systems. Catastrophe loss models normally comprise a series of five modules: stochastic, hazard, exposure, vulnerability, and financial analysis (Grossi and Kunreuther 2005). The stochastic module reflects the population of potential disaster events, their sizes, and their locations, along with their relative probabilities of occurrence within a year. The hazard module concerns the spatial geography of the key physical parameters from each event at each geographic location. The exposure module concerns what is exposed to damage or loss by the disaster event (for example, population, assets, and economic activities at risk). The vulnerability module concerns how the hazard turns into physical loss and damage. The financial analysis module considers the loss in terms of monetary value, translating physical damage into economic terms. [15]

In terms of catastrophe model outputs, both the *probabilistic perspective*, in which the potential effects are weighted by their respective probabilities, and the scenario perspective, in which specific disaster events are reconstructed in significant detail, are important to consider in determining the interdependencies of their consequences (Muir-Wood 2011). Because modeled loss results provide valuable insight into the potential severity and frequency of catastrophic losses and into the volatility of the analyzed risks, decision makers can use catastrophe models to assess the relative benefits of different risk mitigation measures, as well as to design appropriate risk transfer and risk financing solutions.

Of course, catastrophe models require substantial amounts of reliable data for model construction and validation. In this regard, the 2010 OECD Recommendation (OECD 2010b) clearly indicates that governments and relevant public and private institutions would greatly benefit from the promotion of regional and international cooperation and synergies in the collection and sharing of data on exposures to large-scale disasters, as well as in the modeling of the nature of those risks.[16] However, the analysis of national experiences reveals that the quantification of disaster losses and exposures remains a weak link in the DRM cycle.

Notwithstanding the existence of several long-standing, well-respected initiatives in the field of collection and dissemination of data on catastrophic risk exposures and losses arising out of disaster events, such as the International Organization for Standardization's Property Claim Services (PCS) in the United States,[17] PERILS AG in Europe,[18] Swiss Re *Sigma*,[19] Munich Re GEO risks research,[20] the Centre for Research on the Epidemiology of Disasters (CRED) EM-DAT,[21] the DesInventar methodology,[22] and ADRC Global Disaster Identifier Number (GLIDE)[23], the survey and comparison of these initiatives reveals the following:

- First, the definitions and classification criteria used to collect and disseminate data on catastrophic losses vary greatly, giving rise to several discrepancies.
- Second, assessment methodologies are often highly discretionary, and sources of data are not always disclosed to the public, which may generate a lack of transparency and confidence.
- Third, the evaluation of total economic losses appears to be an extremely difficult exercise, and none of the existing initiatives has developed a consistent methodology to perform this task, which, in fact, is extremely important in the context of the design and implementation of ex ante catastrophic risk management strategies at the governmental level.
- Fourth, in a number of geographic areas, including Asia, consistent efforts to collect and disseminate data on insurance industry exposures to catastrophic risks and on the economic impact of disaster events seem to be lacking.

More generally, a lack of international consensus exists regarding good practices for collecting, elaborating, and disseminating data on disaster risk exposures and losses resulting from disasters, especially with regard to the quantification of total economic losses.

A comparative analysis conducted on sample data provided by PCS, Swiss Re, Munich Re, and EM-DAT, for instance, illustrates the effects of discrepancies in the presentation of loss data and rankings.[24] Table 17.1 contains the data related to a sample of six U.S. disasters with very high insured losses in the time frame 1980–2011. Table 17.2 contains the data of a sample of 10 natural disasters worldwide with very high fatalities in the time frame 1980–2011.[25]

Table 17.1 Six Natural Disasters with High Insured Losses, United States, 1980-2011

