The Rise of Natural Disasters in Asia and the Pacific

Learning from ADB's Experience

Independent Evaluation ADB

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ISBN 978-92-9254-194-1 (Print), 978-92-9254-195-8 (PDF)
Publication Stock No. BKK135912-2

Cataloging-In-Publication Data
Asian Development Bank

The rise of natural disasters in Asia and the Pacific: Learning from ADB's experience
Mandaluyong City, Philippines: Asian Development Bank, 2013.

1. Natural disasters. 2. Independent evaluation. I. Asian Development Bank.

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Printed on recycled paper

Contents

Figures and Tables

Figures

Tables

Foreword

The frequency of natural disasters globally has risen markedly in recent decades, particularly the devastating storms and floods that many associate with climate change. In the 2000s, about 150 major floods were recorded worldwide, triple the number in the 1980s. According to one major global insurance group, the incidence of Category 5 storms—the most severe—also tripled.

Asia and the Pacific have borne the brunt of this alarming trend: natural disasters are now four times more likely to affect people in the region than those in Africa, and 25 times more likely than those in Europe. One climate change vulnerability index indicates that all seven cities globally classified as at "extreme risk" are in Asia: Dhaka, Manila, Bangkok, Yangon, Jakarta, Ho Chi Minh, and Kolkata. Financially, Asia accounts for almost half of the estimated global economic cost—close to $1 trillion—caused by natural disasters since the early 1990s.

This enormous toll very likely reflects changes under way in global climate and surging populations concentrated in urban areas. As the world warms, heat waves, storms, rains, and droughts are becoming more extreme sea levels are rising, and landslides, floods, fires, and pests are becoming more common. At the same time, sharply rising populations in a number of developing Asian countries have forced millions to move to marginal lands along low-lying coasts and flood-prone areas in cities. Despite this seemingly unstoppable trend, experience shows time and again that better disaster preparation and prevention can mitigate devastating losses.

Bangladesh has shown us that even poor countries can do exemplary work in preparing for predictable hazards. To take just one example, by setting up community-led early warning systems, public awareness campaigns, and communal facilities, Bangladesh has significantly reduced deaths in the annual onslaught of tropical cyclones. Indonesia's efforts after the 2004 earthquake and tsunami laid the groundwork for much more effective disaster response by decentralizing the reconstruction agency away from Jakarta to improve disaster coordination in the archipelago. In Pakistan, following a succession of calamitous events including the 2005 earthquake, the government created a federally coordinated disaster risk system and integrated risk reduction plan.

While some governments seem to be increasingly recognizing that disaster preparedness should be a part of their development policy mix, many have not. This is often because governments don't treat disaster prevention with the same urgency as disaster response. The Asian Development Bank (ADB) and other influential development organizations can play an important role in changing this mind-set.

To this end, Independent Evaluation took stock of disaster-related assistance in the region in the report *ADB's Response to Natural Disasters and Disaster Risks*. The 2012 evaluation highlights some of the successes and shortcomings of disaster risk reduction in Asia and the Pacific, particularly through case studies in Bangladesh, Indonesia, and Pakistan, and identifies areas for improvement.

Vinod Thomas
Director General
Independent Evaluation

Commuters in Dhaka, Bangladesh, use boats to navigate flooded streets, 1 August 2004. AFP Photo/ Farjana K. Godhuly.

Acknowledgments

The report "ADB's Response to Natural Disasters and Disaster Risks" was prepared by a team led by Tomoo Ueda, Principal Evaluation Specialist with the Independent Evaluation Department (IED). Team members included Andrew Brubaker, Jean Foerster, Eunkyung Kwon, Lucille Ocenar and Stella Labayen. IED Director General Vinod Thomas and Director Walter Kolkma provided overall guidance.

This summary of the report was prepared with the editorial services of Eric Van Zant and Alastair McIndoe and layout services of Alexander Pascual.

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IED retains full responsibility for the report.

Abbreviations

ADB	Asian Development Bank
EM-DAT	Emergency Events Database
GDP	gross domestic product
IED	Independent Evaluation Department
PRC	People's Republic of China

Engineers working on the construction of dikes for flood control in Bangladesh as part of the ADB-supported Flood Rehabilitation Project.

Chapter 1

The Rising Frequency of Natural Disasters in Asia and the Pacific

Faced with the rising frequency of natural disasters across Asia and the Pacific, the response in different countries has varied widely. While it is clear that all governments in the region need to do more to cope with the growing threat, made worse by climate change, a number of countries have been investing wisely in disaster risk reduction projects and programs for a number of years.

In the 1970s, Bangladesh—among Asia's poorest countries and highly vulnerable to an annual cycle of deadly tropical cyclones—embarked on a new course. Over 4 decades, with limited resources and significant resolve, the government has steadily invested in climate-related disaster resilience. It has implemented early warning systems, built community-level storm shelters in coastal regions, and improved evacuation procedures.

Under a program led by the Bangladesh Red Crescent Society, the country built an exemplary early warning system based on a volunteer force of more than 30,000 men and women to disseminate cyclone warnings through village-level focal points and to carry out rescue operations. As a result, while Cyclone Bhola in November 1970 killed over 300,000 people, another storm of similar magnitude, in 1997, took just 188 lives.

The Bangladeshi case underscores the potential for better disaster preparedness in developing Asia and the Pacific. As this report makes clear, the experience in Bangladesh and elsewhere points the way for the development community

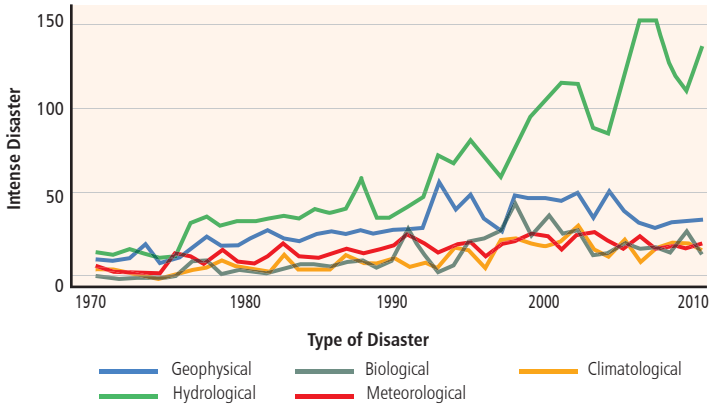
and governments to put far greater emphasis on proactive approaches to natural hazards. Through better preparation, they can help avoid some of the disastrous consequences of storms, earthquakes, and other hazards, even as they also improve disaster response measures. This is crucial as the pressures of climate change and population compound the already difficult cycle of natural disasters.

This report summarizes the broader findings of the evaluation study *Response to Natural Disasters and Disaster Risks*, the Independent Evaluation Department's assessment of the Asian Development Bank's (ADB) interventions in its developing member countries during 1995–2011.[1]

Rising Frequency

The frequency of natural disasters, particularly storms and floods, has clearly been on the rise globally in the last several decades (Figure 1). The occurrence of major floods tripled from about 50 per year in the 1980s to 150 in the 2000s. Munich Re, a major insurance group, notes that the annual number of Category 5 storms, the most severe, also tripled between 1980 and 2008. And according to the Emergency Events Database (EM-DAT) on international disasters from the Centre for Research on the Epidemiology of Disasters, the occurrence of all natural disasters has risen about 600% in the last 60 years.

Figure 1: Global Frequency of Intense Natural Disasters



Source: Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

[1] Independent Evaluation Department (IED). 2012. *Special Evaluation Study: ADB's Response to Natural Disasters and Disaster Risks*. Manila: ADB.

Climate-Related versus Geophysical Disasters

It is important to distinguish, at this point, between hydrometeorological disasters (floods and storms) and geophysical disasters (earthquakes, tsunamis, and volcanic eruptions). The former have been occurring more frequently, while the latter have remained roughly the same, in number of incidents (Table 1).

Table 1: Natural Disasters and Deaths in Asia (by Disaster Type)

Disaster Type	Frequency			Deaths		
	1980–1989	1990–1999	2000–2009	1980–1989	1990–1999	2000–2009
Hydrometeorological	502	781	1,215	85,537	242,539	203,303
Geophysical	115	167	210	11,597	96,859	447,724
Total	617	948	1,425	97,134	339,398	651,027

Source: Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

This likely reflects fundamental changes under way in global climate and surging populations in low-lying megacities, such as Bangkok, Manila, or Jakarta, suggesting a strong underlying human factor. Massive population growth in Asia has forced millions to move to more marginal lands and coastal areas, away from historically economically active areas along rivers and canals. Naturally, this has left people much more vulnerable to droughts or storm surges from typhoons and cyclones, than those in the higher hinterlands. And as the world warms, heat waves, storms, rains, and droughts are becoming more extreme; sea levels are rising and landslides, floods, fires, and pests are becoming more common.

Massive population growth in Asia has forced millions to move to more marginal lands and coastal areas

In fact, total deaths due to hydrometeorological disasters decreased in the decade up to 2009, while deaths due to geophysical disasters are highest.[2] A magnitude 8 earthquake in Sichuan Province of the People's Republic of

[2] Centre for Research on the Epidemiology of Natural Disasters. EM-DAT. http://www.emdat.be/

The town of Angono, Philippines, near Manila, in September 2009, 3 days after tropical storm Ketsana dumped a month's worth of rain in just 9 hours. Emergency services, overwhelmed by the scale of the disaster, were unable to cope with the enormous number of flood victims, prompting an intense debate in the Philippines on disaster preparedness, which was found severely wanting. The storm killed at least 240 people. AFP Photo/ Jay Directo

China, for example, killed nearly 70,000 people, while, even in well-prepared Japan, the 2005 Kobe earthquake killed over 6,000 people.

Whether storm or earthquake, it is imperative to recognize the growing threat to economic development from all disasters and the role of better preparedness in dealing with that threat. According to the International Monetary Fund (IMF), the cost of damage from all types of natural disasters is now 18 times higher than it was in the 1950s.