Ev#	Loss event	Region or country	Overall loss			Insured Loss			Fatalities			Ranking			Dates (start)		
			PCS	Swiss Re	Munich Re	PCS	Swiss Re	Munich Re	PCS	Swiss Re	Munich Re[a]	PCS	Swiss Re	Munich Re	PCS	Swiss Re	Munich Re
1	Hurricane Katrina	USA	nc	nc	125,000	41,100	74,686	62,200	nc	1,836	1,322	1	1	1	nc	8/25/05	8/25/05
2	Earthquake	USA, Northridge	nc	nc	44,000	12,500	21,239	15,300	nc	61	61	3	5	5	nc	1/17/94	1/17/94
3	Hurricane Ike	USA, Caribbean	nc	nc	38,300	11,500	21,141	18,500	nc	136	170	4	6	3	nc	9/6/08	9/6/08
4	Hurricane Andrew	USA	nc	nc	26,500	15,500	25,641	17,000	nc	43	62	2	3	4	nc	8/23/92	8/23/92
5	Hurricane Ivan	USA, Caribbean	nc	nc	23,000	7,110	15,350	13,800	nc	124	125	7	7	6	9/15/04	9/2/04	9/7/04
6	Hurricane Irene	USA, Caribbean	nc	8,000	7,400	nc	5,300	5,600	nc	nc	55	nc	nc	nc	nc	8/22/11	8/22/11

Note: Loss is expressed in US$ million
a. Figures do not include missing people.
Sources:
PCS, *CatCube®* Demo: The top 50 catastrophes and data provided by PCS.
Swiss Re, *Sigma* no. 2/2012, p. 36, Table 9: The 40 most costly insurance losses 1970-2011 (considered only loss events from 1980 onward).
Munich Re, *NatCatSERVICE®* (as at January 2012) and MunichRe Topics GEO 2011

Table 17.2 Ten Natural Disasters with High Fatalities, Worldwide, 1980-2011

Ev#	Loss event	Region or country	Overall loss			Insured Loss			Fatalities			Dates (start)		
			EMDAT	Swiss Re	Munich Re	EMDAT	Swiss Re	Munich Re	EMDAT	Swiss Re	Munich Re[a]	EMDAT	Swiss Re	Munich Re
1	Earthquake	Haiti	8,000	nc	8,000	nc	103	200	222,570	222,570	222,570	1/12/10	1/12/10	1/12/10
2	Earthquake, tsunami	South Asia	nc	nc	10,000	nc	2,381	1,000	182,097	220,000	220,000	12/27/04	12/26/04	12/26/04
3	Cyclone, storm surge	Bangladesh	nc	nc	3,000	nc	3	100	138,866	138,000	139,000	4/29/91	4/29/91	4/29/91
4	Earthquake	Pakistan, India	nc	nc	5,200	nc	0	5	73,338	73,300	88,000	10/8/05	10/8/05	10/8/05
5	Cyclone Nargis	Myanmar	nc	nc	4,000	nc	0	0	138,366	138,300	140,000	5/2/08	5/2/08	5/2/08
6	Heat wave	Europe	10,450[b]	nc	13,800	nc	0	20	67,895[b]	35,000	70,000	July-August 2003	July 2003	July-August 2003
7	Earthquake (aftershocks)	China, Sichuan	85,000	nc	85,000	nc	383	300	87,476	87,449	84,000	5/12/08	5/12/08	5/12/08
8	Earthquake	Iran, Islamic Rep.	8,000	nc	7,100	nc	198	100	40,000	40,000	40,000	6/21/90	6/21/90	6/21/90
9	Flash flood, landslide	Venzuela, RB	nc	nc	3,200	nc	297	220	30,000	10,000	30,000	12/15/99	12/12/99	12/8/99
10	Earthquake	Armenia	14,000	nc	14,000	nc	0	0	25,000	25,000	25,000	12/7/88	12/7/88	12/7/88

Note: Loss is expressed in US$ million
a. Figures do not include missing people.
b. Partial result was obtained from an incomplete data set.
Sources:
Swiss Re, Sigma no. 2/2012, p. 37, Table 10: The 40 worst catastrophes in terms of victims 1970-2011 (considered only loss events from 1980 onward).
Munich Re, NatCatSERVICES® (as at July 2011): Natural disasters 1980-2011, 10 deadliest natural disasters.

Discrepancies in the presentation of disaster loss estimates for the same event can be explained by referring to the different methodologies and selection criteria used by the various entities in charge.

A first feature is the choice of a specific geographic area for the collection of data on disasters (also referred to as *georeferencing*): in the case of PCS, for instance, this area is limited to the United States, the U.S. Virgin Islands, and Puerto Rico. When a disaster occurs, identifying the geographic area is very difficult: for instance, hurricanes may affect a specific state of the United States as well as areas that are not included in the PCS range. Estimates would then concern only losses occurred in the PCS geographic area, excluding losses beyond such boundaries. This result could create divergences in the estimate of losses caused by the same event. Furthermore, complete and accurate total estimates for some disasters appear only after several months, sometimes years, and PCS estimates focus only on certain types of insured property losses.

Both Munich Re and Swiss Re base their U.S. estimates of insured losses on PCS data for natural hazards occurring in the U.S. area but add other information and criteria to underpin their estimates. Only Munich Re publicly disseminates data on overall losses. Moreover, estimates of the insured losses related to the same catastrophic event may differ because of different definitions of what constitutes insured losses. Also, the use of different methods to adjust estimates for inflation—or the lack of such an adjustment—can affect the comparability of insured loss estimates over time.

The reported number of victims can differ as well. Figures may include only deaths or could also cover missing, injured, and homeless people. Injured and homeless people are included in humanitarian organizations' databases (EM-DAT and GLIDE) because classifications of those organizations are different from those used for insurance purposes.

Reported starting dates of disasters are also important to estimate insurance losses. In the case of Hurricane Ivan (see table 17.1, event number 5), disagreement exists on the starting date. The starting date is determined by newspapers, scientific, and other sources on a discretionary basis.

The tables show a remarkable divergence in the representation of the same disaster event under different aspects. An interesting example is offered by the case of Hurricane Ivan (see again table 17.1, event number 5), with respect to which PCS's rating and estimate are determined by all the above-quoted factors (georeferencing, definitions, classifications, lack of adjustment for inflation, selection of starting date).

Another issue related to classification and estimates based on insured losses is that in many instances, because of the low level of insurance penetration in various regions, including many countries in Southeast Asia, disasters causing severe economic losses are not highlighted in the reports because most of these losses are uninsured.

If one focuses on loss estimates related to events that occurred in 2010 and 2011, the figures are again reported differently by the various sources. Following are some examples:

- For the earthquake that occurred in New Zealand on February 22, 2011, Swiss Re *Sigma* estimated total "economic losses" at US$15 billion and "insured losses" at US$12 billion, whereas Munich Re assessed "overall losses" at US$16 billion and "insured losses" at US$13 billion.
- For the flash floods that occurred in France on June 15, 2010, Swiss Re *Sigma* estimated "insured losses" at US$.81 billion, whereas Munich Re assessed "overall losses" at US$1.5 billion and "insured losses" at US$1.07 billion.
- For winter storm Xynthia on February 26–28, 2010, Swiss Re Sigma estimated "insured losses" at US$2.75 billion and

counted 64 victims, whereas Munich Re assessed "overall losses" at US$6.1 billion and "insured losses" at US$3.1 billion and counted 65 victims.

More generally, uninsured losses appear mainly in compilations showing fatalities and sometimes in humanitarian databases, such as EM-DAT and GLIDE, but no consistent methodology for their assessment has been developed to date. A recent example is offered by the losses caused by the devastating 8.8 magnitude earthquake and ensuing tsunami that struck Chile on February 27, 2010; shortly after, economic damages were officially estimated at approximately US$30 billion (this figure is currently reported by all sources quoted previously), but admittedly the assessment is only tentative and may need to be revised, depending on a number of factors.[26]

The aggregate annual insured and uninsured costs of disaster events worldwide are also reported according to different classification criteria by the various sources, leading to data that are hardly comparable. In the past two years, by way of example, according to Swiss Re *Sigma*, disasters caused "total economic losses" of US$370 billion (in 2011) and US$226 billion (in 2010)[26] and "insured losses" attributable to natural events of US$110 billion (in 2011) and US$43 billion (in 2010), whereas Munich Re assessed "overall losses" from natural events at US$380 billion (in 2011) and US$152 billion (in 2010) and "insured losses" at US$105 billion (in 2011) and US$42 billion (in 2010).

The analysis of these data demonstrates that the adoption of nonhomogeneous parameters in the choice of definitions, classifications, adjustments, geographic areas, and other features greatly affects the presentation of data concerning natural events, giving rise to difficulties in the comparison of different elaborations and statistics. Efforts to harmonize classification criteria have been undertaken by several of the already-mentioned stakeholders, such as the implementation of a common disaster category classification and peril terminology (Below, Wirtz, and Guha-Sapir 2009), but the scope of such criteria still appears to be limited.