Heavy Burden on Asia

Asia suffers the brunt of the world's disasters. According to EM-DAT, the region accounted for half of the estimated economic cost of disasters in the world over the past 20 years, or $927 billion in Asia (more than $40 billion annually on average) and $956 billion outside of Asia. While the region generated almost 25% of the world's gross domestic product (GDP) during 1980–2009, it accounted for 38% of global economic losses due to natural disasters in that period.

Natural disasters are now 4 times more likely to affect people in Asia and the Pacific than those in Africa, and 25 times more likely than those in Europe or North America. According to the Climate Change Vulnerability Index compiled by risk management group Maplecroft, all seven cities classified as at "extreme risk" are in Asia: Dhaka, Manila, Bangkok, Yangon, Jakarta, Ho Chi Minh, and Kolkata.

Hotspots: Identifying the Risks

In Asia, Bangladesh, the Philippines, and Viet Nam are at highest risk of human losses and economic damage

In responding to these growing threats, it is first important to know where the dangers lie. The Identification of Global Risk Hotspots project, published by the World Bank and Columbia University in 2005, used data on historical occurrence—actual disaster events—and zoning of areas of high risk to a natural hazard, to determine areas of relatively high risk to lives and livelihoods.[3] It identified 96 countries globally with high mortality risk from two or more hazards, and the top 75 countries at relatively high economic risk from multiple hazards based on GDP. In Asia, the countries at highest risk of human losses and economic damage are Bangladesh, the Philippines, and Viet Nam.

Using this data, the Independent Evaluation study ranked ADB's developing member countries according to mortality risks, as shown in Table 2. Of 44 countries, 20 are rated as "mortality hotspots" and 14 as "high economic risk." Almost the entire populations of Bangladesh and Nepal live in areas of high mortality risk, as do four of five residents of the Philippines, three-quarters of the population of Viet Nam, more than half of Bhutan and Indonesia, and almost half of Pakistan.

In terms of economic risk, more than half of the populations in seven countries are at high risk (or 494 million people), and, in eight countries, more than 50% of GDP is produced in areas at risk. The People's Republic of China alone

[3] Maxx Dilley, Uwe Deichmann, Robert S. Chen, and Arthur L. Lerner-Lam, and Margaret Arnold. 2005. *Natural Disaster Hotspots.* Washington, DC: World Bank.

Table 2: Global Risk Hotspots Analysis

a) Asian Developing Countries at Relatively High Mortality Risk from Multiple Hazards

Ranking	Countries	Percent of Population in Areas at Risk	Estimated Number of People at Risk (million)	Percent of Total Area at Risk
1	Bangladesh	97.7	139.60	97.1
2	Nepal	97.4	25.90	80.2
3	Philippines	88.6	83.50	76.6
4	Viet Nam	71.4	62.70	59.3
5	Bhutan	60.8	0.40	31.2
6	Indonesia	59.3	143.30	10.6
7	Pakistan	49.6	87.84	22.8
8	Afghanistan	46.0	12.20	7.2
9	Georgia	44.0	2.00	19.2
10	Fiji	42.0	0.40	20.0
11	PRC	33.4	450.00	10.6
12	Uzbekistan	30.6	8.50	2.5
13	Tajikistan	28.2	2.20	5.8
14	India	27.2	337.80	21.9
15	Lao PDR	22.4	1.40	9.1
16	Myanmar	16.8	10.10	4.5
17	Samoa	13.9	0.03	1.4
18	Kyrgyz Republic	13.2	0.70	2.3
19	Solomon Islands	12.0	0.06	0.1
20	Thailand	10.7	7.20	2.6

b) Asian Developing Countries at Relatively High Economic Risk from Multiple Hazards

Ranking	Countries	Percent of GDP in Areas at Risk	Percent of Population in Areas at Risk	Estimated Number of People at Risk (million)	Percent of Total Area at Risk
1	Viet Nam	89.4	75.7	66.5	33.2
2	Bangladesh	86.5	83.6	119.5	71.4
3	Philippines	85.2	81.3	76.6	50.3
4	Thailand	81.2	70.1	47.4	47.8
5	Uzbekistan	65.5	65.6	18.2	9.3
6	Indonesia	62.3	67.4	162.8	11.5
7	PRC	56.6	49.8	671.0	13.1
8	Kyrgyz Republic	53.4	51.3	2.8	8.3
9	India	49.6	47.7	571.4	22.1
10	Azerbaijan	42.4	42.3	3.9	15.6
11	Pakistan	41.6	40.1	71.0	9.0
12	Georgia	41.0	40.5	1.8	4.4
13	Tajikistan	38.3	38.2	2.9	4.1
14	Cambodia	34.5	31.3	4.5	9.1

ADB = Asian Development Bank, PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic.

Note: The estimated number of people at risk is based on the 2011 midyear population (except for the PRC which is as of year-end), as reflected in ADB *Key Indicators, 2012,* multiplied by the percent of the population at risk.
Source: Maxx Dilley, Uwe Deichmann, Robert S. Chen, and Arthur L. Lerner-Lam, and Margaret Arnold. 2005. Natural Disaster Hotspots. Washington, DC: World Bank. 2005. Natural Disaster Hotspots: A Global Risk Analysis. Washington, DC: World Bank.

has 671 million people in areas considered at risk and produces 57% of its GDP in areas at risk; the corresponding figures in India are 571 million and 50%.

The People's Republic of China has 671 million people in areas considered at risk and produces 57% of its gross domestic product in areas at risk

Different metrics may produce other results, some confirming and others contradicting results in the hotspots analysis. The United Nations International Strategy for Disaster Reduction risk profile per country for tropical cyclones, floods, and landslides, as well as earthquakes, tsunamis, and droughts, analyzed the mortality and economic loss risk of each economy.[4] By this analysis, economies in Asia and the Pacific make up only the top 3 at risk of earthquake—Vanuatu, Solomon Islands, and Taipei,China—yet the top 10 economies at risk of flood, with Cambodia, Viet Nam, and Bangladesh in the top 3.

Special Assessment

The 2012 Independent Evaluation study, in Vulnerability and Risk Assessment of Natural Disasters in Asia,[5] also investigated the historical accounts of disasters for 27 developing member countries using databases from EM-DAT and the United States Agency for International Development (discussed in Chapter 2). It looked at the damages and the people affected and killed, and synthesized the data to determine the probability of occurrence for various types of natural disaster, the cost of damages to the economy, and the number of killed and vulnerable people for each category of risk. An estimate of the cost for disaster risk reduction measures was proposed for each country.

Quantitatively assessing the threats allows better planning for mitigating the risks to socially acceptable levels, and helps convince governments to invest in short- and long-term mitigating measures.

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[4] United Nations International Strategy for Disaster Reduction (UNISDR). 2009. *Global Assessment Report on Disaster Risk Reduction.* Geneva: UNISDR.

[5] For a complete analysis, please see Supplementary Appendix B, Vulnerability and Risk Assessment of Natural Disasters in Asia in IED. 2012. *ADB's Response to Natural Disasters and Disaster Risks*. Manila: ADB.

While the number of natural disasters is increasing at a phenomenal rate—up 600% in the last 60 years—as noted earlier, the analysis also shows that in Asia the number of people killed appears to be declining in some cases, such as in Bangladesh. This may be because the forecasting of floods and storms has improved considerably, allowing evacuations to safe havens before floods or storms hit. Dramatic improvement in rescue from flooded areas, and much better public health measures may have also helped lower deaths.

That said, while countries such as the People's Republic of China and the Republic of Korea, through clear public-health policies, have reduced deaths, vulnerability in less developed countries remains high, with many people living subsistence livelihoods offering little leeway for effective disaster response.

Responding to a Rising Trend

According to United Nations estimates, every dollar spent on disaster prevention can save at least $4 on disaster recovery expenses later. Governments and communities in Asia and the Pacific therefore need to recognize the increasingly endemic nature of natural disasters in the region, and how they can derail economic growth and development, and to act on it.

Experts in the field support a systematic approach to natural disasters that is focused on risk and vulnerability and employs the concept of disaster risk management. ADB supports this approach. Under what is termed a "disaster risk cycle," it calls for concerted action within an integrated disaster risk management framework that combines disaster risk reduction, disaster preparedness, post-disaster relief, early recovery, reconstruction, and disaster risk financing goals under an integrated framework or one policy umbrella.

In recent years, the approach to disaster risk management has also evolved to deal with climate change. As global temperatures rise, exposure increases, and vulnerability remains high for significant parts of Asia's population.

Investment in increasing resilience to natural disasters will be far-reaching if it is integrated into development policies, strategies, plans, and assistance programs. Although certain recurrent disasters are foreseeable for many countries, they are not always considered in country strategies and lending programs (Appendix 1).

The development community, including ADB, needs to put greater emphasis on disaster resilience in their interactions with clients, if not in their actual lending to client countries.

Vulnerable Populations Need Special Attention

Disaster risk reduction calls for special attention to social vulnerability. For example, the United Nations Children's Fund and the United Nations International Strategy for Disaster Reduction note that death rates for women due to natural disasters are substantially higher than those for men. Women accounted for 61% of the victims of Cyclone Nargis in Myanmar (2008), 67% of the Indian Ocean tsunami in Banda Aceh (2004), and 91% of Cyclone Gorky in Bangladesh (1991).

Furthermore, there is nothing "natural" about the social, political, and economic effects of cyclones, earthquakes, volcanic eruptions, or floods. Harm depends on exposure to these hazards (such as living in an active earthquake zone) and social vulnerability (the poor are often compelled to live in hazardous areas). In addition, vulnerability depends on social class, age, physical ability, gender, and ethnicity.

Chapter 2

Learning from Experience: Case Studies from Bangladesh, Indonesia, and Pakistan

The Asian Development Bank (ADB) has provided significant funding for natural disaster management to Bangladesh, the People's Republic of China, India, Indonesia, Pakistan, and the Philippines. The Independent Evaluation Department's study conducted case studies of three countries, looking closely at the water sector in Bangladesh, the urban and social sector in Indonesia, and the transport sector in Pakistan.

Bangladesh—Doing More with Less

As a country at the confluence of three major rivers forming the world's largest delta, Bangladesh is unique in many ways. About 80% of land area is on the floodplain formed by the Padma, Brahmaputra, and Meghna rivers, home to most of the country's 161 million people and one of the globe's most densely populated regions. Here, the monsoon rolling in off the Indian Ocean drops 80% of its annual rainfall in just 3 or 4 months. Rivers frequently flood and major cyclones make landfall with devastating consequences.