Although it is acknowledged that each *private* provider of data on catastrophic losses has an interest in differentiating its offer for legitimate commercial purposes, from a governmental perspective there seem to be an interest in developing harmonized taxonomies, categories, and data collection procedures at the public sector level, with a view to facilitating access to and comparison of information, data, and statistics on disaster losses and possibly also on disaster risk exposures on a global scale. The possible future use of harmonized criteria for the collection and presentation of data on disaster events could well coexist with current private initiatives, and it would certainly enhance the ability of governments to use loss and exposure data for the purpose of designing and implementing effective and efficient DRM strategies.

2011 OECD Survey on Disaster Data Collection

To conduct an assessment of possible benefits and costs of promoting action within the OECD on the quantification of disaster losses and risk exposures and to respond to the previously mentioned concerns, the OECD circulated a questionnaire in 2011 on data and procedures to quantify disaster risks, on the possible difficulties encountered by countries, and on the relevant national initiatives in this field.

Some important conclusions stand out from the country replies:[27]

- Nearly all OECD countries that have responded to the questionnaire see themselves as prone to natural disasters; flood risk is the disaster most often referred to.
- With respect to quantification of insured losses,

– The definition not only of *disaster events*, but also of *insured disaster losses*, varies from country to country, making relevant international comparisons difficult to establish.

  The definition of disaster events ranges from very general, as in Finland, to far more detailed, as in Hungary. Certain countries provide quantitative thresholds—for example, minimum aggregate loss in Australia and number of buildings affected in Turkey.

  The definition of insured disaster losses also differs from country to country, because the data-gathering perimeters differ: some countries collect only data on property insurance, whereas others also cover liability, business interruption, and so on. Also, certain countries include only insured losses incurred by publicly backed insurance schemes, which may be substantial.

– More than half the responding countries find providing aggregate amounts of insured losses resulting from disasters for a given (recent) year difficult, and many of them do not collect such data at the national or subnational level.

  Six countries do not collect data on insured disaster losses at the national (or subnational) level. In more than half the countries, information is collected by the private sector, and in about half of them, it is collected by the public sector as well. Several countries, such as Australia, Canada, Ireland, Mexico, and the United States, refer to private sources only. These data collection activities are conducted on a voluntary basis in some countries (Australia, New Zealand, and Turkey for insured loss caused by catastrophic events other than earthquakes). Eight of the countries that collect insured loss data indicate that they review the collected data on a regular basis.

• With respect to quantification of uninsured losses and exposures, aggregate data on insured exposures or on uninsured losses that are difficult to estimate because they affect many different populations, communities, goods, buildings, or infrastructure are computed at the national level in only about one-fourth of the responding countries.

  Data on insured exposures to natural and human-made disasters are collected or disseminated at a national (or subnational), regional, or international level in only six countries.

• With respect to quantification of government spending, about one-third of the countries reviewed do not have aggregate data on government spending incurred to cover uninsured economic losses after a disaster (for example, emergency response costs, temporary housing, payments to households for physical damage, and reconstruction costs including public assets and infrastructure) because the centralization or harmonization of various sets of data collected requires in-depth cooperation between different government agencies that is often time consuming. In the absence of such data, design of adequate tools for the financial management of disasters at the national level may prove difficult. Data from several ministries or institutions will need to be shared to compute the global figures to be disseminated at a national (or subnational) level. To overcome this difficulty, some of the responding countries (Austria, Canada, New Zealand, and Turkey) have established a special entity to coordinate the data collection at the national level, and such reform is under way in France.

These shortcomings and gaps affecting the data on the economic and social impacts of catastrophic events are raising concerns, because these data are the basis on which governments build their disaster management strategies. In several OECD countries, the process of data gathering and dissemination on insured losses and risk exposures is therefore attracting growing interest. It is currently being reviewed and improved in eight of the countries surveyed, thereby providing some interesting development paths for other countries. At the international level, these discrepancies call for in-depth reviews of national data collection and dissemination practices, with a view to identifying best practices, including a possible basic methodology or framework for the collection, elaboration, and dissemination of data on catastrophic risks and losses. Efforts toward common understanding and possible harmonization, when relevant, of basic definitions and classification criteria, including for the quantification of total economic losses caused by a disaster on a global scale, should be enhanced further.