Indeed, the hotspots analysis of disaster risk conducted by the World Bank Columbia University, discussed earlier, shows that almost the entire population of Bangladesh lives in areas of high mortality risk.

Bangladesh's Response to Disaster Risk

Bangladesh, as a poor, developing country, also stands out for the impressive scale of its achievement in dealing with the disasters inherent to its geography

Bangladesh, as a poor, developing country, also stands out for the impressive scale of its achievement in dealing with the disasters inherent to its geography.

After Cyclone Bhola claimed more than 300,000 lives in November 1970, the country focused on overcoming its challenging environment, despite limited finances.

In 1972, the Bangladesh Red Crescent Society started the Cyclone Preparedness Programme, managing it jointly with the Ministry of Disaster Management and Relief. The program's volunteer force of nearly 33,000 men and women disseminates cyclone information through village focal points, and carries out rescue operations in coastal regions. The government also prioritized capacity improvements among concerned government organizations to develop early warning systems, with the support of a number of aid agencies.

Bangladesh has identified a host of activities for adaptation to floods and cyclones (both policies and capital investments). The country has invested more than $10 billion over 30 years to become more climate-resilient and less vulnerable.

Bangladesh follows a three-part model to guide disaster risk and emergency response management efforts within the government. Two components are involved in risk reduction, and one in responding to natural hazards. Risk reduction includes assessing the natural hazard risk environment (on variables such as climate change, community preparedness, and so on) and managing the risk environment (achieving a balance in risk reduction options for various risks).

Responding to threats from natural hazards includes activating emergency measures, mobilizing resources, using vulnerability and risk databases to determine potential impact scenarios, and managing effective communication

at all levels. The data gathered after assessing threats feed into the risk reduction activities by both redefining and managing risks.

The government has introduced the reforms necessary to support and implement structural and nonstructural measures in infrastructure projects. It created the Disaster Management Bureau in 1992, and formulated the National Plan for Disaster Management 2010–2015 to provide a strategic framework for disaster management with the broad national objective of disaster risk reduction and emergency preparedness. The government has also explicitly acknowledged the links between disaster management and poverty.

The disaster management plan guides the relevant sectors and disaster committees at all levels to prepare and implement their specific plans. There are now disaster management plans at all levels of government and in all sectors.

However, not all agencies and communities have the necessary knowledge, skills, and resources to implement the plan. In general, these agencies have limited resources and capacity, which affects their effectiveness. Similarly, grassroots and local institutions also need to be strengthened in disaster preparedness and response. It is in these and other areas where the development organizations, including ADB, can be useful.

Development Community Response

In the development community, the United Nations-chaired Donor Working Group on Disaster and Emergency Response helps align the Bangladeshi aid program with government disaster management strategy. Its two-pronged approach features disaster response on one side and better disaster protection and management on the other.

The World Bank provides major support for integrated investments under this approach that respond to both recovery and prevention. It has also mainstreamed disaster risk reduction components into its traditional projects through a review process led by the Global Facility for Disaster Reduction and Recovery.

The United Nations, the World Bank, and major donors established the facility in 2005 as a partnership to mainstream disaster risk reduction and

climate change adaptation in country development strategies. It does this by supporting country-led implementation of the Hyogo Framework for Action.

The framework, with 168 government and international organizations as signatories, was established in 2005 to reduce disaster losses by 2015. Hyogo aims to see disaster risk reduction integrated into development policies and planning and to have it incorporated into emergency preparedness, response, and recovery programs, and to strengthen the institutional capacities for building resilience to hazards. The framework provides the intellectual foundations for national disaster risk reduction systems.

The World Bank, which manages the facility, has mainstreamed disaster risk reduction components into its traditional projects through a review process led by the facility. It provides advice on the inclusion of risk reduction components into projects, funds damage assessments after major disasters, and supports post-disaster project formulation.

ADB's Role

There is considerable room for ADB to increase its support for disaster prevention programs

There is considerable room for ADB, by contrast, to increase its support for disaster prevention programs—and it has demonstrated some innovative efforts that could point the way (Table 3). Given the frequency of natural disasters in Bangladesh, it is surprising that ADB has not done more in disaster prevention (see Appendix 2 for a chronology of disasters in the country since the 1990s and ADB's support).

To be sure, ADB is making progress toward greater support for disaster prevention. One project addressing riverbank erosion in Bangladesh—the Jamuna–Meghna River Erosion Mitigation Project—shows that ADB can be innovative in disaster prevention work. The project comprised riverbank protection works, disaster preparedness, management training, and support for riverbank erosion data management and analysis. It covered the districts of Pabna and Chandpur, two areas affected by a 1998 flood.

Table 3: ADB Disaster-Related Investment in Bangladesh

Period	Disaster Recovery		Disaster Prevention		Total	
	Number of Projects	Volume ($ million)	Number of Projects	Volume ($ million)	Number of Projects	Volume ($ million)
1995–1999	1	104.0	–	–	1	104.0
2000–2004	1	54.8	4	216.2	5	271.0
2005–2009	6	361.7	2	22.0	8	383.7
2010–2011	–	–	2	115.0	2	115.0

– = not available.

Source: Independent Evaluation Department database on ADB's natural disaster-related support.

About 10,000 hectares of land in Bangladesh are eroded by rivers annually and around 100,000 people displaced, many of them becoming urban squatters.

A particularly noteworthy component of the Jamuna–Meghna project is its use of cheaper geo-textile revetments instead of concrete for rebuilding embankments, which are 30%–50% of the cost.[6] The project used these savings to extend its reach and exceed its target area. The project also contributed to the government's planning and early warning system, and protected previous ADB investments in irrigation and agriculture.

Other noteworthy projects include a 2004 integrated water resources management project with associated infrastructure for flood protection in southwestern Bangladesh. Recovery support for the 2004 flood (the Emergency Flood Damage Rehabilitation Project) also included the Early Warning Systems Study, which identified 22 possible interventions for the existing flood forecasting system.

Since 2008, an increasing number of ADB technical assistance activities have been related to climate change. Some have been implemented in parallel with related projects such that climate change adaptation measures generated under the technical assistance are then integrated with loan project design. For example, adaptation options in the project Strengthening the Resilience of the Water Sector in Khulna to Climate Change Adaptation were integrated into two projects.

ADB's forward programs, meanwhile, focus more on risk reduction than in the past. Financing facilities are being proposed for riverbank erosion and flood protection of secondary cities, while the climate change technical

[6] A revetment is a sloping structure placed on river banks to absorb incoming water.

assistance projects—Strengthening the Resilience of the Water Sector in Khulna to Climate Change, Supporting Implementation of the Bangladesh Climate Change Strategy and Action Plan (Subproject 1), and Climate Change Capacity Building and Knowledge Management—are clearly developing components for things such as risk-proofing roads and shelters.

However, ADB could have done more in disaster prevention. Four of six projects during 1999–2011 for disaster risk management were for emergency support after cyclones and floods in 2000, 2004, and 2007.

There is also room for ADB to participate more fully in efforts already under way in Bangladesh, such as the Donor Working Group on Disaster and Emergency Response chaired by the United Nations Resident Coordinator. That ADB is not a member of this aid working group seems a surprising omission given the size of ADB's program.

ADB also does not have dedicated focal points in the Bangladesh resident mission in Dhaka or officers with special skills in disaster risk management.

Climate Change and Other Challenges

Despite Bangladesh's successes, the magnitude of the problems it faces remains large and threatens to grow as climate change increases vulnerability. The government needs to improve its capacity further for integrating disaster and risk reduction into its institutional culture and practices, including across all ministries.

Despite Bangladesh's successes, the magnitude of its problems remains large and threatens to grow as climate change increases vulnerability

Work is also required to strengthen and accelerate the decentralization process and awareness raising. In addition, the country needs to improve flood and vulnerability forecasting and disaster early warning systems, identify alternative financing sources, accelerate social investment, and undertake innovative sustainable social protection schemes that reduce vulnerability.

Within this context, and as the government's and ADB's focus has shifted from recovery to prevention, ADB will need to consider working differently. ADB could help Bangladesh strengthen its capacity and mainstream disaster risk management across various line ministries and improve and upgrade standards for infrastructure development.

ADB also needs to continue investing in the protection of high-value areas such as the Secondary Cities Flood Protection Project (which has two phases), further link these investments to vulnerability, and explore with the government longer-term financing options to ensure sustainability. The two-phase project's design was based on the government's Flood Action Plan, which was formulated after devastating floods in 1987 and 1988. Under the plan, Dhaka and 15 district towns were identified for urban flood protection.

Indonesia: Recovering from Tragedy

The Indonesian archipelago of about 18,000 islands endures almost every kind of natural hazard, making it one of the world's most vulnerable countries. This poses an immense challenge to efforts to improve human development and promote inclusive economic growth in the country.

Among countries hit by the earthquake and tsunami off the coast of northwest Sumatra on 26 December 2004, it suffered the most casualties. Of the estimated 230,000 lives lost in the catastrophe, more than 160,000 were in Indonesia.[7] Infrastructure was largely wiped out in the worst-hit coastal communities, and the disaster rendered 20% of the population of Aceh Province homeless and damaged 20% of the land area of Nias Island. Just 3 months later, another powerful undersea earthquake off Sumatra caused 850 deaths and nearly 6,000 injuries on Nias.

Yet, in its handling of this tragedy, Indonesia has also presented the development community and other governments a strong example of how to respond to natural disaster, particularly the effectiveness of decentralization and a system for locally based decision making.

[7] Various sources put death tolls in the next most affected countries at more than 35,000 in Sri Lanka, more than 18,000 in India, and more than 8,000 in Thailand.

In Indonesia, this meant establishing authority not in the capital, Jakarta, but in the province of Banda Aceh, which suffered the worst of the disaster. While typically a highly centralized country, the government established the Agency for Rehabilitation and Reconstruction of Aceh and Nias (locally known as Badan Nasional Penanggulangan Bencana). The agency effectively delegated power and organized the broad international development community response. This paved the way for a more permanent agency overseeing disaster risk management.

It was a monumental task, handled well. The international community provided $7.2 billion in total reconstruction support, comprising $5.2 billion in grants from the government and aid agencies, $1.6 billion from nongovernment organizations, and $0.4 billion from multilateral and bilateral agencies. ADB provided a grant of $291.0 million to the Earthquake and Tsunami Emergency Support Project, $10.0 million to the Multi-Donor Fund, complementary grants of $28.0 million, and reprogrammed loans of up to $33.0 million. ADB financed construction of about 6,000 houses and 1,500 surrounding facilities.

In 2008, the government dissolved the agency and consolidated authority in the National Agency for Disaster Management, giving it responsibility for standardizing and implementing disaster management legislation, coordinating donations and international aid, and using state funds for disaster prevention, emergency response, and rehabilitation. For 2010–2014, it has provided a budget of $700 million for risk reduction.

The new agency is also receiving institutional and technical support from the United Nations Development Programme and the World Bank, as well as bilateral agencies such as the Australian Agency for International Development and the Japan International Cooperation Agency.

Challenges Continue

Indonesia has grappled with the effects of several other major natural disasters, including powerful earthquakes in 2005 and 2006, and large-scale flooding in Jakarta in 2007 and 2013.

And the country's vulnerability to floods is likely to increase with the prospect of more frequent hydrometeorological events, a global phenomenon in which Asia is already bearing the brunt. In addition, haze-cloaking large forest fires, often started by slash-and-burn farming, remain a perennial environmental threat to Indonesia and some if its neighbors.

Statistically, the most significant damage comes from earthquakes (48.2%), wildfires (38.8%), and floods (10%).[8]

Assessment of ADB's Support

After Pakistan and Bangladesh, Indonesia was the biggest recipient of loans and grants from ADB during 1995–2011 (Table 4) . Unlike in Bangladesh and Pakistan, ADB's disaster prevention investment in Indonesia has been significant since the early 1990s. Support programs since the mid-1990s have focused on addressing the country's perennial flooding, the drought caused by the El Niño phenomenon, forest fires, and, lately, climate change (see Appendix 2 for a chronology of disasters in the country since the 1990s and ADB's support).

The Independent Evaluation Department's assessment of ADB's country partnership strategies and business plans for Indonesia during 1995–2011 found they were sensitive to the country's exposure to natural disasters. The following are the main evaluative findings showing what progress has been made in ADB's support for Indonesia's efforts to improve disaster risk management—and areas that still need greater attention.

Table 4: ADB Disaster-Related Investment in Indonesia

Period	Disaster Recovery		Disaster Prevention		Total	
	Number of Projects	Volume ($ million)	Number of Projects	Volume ($ million)	Number of Projects	Volume ($ million)
1995–1999	–	–	3	193	3	193
2000–2004	–	–	1	50	1	50
2005–2009	8	316	3	67	11	382
2010–2011	–	–	1	4	1	4

– = not available.

Source: Independent Evaluation Department database on ADB's natural disaster-related support.

[8] Derived and computed from the EM-DAT database 2012.

Flood control and management. ADB's support for flood risk has shifted from a focus on flood control in the 1990s to a more comprehensive approach to flood management within a river basin framework. Interventions have included both structural measures, such as improving the discharge carrying capacity of rivers, and nonstructural ones, such as flood warning systems, hazard mapping, and restricting settlement in flood-prone areas.

One project that was able to significantly reduce the human and economic impacts of flooding was the $116-million South Java Flood Control Sector Project, completed in 2006. Flooding is a major problem in South Java and regarded by the local populations as a severe handicap to their livelihoods, health, and general well-being. The project directly benefited nearly 300,000 residents and addressed disaster prevention and preparedness through, among other things, the protection and raising of riverbanks and widening roads.

Early warning systems. Improving Indonesia's flood forecasting and early warning systems was an important area of ADB's disaster risk management support. Interventions included support for telemetry to transmit information about river levels and more reliable satellite-based systems to increase the lead time in flood warnings. For example, ADB technical assistance operations supported investments in water-related disaster management. Water levels were recorded in rainfall stations, and the information was transferred to a base station using a dedicated radio frequency, allowing the generation of flood warnings more than a half day in advance, allowing evacuation.

Climate change mitigation and adaptation. ADB's country partnership strategy for 2012–2014 supports Indonesia's development objective of environmental sustainability, and includes climate change mitigation and adaptation activities. The strategy supports the implementation of Indonesia's climate change road map, which recognizes the country's greenhouse gas mitigation efforts (Indonesia being one of the world's top 10 greenhouse-gas emitting countries).[9]

ADB's country partnership strategy also recognizes Indonesia's vulnerability to climate-related risks. The strategy pursues adaptation alongside mitigation.

[9] Republic of Indonesia. 2009. *Indonesia Climate Change Sectoral Roadmap*. Jakarta.

Indonesia's climate change mitigation agenda is more advanced than some other developing countries in the region, as is evident from the progress in implementing mitigation projects financed by the Climate Investment Funds, a multidonor trust fund, the Forest Investment Program, and other bilateral and multilateral development partners. Climate change adaptation is at an early stage of mainstreaming into the country's development agenda and budgets are provide both the national and local levels.

Geological hazards. Despite high vulnerability to geological hazards, these are not specifically addressed in the country's development planning, and ADB's country partnership strategy does not prioritize disaster preparedness or mitigation for geological hazards. However, ADB provided housing reconstruction support using seismic-resistant designs in its response to the tsunami in 2004. Indonesia's tsunami early warning system was also effective during the April 2012 undersea earthquakes off the west coast of northern Sumatra. But such measures are not sufficient to ward off major risks from future geophysical events. More priority needs to be given to building codes, land-use plans, and retrofitting essential infrastructure, especially in earthquake-prone areas.

Disaster coordination. The National Agency for Disaster Management, which is under the Office of the President, is responsible for standardizing and implementing disaster management legislation, coordinating international aid, and using state revenue for disaster prevention, emergency response, and rehabilitation. The agency receives institutional and technical support from the United Nations Development Programme and World Bank, and bilateral sources, such as from the Australian Agency for International Development and the Japan International Cooperation Agency. Bilateral agencies also send scientists and engineers to support and improve technical capacity. The evaluation study found problems arising from a lack of coordination and miscommunication due to overlapping mandates across agencies.

Disaster risk insurance. ADB works closely with Indonesia, the Philippines, and Viet Nam in developing disaster risk insurance products for rural and urban areas. In Indonesia, a technical assistance project approved in 2011, Developing a Disaster Risk Financing Capability, aims to establish an integrated disaster risk management framework building on disaster risk financing, disaster risk reduction, and climate change adaptation. Projects supporting

these areas aim to advance the use of finance instruments, link the financing to investments in risk reduction, and promote climate change adaptation.

Tsunami Recovery Support

ADB led its support for Indonesia's reconstruction and recovery from the Indian Ocean tsunami with a grant of $291 million to the Earthquake and Tsunami Emergency Support Project, approved in April 2005.[10] This was one of ADB's largest ever grant-funding allocations for disaster recovery support, and one of the largest tsunami-support contributions from a multilateral source for Indonesia.

The project covered 12 sectors across 5 components, and aimed to revive the economies of Aceh and North Sumatra by restoring fisheries and agriculture production by mid-2008.[11] A notable feature of the Earthquake and Tsunami Emergency Support Project was that housing was the largest component, accounting for $75 million of the project cost (complemented by livelihood restoration for micro and small enterprises). This was noteworthy because ADB does not usually provide a housing component in funding for disaster support, while livelihood components are typically very small. By helping restore essential public services and rebuilding social and physical infrastructure, the Earthquake and Tsunami Emergency Support Project had major direct and indirect impact on economic revival and livelihood restoration.

ADB's post-tsunami efforts in Indonesia centered on rebuilding vital infrastructure and livelihood restoration

ADB's post-tsunami efforts in Indonesia centered on rebuilding vital infrastructure and livelihood restoration. In the project completion report for the Earthquake and Tsunami Emergency Support Project, ADB self-evaluated its support programs as successful overall. After a field

[10] ADB support for the government's reconstruction and recovery program also included a $10 million contribution to the Multi-Donor Fund, complementary grants of $28 million, and reprogrammed loans of up to $33 million.

[11] The five components included (i) livelihood support in agriculture, fisheries, and micro and small enterprises; (ii) social services covering health and education; (iii) community infrastructure, covering rural water supply and sanitation, housing, and irrigation; (iv) physical infrastructure, including roads, bridges, and power; and (v) fiduciary oversight.

visit to Aceh in June 2012, Independent Evaluation generally agreed with this assessment, although its evaluation study points out that ADB needs to fully account for the complexity of such disaster operations. Its country case study for Indonesia focuses on ADB's response and support in the provinces of Aceh and Nias, and takes a special interest in ADB's work in housing restoration.

Housing

The Earthquake and Tsunami Emergency Support Project financed the construction of about 6,000 housing units and 1,500 surrounding facilities. The government's Agency for the Rehabilitation and Reconstruction of Aceh and Nias set a minimum area requirement of 36 square meters per unit and minimum facility requirements. Independent Evaluation found that all agencies engaged in housing reconstruction, including nongovernment organizations, complied with the minimum requirements, although each agency adopted slightly different levels of quality and finish, a reflection of available budgets.

The Tsunami & Disaster Mitigation Research Center, Banda Aceh.

ADB's housing was of better quality than units directly procured by the Agency for the Rehabilitation and Reconstruction of Aceh-Nias, but the housing built by some other development agencies was of better quality. In general, ADB houses were well built and, importantly, suffered no serious damage when an earthquake struck near Aceh Province in April 2012. ADB's housing units were connected to the water supply network, and had water meters, septic tanks, and a regular supply of electricity.

The following photographs show ADB housing units at the Miurek Lam Reudeup Sub Village. With these and other units in Kampong Pandeh Village, ADB built 153 units in the two villages. Here, the United Nations Human

Settlements Programme provided a sewage sludge treatment facility, which converted sludge into fertilizer.

The Miurek Lam Reudeup housing village, which was generally built by the Asian Development Bank, used standard construction materials.