Conclusions and Lessons Learned

The series of recent major disasters has prompted many regions and countries, far beyond the areas directly affected, to revisit their strategy on the management of disaster risks and has stimulated discussions on the need to improve risk assessment and the current financial coverage of extreme natural events, among other elements of these DRM strategies. It brought to light significant issues, such as the difficulty of assessing the risk of a combination of different perils or the low disaster insurance penetration rates, including in developed countries. Improved mechanisms and arrangements are being sought to ensure enhanced financial resilience and protection.

Box 17.1 Case Study: Assessing the Risk of Flood Defense Failures

In periods of extremely high precipitation, the flood scenarios that pose the greatest level of risk to populations and economic activity involve a failure of flood control assets, such as dikes, levies, and floodwalls. Risk analysis (hazard, exposure, and vulnerability) should therefore take into account the possibility of such failures, but modeling failure requires accurate information about the condition and maintenance of flood defense assets. The unfortunate reality is that most countries do not keep complete and accurate inventories of these assets, much less databases that provide up-to-date and publicly available information about their condition and maintenance. Countries such as the United States (National Levee Database), France (BARDIGUES), and the United Kingdom have made progress in this direction.

In the United States, the Army Corps of Engineers launched the National Levee Database in 2011. It currently includes information on 92 percent of federal levee systems,[a] and plans are to expand the database to include other flood protection systems and to reflect new inspections as reports become available. In addition to physical data points such as location and length of the system, the public can view when the last inspection was performed and a qualitative rating such as acceptable, minimally acceptable, and unacceptable, which could help decision makers target limited resources for maintenance. Among database's impressive features is a mapping tool, which uses Google Earth to enable users to see component parts of a levee system and overlay federal data sets for flood insurance rate maps, data from the U.S. Geological Survey, real-time weather conditions, and forecast water levels. In addition to facilitating risk assessments, these tools link activities, such as flood risk communication, levee system evaluation for the NFIP, and flood plain management. Among the parties that could benefit from these features are flood plain managers; levee and drainage district officials; private users, such as property owners protected by a levee; and purchasers or lessees performing real estate due diligence.

Box 17.1 Case Study: Assessing the Risk of Flood Defense Failures *continued*

Countries should build and continuously update and improve databases of flood defenses and their condition to help target investment more precisely to where it is most needed. Currently, significant variability exists between countries with regard to the completeness of such databases, their openness to the public, and transparency about the evaluations conducted of the protective assets covered. One challenge to building and maintaining these data sets is cost, but the benefit would be to motivate exposed communities to support continuance.

a. See http://nld.usace.army.mil/egis/f?p=471:1:1983829781918781. These systems are levee systems owned, operated, and maintained by the corps; systems constructed by the corps but operated and maintained by local sponsors; and systems owned, operated, and maintained by local entities that are active in the PL 84-99 program.

In this regard, several lessons can be learned from OECD country experience. First, in the design of a sound financial management strategy to cope with disaster risks, the following variables should be considered:

- The vulnerability and exposure of the country to natural hazards and the risk differentials across the country;
- The extent of public sector financial resources available for the coverage of emergency relief costs and disaster losses;
- The policy objectives to be pursued by the strategy—for example, obtaining liquidity to cover emergency relief costs, protecting public assets and infrastructure exposed to risk, providing protection to private assets exposed to risk, making coverage available to individuals and businesses, and introducing incentives to invest in cost-effective disaster risk prevention and mitigation measures;
- The financial capacity of the insurance industry (capitalization, access to reinsurance, access to capital market instruments, and so on);
- The operational capacity of the insurance industry (marketing, premium collection, claims management and payment services, business continuity plans, and so on).

Second, financial management strategies should primarily focus on promoting techniques of prevention, adaptation, and mitigation. Public and private investments in disaster risk reduction and mitigation measures, by limiting exposure and vulnerability to disaster risks, facilitate the development of new risk financing, risk sharing, and risk transfer tools.

Third, although governments are often expected to play an important role in the financial management of large-scale disasters, especially for megarisks, moral hazard and crowding out of private sector initiatives should be avoided or at least limited. In theory, once those who are exposed to disaster risks have been granted access to, or have used, financial management tools such as disaster insurance, the public authority should refrain from making ad hoc ex post compensation payments to the victims of disasters in a manner that would undermine ex ante solutions. It should however be noted that it will be extremely difficult for the government to make a credible commitment not to provide compensation once a disaster occurred.