ADB's housing operations in Aceh demonstrated that recovery operations can become entangled in sensitive social issues. Only tsunami victims were eligible for support for housing reconstruction, but it was sometimes difficult to separate disaster victims from other vulnerable groups demanding similar types of support to improve their lives. Housing sites closer to the provincial capital, Banda Aceh, were inhabited mostly by former house owners. But the situation was more complex at the more distant Labuy housing site, which had a larger proportion of residents who were migrants from other areas. These residents had arrived after the tsunami, a result of a long-standing conflict in Aceh.

Livelihoods

For Indonesia, as well as the Maldives and Sri Lanka, more than a fifth of total tsunami recovery support was allocated to livelihood restoration. ADB rated this aspect of its tsunami assistance as highly effective in its project completion report. However, its livelihood program was criticized in some quarters for falling short of serving all beneficiary communities.

Livelihood restoration focused on fisheries, a major part of the local economy in affected coastal communities, with assistance reaching 23,700 fisherfolk, aquaculture farmers, and fish traders and sellers by providing tools, equipment, and basic infrastructure.

Livelihood interventions included cash assistance for microenterprises. A fund of nearly $1 million provided one-time grants through a nongovernment organization for 6,000 tsunami-affected businesses (and indirectly benefited 35,000 household members). A microfinance innovation fund of $8.5 million was set up to provide market-based financing for eight rural credit banks and two commercial banks to expand grants to micro, small, and medium-sized enterprises. This support also became a platform to strengthen the capacity of financial institutions to provide microfinance loans.

Some livelihood interventions also encountered problems in the eligibility of beneficiaries. The Independent Evaluation Department's review of ADB's support for livelihood restoration in four small-scale projects led by the Japan Fund for Poverty Reduction during a field visit showed that, in one project—an organic fertilizer enterprise—neither the proprietor nor the employees were in fact tsunami victims.

Agriculture

ADB's tsunami support also included an agriculture component to restore production in affected areas in Aceh and Nias. Some 3,400 hectares of slight to moderately damaged farmland were cleared, inputs were provided, and farming restored. Drainage improvements and equipment such as hand tools, tractors, threshers, and water pumps for 18,500 hectares were provided. By the end of 2007, agricultural production had recovered to pre-tsunami levels—and has since surpassed them and is still rising.

Pakistan: Challenging Terrain

Pakistan's diverse terrain, ranging from mountains in the north to floodplains and deserts in the south, make it vulnerable to a variety of natural hazards, which complicates its response to disaster risk management.

The Hindu Kush and Himalaya mountains expose the northern region to winter storms, avalanches, and floods. Droughts and floods, meanwhile, threaten the floodplains of the Indus River in the southeast, and earthquakes almost all of the country. Indeed, Pakistan has been hit by three earthquakes exceeding magnitude 7.5 in the past 75 years, causing more than 120,000 deaths.

Given these hazards, Pakistan has shown insufficient political commitment to disaster risk management, and its focus on disaster response rather than prevention has added to the difficulties. But the government has made progress in better coordinating its disaster response after a devastating earthquake in 2005 by establishing a long-overdue and comprehensive national disaster management system led by the defense forces. Greater commitment from government, funding, human resources, and coordination are now needed if the system is to function effectively. It is in these areas where the development community can be helpful.

According to the Disasters Emergency Committee, an umbrella group of charities in the United Kingdom: "While the government has instituted a comprehensive disaster risk reduction governance system in Pakistan on paper, in reality the system suffers from a lack of political commitment, funding, skilled human resources, and coordination and suffers from fragmentation and overlapping and unclear mandates among government agencies ...The system is especially weak at the local district levels where the bulk of implementation occurs."[12] The national disaster risk reduction system, the committee notes, also focuses mainly on response and ignores other, more sustainable approaches, such as prevention and mitigation, that address the root causes of disaster risk.

Hazard Profile

The October 2005 earthquake in northeastern Pakistan was the most debilitating natural disaster in the country's recent history. About 73,000 people died, more than 70,000 were severely injured, and more than 2.8 million were left without shelter. Affected areas included densely populated, low-lying regions as well as mountainous regions with small, dispersed rural settlements. Overall damage was estimated at about $5.2 billion, including relief expenses, livelihood support for victims, and reconstruction costs.

Before 2005, droughts were a more significant hazard than earthquakes or floods, but both took a renewed, devastating toll in the latter half of the last decade. The country was still reeling from the impacts of the 1998–2002

[12] Disasters Emergency Committee. 2012. *Disaster Risk Reduction in Pakistan: The Contribution of DEC Member Agencies, 2010–2012*. London.

drought when the 2005 quake struck, while devastating floods in 2010 and 2011 affected millions.

The October 2005 earthquake in northeastern Pakistan was the most debilitating natural disaster in the country's recent history

The 2010 flood crisis began in July following heavy monsoon rains in Khyber Pakhtunkhwa, Sindh, Punjab, and Balochistan provinces. The United Nations estimates that almost 2,000 people were killed, over 1.7 million homes destroyed, and almost 18 million people seriously affected. The floods impacted more people than the 2004 Indian Ocean tsunami, the 2005 Pakistan earthquake, and the 2010 Haiti earthquake combined.

The floods submerged 17 million acres of Pakistan's most fertile cropland and killed 200,000 livestock, according to the Disasters Emergency Committee. At the worst point, about 20% of the country's total area was underwater, while disease complicated matters after the floods receded. Extensive damage to crops and physical infrastructure contributed to economic impact estimated around $10 billion.

Pakistan's Response to Disasters

Natural disaster management in Pakistan, mostly led by the army, had focused on rescue and relief until the 1960s, when major disasters other than droughts were rare. After the floods in the 1970s and 1990s and the 2005 earthquake, as noted, Pakistan finally instituted a comprehensive disaster management system, comprising the National Disaster Management Commission.

Two weeks after the 2005 earthquake, the government set up the Earthquake Reconstruction and Rehabilitation Authority, which provided speedy processing and preparation of ADB projects. But implementation was slow and substantially hindered by unstable mountain slopes, difficult accessibility and logistics in the project areas, and weak government capacity for implementing a major reconstruction investment program within a short time frame. The limited capacity of local governments to properly operate and maintain new facilities was also an obstacle.

Pakistan's National Highway N70, south of the city of Multan, after the floods of 2010.

In 2007, the government formulated a Natural Disaster Risk Management Framework to guide the work of the entire system in the area of disaster risk management. In 2010, it mandated the National Disaster Management Authority to act as the implementing, coordinating, and monitoring arm of the National Disaster Management Commission and to provide technical guidance to provincial and district authorities for project and program implementation.

Nonetheless, the system's effective operation still needs stronger political commitment, sufficient funding, skilled human resources, better coordination, and clear delineation of mandates among government agencies. The system is weak, especially at the district level.

According to the Disasters Emergency Committee, the ongoing lack of disaster risk reduction work in the country contributed to the massive damage of the 2010 floods.

Preparedness for floods, nonetheless, is better than for other natural hazards. Presently, only the army has adequate capacity for effective relocation, rescue, and immediate response. While most vulnerable districts have developed contingency plans, these need to be prepared bottom–up and backed with adequate resources and capacity. The study concluded that while Pakistan has set up the disaster risk reduction governance system, it needs greater funding,

political support, and coordination to work more effectively. Most of the focus is on avoidance and response, the least sustainable form of disaster risk reduction, and even those activities are not highly efficient or effective. More durable forms, such as mitigation and preparedness, need more attention, but development projects often result in undermining prevention activities.

ADB's Role in Disaster Response

ADB has been working with the disaster management authority in disaster response efforts. In 2010, it coordinated with the authority in the damage and needs assessment during major floods, and helped get blankets, tents, and emergency rescue equipment to people in flooded areas and for stockpiling for future disasters (see Appendix 2 for a chronology of disasters in the country since the 1990s and ADB's support).

ADB's natural disaster-related lending in Pakistan from 1995 to 2011 focused on disaster recovery. Loans and grants for 10 projects amounting to $1.56 billion went to such operations, while a much smaller $663 million supported disaster prevention activities in 9 projects (Table 5).

After the 2005 earthquake, ADB provided Pakistan the following emergency loans and grants, primarily through the Earthquake Emergency Assistance Project from the Asian Development Fund, providing $220.0 million, in addition to $12.5 million from loan savings from the Second Science Education Sector Project.

It also provided $110.0 million through the Earthquake Emergency Assistance: Pakistan Earthquake Fund, $37.5 million through the Earthquake Emergency

Table 5: ADB Disaster-Related Investment in Pakistan

Period	Disaster Recovery		Disaster Prevention		Total	
	Number of Projects	Volume ($ million)	Number of Projects	Volume ($ million)	Number of Projects	Volume ($ million)
1995–1999	–	–	2	240	2	240
2000–2004	1	100	2	93	3	193
2005–2009	5	800	5	330	10	1,130
2010–2011	4	656	–	–	4	656

– = not available or not applicable.

Source: Independent Evaluation Department database on ADB's natural disaster-related support.

Assistance, and $2.0 million in technical assistance for capacity building in the Office of the Auditor General of Pakistan.

The Earthquake Emergency Assistance Project aimed to restore infrastructure damaged or destroyed in northeastern Pakistan, addressing urgently required facilities in the transport, power, and health and education sectors. ADB approved it in 2005, aiming for prompt completion by the end of 2008.

The transport component targeted rehabilitating earthquake-damaged major roads and bridges (except national highways) within all nine affected districts in northeastern Pakistan. It focused on repairing and rehabilitating damaged major roads and bridges under the Public Works Department and Local Government and Rural Development Department, plus the National Highway Authority and district governments.

A field visit by officers of the independent evaluation in May 2012 found that of 860 kilometers (km) of roads included in the program, about 800 km had been completed by June 2011. Civil works completed totaled PRs511 million against a total project cost of PRs800 million. Three sections remained incomplete.

Under the Punjab Irrigated Agriculture Investment Program, part of a multitranche financing facility, ADB is building a canal and barrage about 2 hours from Lahore that will not only improve water supply for farmers, but also provide more controlled release of water during floods (on this and the previous page).

Motorists cross a flooded road in Marikina in metropolitan Manila in September 2009, a day after tropical storm Ketsana lashed the Philippine capital and surrounding areas. AFP Photo / Ted Aljibe.

Chapter 3

Assessing Disaster Risk: A Tool for Policy Makers and Development Partners

The People's Republic of China (PRC) suffers more damage from natural disasters than any other country in the world, and is especially vulnerable to floods, earthquakes, and violent storms. Disasters such as the 1998 severe flooding of the Yangtze River or the 2008 Sichuan earthquake took a particularly large toll.

Natural disasters also afflict far less densely populated regions, such as the small island countries of the Pacific. When disasters strike in these areas, they may not make world headlines, but, proportionately, the impact may be even greater.

The types and effects of disaster vary from country to country, warranting a closer analysis. This section therefore groups the most prevalent disaster types among selected developing countries in Asia and the Pacific. As a quantitative risk assessment of countries' exposure to natural disasters, it provides valuable inputs into disaster mitigation plans and may help convince decision makers to invest in disaster preparedness measures.

Independent Evaluation analyzed the historical accounts of natural disasters of 27 of its developing member countries—stretching from the Central Asian republics to the Pacific islands—from the databases of the Centre for Research on the Epidemiology of Disasters (Emergency Events Database [EM-DAT]) and the United States Agency for International Development.

Data analyzing nine types of natural hazards were synthesized to determine the probability of various types of natural disasters occurring in a particular country, the cost to the economy, and the number of people killed or vulnerable to each type of disaster risk.[13]

An estimate of the cost for disaster risk reduction measures is given for each country. These risk vulnerability profiles are useful for designing multisector investment plans to reduce disaster risks to acceptable and affordable levels.[14]

Results of the Disaster Risk Assessment

Eight countries account for 90% of the damage in the countries reviewed: the People's Republic of China, India, Indonesia, the Maldives, Myanmar, Pakistan, Sri Lanka, and Thailand

Table 6 shows the damage value for different probabilities of disaster occurrence, ranging from 0.01% to 50%. For a 5% probability event, the total damage for 26 of the ADB developing member countries (excluding Timor-Leste) is $26.9 billion; for a very low probability event, the damage quadruples to $109.0 billion. Eight countries account for 90% of the damage in the countries reviewed: the People's Republic of China, India, Indonesia, the Maldives, Myanmar, Pakistan, Sri Lanka, and Thailand.

Table 7 shows the impact of natural disasters on economic growth at different probability levels. At their worst, natural disasters not only affect a country's

[13] The nine natural hazards are avalanches and landslides; drought; earthquakes and tsunamis; extreme temperature; floods and tidal surges; wildfire; wind storms, cyclones, typhoons; wave surges; and volcanic eruptions.

[14] The probability analysis is based on W. Weibull. 1939. A Statistical theory of the strength of materials. *Ing Vetensk Akad Handl*. 151: pages 1–45. For a complete description of the analysis methodology, please see Appendix 3 on page 63.

Table 6: Damage for Different Probabilities of Disaster Occurrence ($ million)

	Country	Probability %							
		50	20	10	5	1	0.50	0.10	0.01
1	PRC	0	388	4,679	16,250	43,994	49,827	55,046	56,293
2	Thailand	37	186	638	1,093	3,808	6,520	11,361	11,361
3	Indonesia	0	2	160	1,288	6,836	8,421	9,950	10,331
4	Pakistan	0	9	297	1,726	7,050	8,405	9,676	9,987
5	India	10	411	1,445	2,707	4,474	4,764	5,009	5,066
6	Myanmar	0	0	5	98	1,050	1,412	1,790	1,889
7	Sri Lanka	0	12	109	324	774	864	1,131	1,633
8	Bangladesh	0	2	56	280	1,012	1,188	1,351	1,391
9	Malaysia	0	12	122	388	982	1,103	1,210	1,236
10	Mongolia	0	0	5	151	1,210	1,210	1,210	1,210
11	Tajikistan	11	135	307	464	645	672	903	1,050
12	Fiji	0	226	413	559	711	806	901	906
13	Nepal	0	1	34	166	586	686	779	801
14	Viet Nam	37	226	413	559	711	733	751	755
15	Philippines	2	63	202	363	580	616	645	652
16	Cambodia	–	–	38	94	224	280	410	596
17	Lao PDR	0	0	10	63	272	326	378	390
18	Vanuatu	0	0	0	12	123	220	349	388
19	Kazakhstan	0	19	80	166	298	321	340	345
20	Maldives	3	6	12	25	49	98	295	305
21	Uzbekistan	0	0	8	50	211	253	292	302
22	Afghanistan	0	0	10	54	213	252	289	298
23	Azerbaijan	–	0	6	26	83	96	107	110
24	Papua New Guinea	0	0	1	9	53	66	79	83
25	Tonga	0	0	2	8	31	44	50	52
26	FSM	0	0	0	0	2	6	12	24
	Total	100	1,700	9,052	26,922	75,982	89,190	104,315	109,142

– = not available; FSM = Federated States of Micronesia, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

gross domestic product (GDP) in the year that they strike, but also in successive years. Economies generally rebound if there is a large infusion of capital through stimulus measures. One measure of an economy's robustness is how fast it rebounds after the shock of a natural disaster. For developing countries, inflows of external and aid capital are also decisive for the speed of recovery.

Many of the economies most vulnerable to natural disasters are the small island countries. In Fiji, the Maldives, Tonga, and Vanuatu GDP was affected by more than 10% and, in some cases, up to 50%, depending on the probability level for disaster occurrence. Recovery in these economies—which are also at risk from rising sea levels caused by climate change—can take years.

Table 7: Economic Damage as % of GDP by Probability of Disaster Occurrence

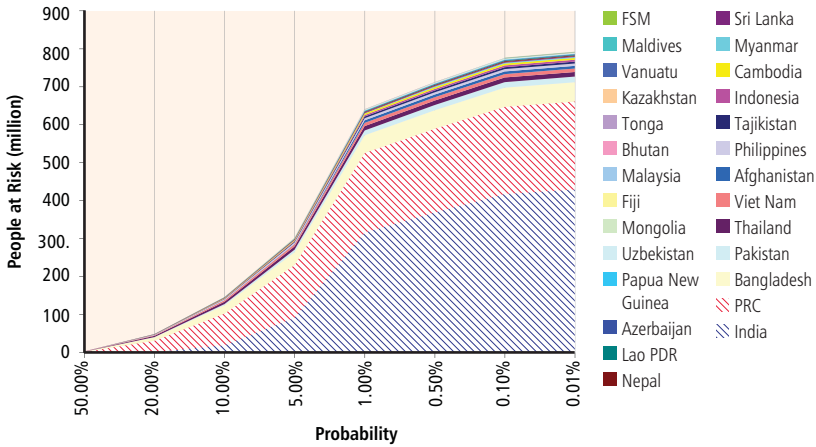
	Developing Asian Countries	GDP 2011 ($ billion)	Probability of Damage				
			5%	1.00%	0.50%	0.10%	0.01%
1	Afghanistan	16.70	0.33	1.27	1.51	1.73	1.79
2	Azerbaijan	56.25	0.05	0.15	0.17	0.19	0.20
3	Bangladesh	108.55	0.26	0.93	1.09	1.24	1.28
4	Cambodia	12.56	0.75	1.78	2.23	3.27	4.75
5	PRC	6,254.76	0.26	0.70	0.80	0.88	0.90
6	Fiji	3.16	17.70	22.53	25.54	28.54	28.70
7	India	1,587.83	0.17	0.28	0.30	0.32	0.32
8	Indonesia	767.75	0.17	0.89	1.10	1.30	1.35
9	Kazakhstan	148.51	0.11	0.20	0.22	0.23	0.23
10	Lao PDR	6.67	0.95	4.08	4.89	5.66	5.85
11	Malaysia	241.22	0.16	0.41	0.46	0.50	0.51
12	Maldives	1.98	1.24	2.48	4.96	14.89	100.59
13	FSM	0.30	0.16	0.66	1.98	3.96	7.91
14	Mongolia	7.55	2.00	5.96	9.94	11.93	16.03
15	Myanmar	48.03	0.20	2.19	2.94	3.73	3.93
16	Nepal	16.58	1.00	3.53	4.14	4.70	4.83
17	Pakistan	175.61	0.98	4.01	4.79	5.51	5.69
18	Papua New Guinea	10.22	0.08	0.51	0.65	0.78	0.81
19	Philippines	193.31	0.19	0.30	0.32	0.33	0.34
20	Sri Lanka	53.84	0.60	1.44	1.60	2.10	3.03
21	Tajikistan	5.76	8.05	11.19	11.66	15.67	18.22
22	Thailand	323.51	0.34	1.18	2.02	3.51	3.51
23	Tonga	0.35	2.38	8.89	12.58	14.35	14.78
24	Uzbekistan	38.72	0.13	0.55	0.65	0.75	0.78
25	Vanuatu	0.74	1.63	16.72	29.81	47.36	52.56
26	Viet Nam	103.65	0.54	0.69	0.71	0.72	0.73
	Total	10,184.09	0.26	0.74	0.87	1.02	1.06

FSM = Federated States of Micronesia, GDP = gross domestic product, IMF = International Monetary Fund, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Mongolia and Tajikistan also show very high degrees of vulnerability. Countries whose gross domestic products are affected by 3%–5% include Cambodia, Nepal, Pakistan, Sri Lanka, and Thailand. Providing this type of quantitative risk assessment is important for mobilizing funds for natural disaster recovery and prevention.

Figure 2 and Table 8 show the vulnerability of populations in several of the countries in the region most at risk from natural disasters, determined from data of the numbers of people affected. Asia's high population density leaves people vulnerable to natural disasters. About 791 million people in Asia, 22% of the region's population, are at risk from a one in 10,000 years natural disaster.

Figure 2: Population at Risk in Selected Asian Developing Countries



FSM = Federated States of Micronesia, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Of the total increase in the number of people affected by intense disasters from 1971–1980 to 2001–2010, 90% is in Asia and the Pacific. The region also accounted for over half of the 3 million lives lost to intense disasters during 1971–2010, as well as half of the increase in the global number of deaths from 1971–1980 to 2001–2010. In addition, the majority of the people who died during these two periods in Asia (95.8% and 91.5%, respectively) were in the low and lower-middle income countries.