Fourth, having an operational private insurance industry is greatly advantageous: the insurance market may be able to absorb some disaster risk that would otherwise fall on the government. Moreover, even if financial capacity in the market is insufficient to provide adequate protection, the administrative resources of the private insurance industry can provide a platform for establishing a government-funded and government-directed program. In this respect, insurance companies can perform key services, such as marketing of the policies, premium collection, loss adjustment, and claim payment.

Fifth, risk-based premiums lower moral hazard and encourage risk prevention, but coverage can be expensive. In the context of a national or regional risk pool, some degree of cross-subsidization may be needed to make the system acceptable and workable. In any case, recognizing the impact of risk differentials across the territory of a country or region is important, as is incorporating such risk differentials in the pricing mechanism insofar as possible.

Sixth, compulsion of disaster risk insurance is viewed in several countries as an approach to develop more comprehensive insurance coverage and build national insurance capacity. Insurance penetration remains an issue in several countries, even if the purchase of coverage is mandatory. This approach may depend on the insurance culture of the population, on the level of disaster risk awareness, and on the credibility of the ex ante arrangements. Introducing checks on compliance with mandatory insurance requirements is advisable.

Seventh, the transparency and comparability of data on disaster losses and disaster risk exposures should be further enhanced at the regional and international levels:

- The possible development of harmonized definitions (for example, for insured losses and total economic losses resulting from a disaster); taxonomies; and classification criteria for disaster events could be promoted to facilitate access to and comparison of information, data, and statistics on disaster losses and possibly also on catastrophic risk exposures on a global scale. Such criteria, in turn, would allow for the design and implementation of better DRM strategies at national or regional level.
- A more in-depth review of national practices for collecting, elaborating, and disseminating data on disaster risk exposures and losses resulting from disasters, with a view to identifying best practices, should be encouraged to improve the quality of procedures currently in place.
- For very large-scale disaster events affecting large geographic areas, moreover, the coordinated involvement of government authorities and possibly private actors in the process of collecting and disseminating information on total—insured and uninsured—economic losses caused by a disaster on a global scale (that is, across political regions) should be promoted.

Finally, to stimulate progress on disaster risk management, comparative studies of national or regional DRM strategies, focusing on the understanding of relevant constraints and institutional arrangements that are likely to affect risk prevention as well as the availability of financial coverage and the roles of government and the private sector in disaster risk management (for example, nature and potential development of insurance markets, availability of mortgages, respective roles of local and national governments) should be promoted. They should include case studies to showcase innovations in disaster risk assessment, management, transfer, and financing. Also, the achievement and dissemination of postdisaster reviews on the basis of improved data sets should be further encouraged.

Enhanced international cooperation will help identify and develop policy options to increase the financial coverage of disaster risks and adequately protect populations, businesses, and assets at risk, while alleviating the financial burden expected to be borne by the government in the event of any future disaster.