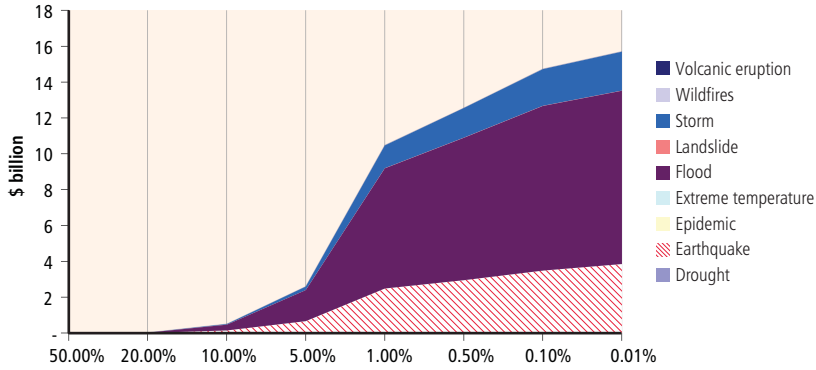
Table 8: Global Annual Average Number of People Affected by Intense Disasters (million)

Period	Geophysical	Meteorological	Hydrological	Climatological	Biological
By 10-year Period					
1971–1980	15.4	65.9	225.0	278.8	2.3
1981–1990	34.6	139.8	473.4	596.9	1.7
1991–2000	26.6	221.9	1,466.0	372.5	14.5
2001–2010	88.5	390.8	1,066.8	784.9	5.0
1971–2010	41.3	204.6	807.8	508.3	5.9

Note: People requiring immediate assistance (basic survival needs such as food, water, shelter, sanitation, and immediate medical assistance) during an emergency situation.
Sources: Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Bangladesh, Myanmar, Nepal, Pakistan, and Sri Lanka are most exposed to floods, which cause 61% of damages, followed by earthquakes (25%) and cyclones (14%). Figure 3 shows the damage probability profile by type of hazard in these countries.

Figure 3: Damage Risk in Bangladesh, Myanmar, Nepal, Pakistan, and Sri Lanka (by Disaster Type)

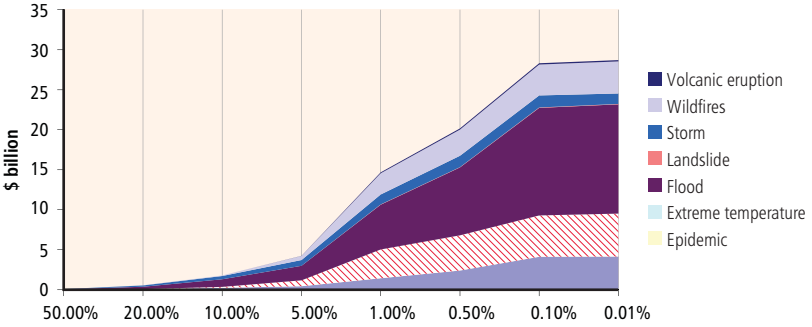


Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

India is exposed to many types of natural disasters, but their effect on populations and damage to the economy can differ widely. EM-DAT data show that drought affects 53.1% of the population but causes only 4.4% of the total damage resulting from natural disasters. Conversely, storms cause 4.5% of damage, but affect 20.6% of people. More in kilter, floods cause 64.7% of the damage and affect 40.6% of the population. Droughts pose special challenges for India where most lands are under-irrigated and rainfall variability high.

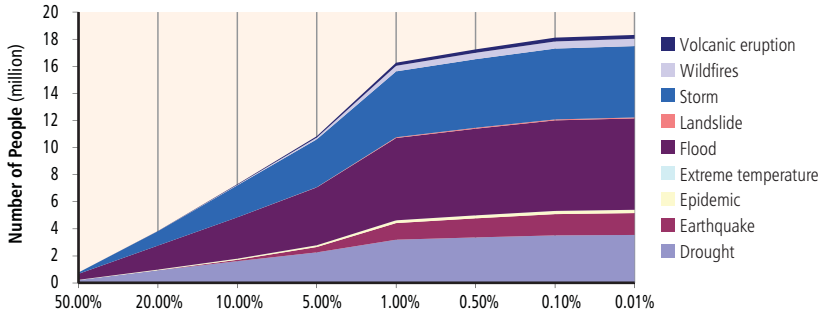
Figures 4 and 5 show aggregated data for Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, the Philippines, Thailand, and

Figure 4: Damage Risk in Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, the Philippines, Thailand, and Viet Nam (by Disaster Type)



Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Figure 5: Number of People Affected in Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, the Philippines, Thailand, and Viet Nam (by Disaster Type)



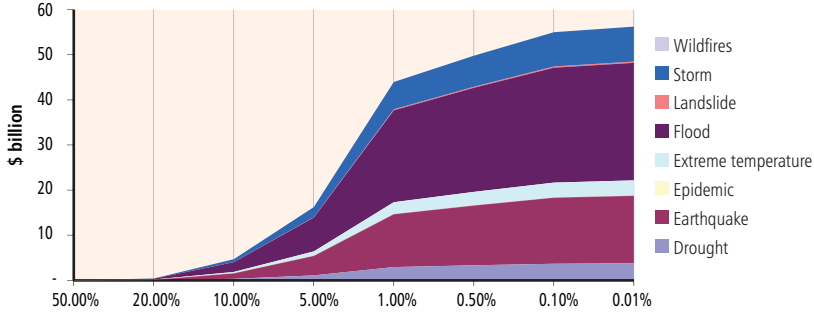
Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Viet Nam of the damage risk by type of natural disaster and the number of people affected by different types of natural disasters, based on probability events.

As noted, the PRC suffers the brunt of the damage. The country's total damage cost is estimated at $56 billion for a 0.01% probability, and up to 200 million people affected (Figures 6 and 7).

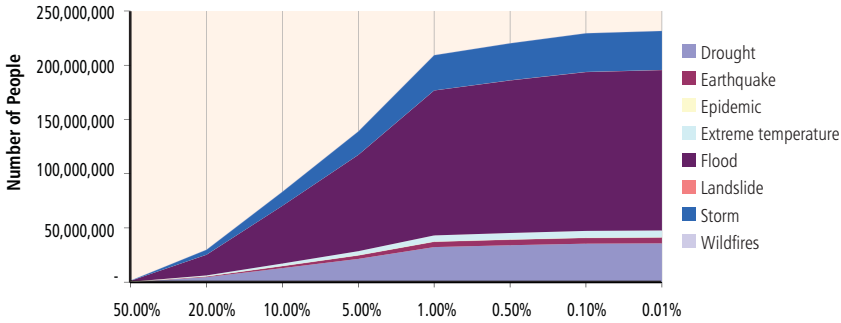
Astronomical tolls were observed in some major disasters during the 1990s, such as the severe flooding of the Yangtze River and other rivers in the northeast in 1998. This affected 238 million people and caused damage of $30 billion. In 2008, the earthquake in Sichuan Province affected 46 million people and caused damages of $46 billion.

Figure 6: Damage Risk in the People's Republic of China (by Disaster Type)



Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Figure 7: Number of People Affected in the People's Republic of China (by Disaster Type)



Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Fiji, the Maldives, the Federated States of Micronesia, Papua New Guinea, Tonga, and Vanuatu are all highly vulnerable to natural disasters , with 2 million people on these islands vulnerable to a 0.01% probability event. In absolute numbers, this may seem relatively small compared to population at risk in other developing countries in the region. But a 0.01% event probability of a major tsunami or cyclone would affect 95% of Tonga's population, 91% in the Federated States of Micronesia, 46% in Fiji, and 32% in the Maldives. For a 0.01% probability event, the damage is calculated at $2 billion. This would have a very considerable impact on the GDPs of these small island economies (29% in Fiji, for example).

Investment Needs for Disaster Risk Reduction

Going by the experience of many countries in the region exposed to natural hazards, the investment needed to reduce losses from natural disasters from a 1% probability event is about 20%–25% of the damage that event would create. Based on this method, this analysis derived a table of needed investments for disaster risk reduction in the region's developing countries.

The PRC, India, Indonesia, Pakistan, and Thailand need the most investment for disaster risk reduction. If the protection levels are reduced from risk level 0.1% to 1%, the investment for disaster risk reduction declines from $33.1 billion to $27.3 billion. At the 5% protection level, it falls dramatically to about $12.6 billion.

The analysis makes the following recommendations to strengthen disaster risk management:

- Major structures in which a natural disaster could cause loss of life and a heavy loss of assets should be protected to a 0.01% probability,
- minor structures to 1%,
- medium structures with no loss of life to 1%, and
- canals and other waterways to 5%.

Table 9 shows desirable investment amounts in developing countries in Asia and the Pacific.

Table 9: Desirable Investment Amounts for Disaster Risk Reduction by Probability of Disaster Occurrence ($ million)

Country	Probability							
	50	20	10	5	1	0.50	0.10	0.01
Afghanistan	0	0	4	16	55	64	72	74
Azerbaijan	0	0	3	9	24	28	31	31
Bangladesh	0	2	24	86	276	316	354	363
Cambodia	–	–	14	38	85	94	104	108
PRC	0	429	2,293	6,142	15,006	16,732	18,275	18,644
India	17	482	1,165	1,928	2,985	3,155	3,299	3,332
Indonesia	0	3	62	329	1,524	1,805	2,075	2,142
Kazakhstan	0	9	27	52	93	100	106	108
Malaysia	0	13	62	156	358	396	430	438
Maldives	6	16	23	29	40	43	49	52
FSM	–	–	–	0.1	0.5	0.6	0.9	1.0
Mongolia	0	0	2	30	231	275	311	319
Myanmar	3	74	172	276	414	436	455	459
Nepal	0	0	7	33	117	137	156	160
Pakistan	0	2	59	345	1,410	1,681	1,935	1,997
Papua New Guinea	0	0	1	5	32	40	48	50
Philippines	0	13	40	73	116	123	129	130
Sri Lanka	0	14	58	138	299	330	359	368
Tajikistan	21	182	344	486	649	673	696	703
Thailand	67	314	617	935	1,657	1,846	2,110	2,185
Uzbekistan	0	0	3	14	53	61	69	71
Viet Nam	68	358	594	772	959	986	1,008	1,013
Fiji	1	250	486	664	851	879	904	910
Tonga	0	0	1	3	8	10	11	11
Lao PDR	0	0	4	18	67	78	88	91
Vanuatu	–	0	0	2	22	28	37	39
Sum	**184**	**2,162**	**6,064**	**12,580**	**27,333**	**30,318**	**33,111**	**33,799**

– = not available or not applicable; FSM = Federated States of Micronesia, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Source: Computed from data from the Centre for Research on the Epidemiology of Disasters. Emergency Events Database. http://www.emdat.be/.