Notes

1. Estimates are based on the preliminary assessments recently made by Munich Re (2012) and Swiss Re (2012), among others.
2. The social and economic consequences of disasters are complex and manifold, raising critical issues in the fields of health, education, employment, migration, gender inequalities, and children rights as well.
3. OECD recommendations are not legally binding, but practice accords them persuasive force as representing the political will of member countries, and member countries are expected to do their utmost to fully implement a recommendation.
4. Established in 2006, the High-Level Advisory Board, composed of high-level experts from governments, the private sector, and leading research institutions, plays a leading role in identifying and discussing the major policy issues related to the financial management of large-scale catastrophes. It also performs advisory functions for the OECD secretary-general, the Insurance and Private Pensions Committee, and the Committee on Financial Markets in drafting guidelines, good practices, recommendations, and principles. See http://www.oecd.org/daf/fin/catrisks.
5. If one knows in advance that the government or international donors will provide ample financial assistance after hardship to those who were not protected, the economic incentive for those in hazard-prone areas either to engage in loss reduction measures prior to a disaster or to purchase adequate insurance coverage, when available, will be less (see OECD 2010b).
6. See OECD (2011), offering an in-depth analysis of the financial and legal implications of the possible use of catastrophe-linked securities in the financial management of large-scale risks, including a set of recommendations for governments. See OECD (2008), containing three reports focusing on different institutional approaches to the financial management of large-scale catastrophes in selected OECD and non-OECD countries, the role of risk mitigation and insurance in reducing the impact of natural disasters, and the importance of strategic leadership in the management of nonconventional crises. See also Monti 2003; OECD 2004, 2005a, 2005b.
7. Other regulatory measures may be aimed at setting up, depending on specific country conditions and exposures, an appropriate legal framework for the development of market-based microinsurance solutions within the reach of the poorer layers of the population.
8. Suggestions for improving the functioning of the EUSF were put forward by the European Commission on October 6, 2011, alongside proposed legislation that will frame cohesion policy for 2014–20. See European Commission (2011).
9. The Australian government provides funding through NDRRA to states and territories to help pay for natural disaster relief and recovery costs. The NDRRA Determination 2011 and the NDRRA Community Recovery Package Guidelines 2011 are available at http://www.em.gov.au.
10. As reserves grow in the absence of disasters, strong political pressure may exist for using accumulated funds for other projects.
11. Current information on the initiative launched by the Federal Emergency Management Agency to reform the U.S. NFIP is available at http://www.fema.gov/; possible improvements to the NFIP have been suggested, among others, by Michel-Kerjan and Kunreuther (2011).
12. Outside the OECD area, an interesting example is offered by the Caribbean Catastrophe Risk Insurance Facility (CCRIF), a joint reserve fund established to provide participating CARICOM (Caribbean Community) governments an instrument to address the need for short-term liquidity to start recovery efforts while maintaining essential government services in the aftermath of natural disasters. CCRIF, set up as a nonprofit mutual insurance entity in the Cayman Islands, is a multicountry risk pool and an insurance instrument to develop parametric policies backed by both traditional reinsurance and capital markets. It is designed to limit the financial impact of devastating hurricanes and earthquakes by quickly providing financial liquidity when a policy is triggered. CCRIF estimates the loss on the ground by using data from the U.S. National Hurricane Center in the case of hurricanes and the U.S. Geological Survey in the case of earthquakes and through a preagreed proxy relationship developed within a catastrophe risk model (see Cummins and Mahul 2009, 165ff).
13. The effectiveness of enforcement mechanisms to ensure compliance with the mandatory purchase requirement is a key component of this policy. Low levels of disaster insurance take-up rates have been observed even in countries that introduced this mandatory requirement.
14. Depending on local economic conditions and exposure levels, actuarially based pricing can make disaster insurance premiums unaffordable when one considers extreme events on the tail of the distribution, given the cost of capital required by solvency regulations worldwide.
15. By evaluating the loss from each of the stochastic events in the simulation, one can generate an exceedance probability (EP) curve displaying the probability that a loss will be in excess of different thresholds. The integral under the EP curve is the average annualized loss, which is a critical parameter to be considered when mapping risk cost.
16. A notable example concerning geophysical hazards is the Global Earthquake Model (GEM) initiative, promoted by the OECD. At present, the GEM is established as a foundation, a public-private partnership that drives a collaborative effort aimed at developing and deploying tools and resources for earthquake risk assessment worldwide that are based on uniform global databases, methodologies, and open source software. See http://www.globalquakemodel.org.
17. For information about the PCS, see: http://www.iso.com/pcs/.
18. For information about PERILS, see http://www.perils.org.
19. For information about Swiss Re, see http://www.swissre.com.
20. For information about Munich Re GEO risks research, see http://www.munichre.com/touch/naturalhazards.
21. For information about CRED EM-DAT, see http://www.emdat.be/database.
22. The DesInventar methodology proposes the use of historical data about the effect of disasters, collected in a systematic and homogeneous manner, in the process of identifying hazards and vulnerabilities and, thus, risks on specific regions. Data must be collected following a set of standards and is time stamped and georeferenced and disaggregated to a relatively small geographic unit, usually a low-level administrative unit (http://www.desinventar.net/).
23. For information about GLIDE, see http://www.glidenumber.net/.
24. This analysis constitutes an update of the comparative exercise conducted by Monti and Tagliapietra (2009).
25. The issue is dealt with by Muir-Wood (2011).
26. The annual aggregate estimates of "total economic losses" provided by Swiss Re Sigma also include losses caused by human-made disasters.
27. The responding countries were Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, India, Israel, Japan, Luxembourg, Mexico, New Zealand, Poland, the Slovak Republic, Slovenia, South Africa, Spain, Portugal, Turkey, and the United States.

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