Chapter 4

ADB's Evolving Approach to Natural Disasters

The Asian Development Bank (ADB) in 1987 was the first regional multilateral development bank to adopt a disaster and emergency assistance policy, focused on disaster recovery in Pacific countries. Since then, ADB has steadily increased the depth and scope of its support to developing member countries vulnerable to natural disasters and disaster risks—a reflection of the increased frequency of natural disasters hitting the region, and the concerns of governments over the impact these have on economic development.

ADB in 1987 was the first regional multilateral development bank to adopt a disaster and emergency assistance policy

Post-disaster support through emergency assistance loans became available to client governments in a broader 1989 policy, which incorporated elements of disaster risk reduction. The Disaster and Emergency Assistance Policy of 2004, which is still in force, ushered in a more proactive approach to disaster response. It encourages investments in disaster prevention and mitigation, and identifies livelihood restoration as part of transitional assistance following immediate support for rehabilitating high-priority physical and social infrastructure in disaster areas.

Strategy 2020, ADB's current long-term strategic framework adopted in 2008, does not include disaster management among its five core operational areas. But it does underscore the importance of mainstreaming disaster risk management, and of ADB providing early and medium-term disaster response and support in partnership with specialized aid agencies.[15]

Evaluating ADB's Disaster Response Management

The 2012 Independent Evaluation of ADB's disaster-related assistance assessed (i) the relevance of ADB's disaster management policy and operations in the context of increasing natural disasters in the region, (ii) the responsiveness of ADB's disaster risk and recovery management, and (iii) the results achieved and anticipated to have been achieved over the period reviewed.

The evaluation covered a wide range of material, including project documents, ADB country strategies, and loan and grant data to assess ADB's disaster-related portfolio and technical assistance operations. In addition, country cases studies were done on Bangladesh, Indonesia, and Pakistan, ADB's three largest borrower countries for disaster support. In these countries, ADB has gradually increased its attention to preventive measures, particularly flood protection, but in many other developing member countries this is still quite a small component.

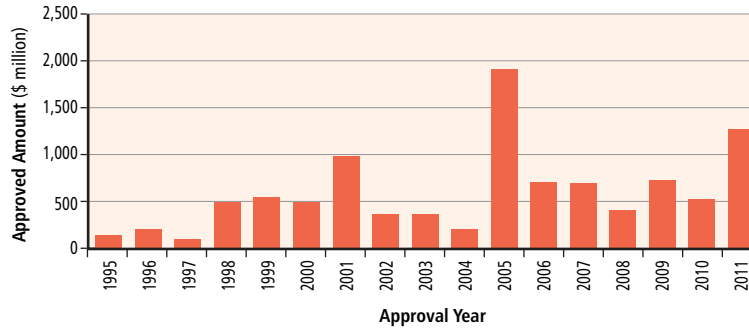
ADB's Natural Disaster Portfolio

Some 264 natural disaster-related interventions were identified during 1995–2011 totaling more than $10.00 billion. This represented 8% of total ADB loans approved during the period reviewed. Of the total amount for disaster-related projects, $8.55 billion was in loans (104 of them), $1.31 billion in grants (67), $415.7 million in multitranche financing facility tranches (6), and $96.8 million in technical assistance operations (87).

ADB has seen a gradual increase in investments in disaster prevention support for developing member countries, and a growing number of projects now include a disaster prevention component along with other activities. Even so, only 43 of 177 disaster-related projects during 1995–2011 were predominantly

[15] Strategy 2020's five core operational areas are infrastructure, environment, regional cooperation and integration, finance sector development, and education.

Figure 8: ADB's Natural Disaster-Related Portfolio: Approved Loans, Grants, and Multi-tranche Financing Facility



ADB = Asian Development Bank.
Source: Independent Evaluation Department database on ADB's natural disaster-related support.

on disaster prevention, accounting for one-third of approvals, compared with two-thirds for disaster recovery (Table 10).

As Figure 8 shows ADB's financing for natural disaster management has been rather uneven, a reflection of the large amounts approved for disaster response in particular years. For example, the very pronounced spike in approvals in 2005 was in response to the December 2004 Indian Ocean tsunami. It is noteworthy that in all but 2 years in the period reviewed, flood-related interventions comprised at least 60% of the total volume of projects, showing that floods are the most recurring type of natural disaster in the region.

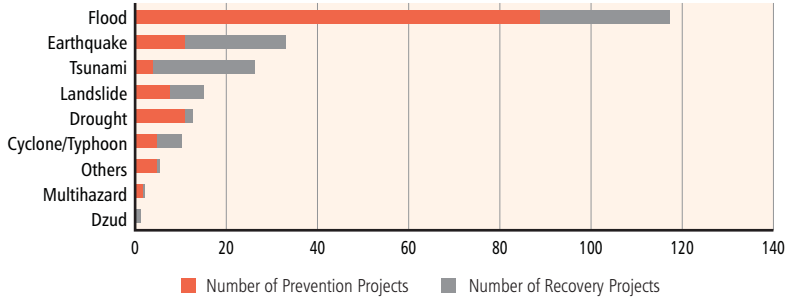
Table 10: ADB Natural Disaster-Related Projects (1995–2011)

Project Type	Number	% Share	$ million	% Share
Natural Disaster-Related Projects	177		10,274	
A. Disaster Prevention	110	62	5,945	58
Structural mitigation measures	43	24	3,272	32
Nonstructural mitigation measures	27	15	1,181	11
Nonspecific[a]	40	23	1,492	15
B. Disaster Recovery	67	38	4,329	42
Emergency assistance loans	38	21	4,126	40
Non-emergency assistance loans	29	16	203	2

[a] Mainly large-scale development and infrastructure projects, with irrigation and transportation components.

Source: Independent Evaluation Department database.

Figure 9: Prevention and Recovery Projects in Natural Disaster Portfolio (by Disaster Type, 1995–2011)

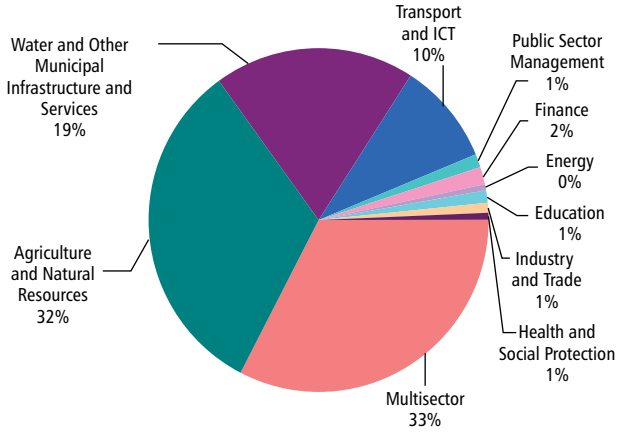


Note: *Dzud* refers to extreme cold spells in Mongolia.
Source: Independent Evaluation Department database on ADB's natural disaster-related support.

Figure 9 breaks down the allocation of the Asian Development Bank's disaster-related loans and grants by disaster type and Figure 10 by sector. Figure 11 shows the top 10 country recipients of ADB loans and grants for natural disasters.

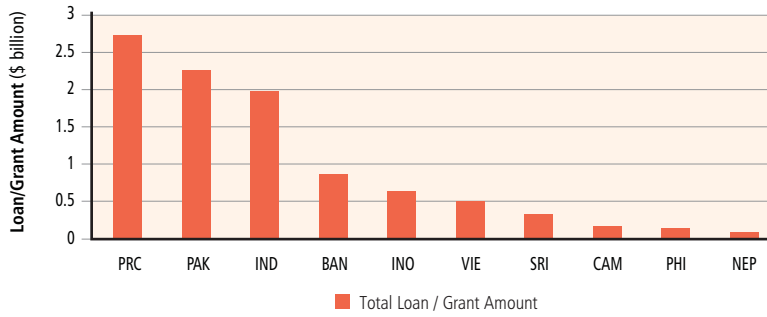
ADB's largest response to a single natural disaster was for the Indian Ocean tsunami ($777.0 million), with Indonesia the biggest country recipient, at $312.5 million. ADB's largest approved amount for earthquake recovery in one country was for the Gujarat Earthquake Rehabilitation and Reconstruction Project ($500.0 million) in 2001 in India.

Figure 10: Natural Disaster Portfolio Composition (by Sector, 1995–2011)



ICT = information and communication technology.
Source: Independent Evaluation Department database on Asian Development Bank's natural disaster-related support.

Figure 11: Top 10 Country Recipients of ADB Loans and Grants for Natural Disasters (1995–2011)



ADB = Asian Development Bank, BAN = Bangladesh, CAM = Cambodia, IND = India, INO = Indonesia, NEP = Nepal, PAK = Pakistan, PHI = Philippines, PRC = People's Republic of China, SRI = Sri Lanka, VIE = Viet Nam.

Source: Independent Evaluation Department database on ADB's natural disaster-related support.

ADB's disaster-related technical assistance operations focus on climate change adaptation, accounting for 30 of 87 technical assistance operations during 1995–2011, followed by disaster risk reduction (28).[16] The main aim of ADB's technical assistance in this area is to integrate adaptation measures into policy and institutional frameworks, either as regional or country initiatives. The main country recipients have been Indonesia and Nepal.

ADB's Approach to Natural Disasters

Experts support a systematic approach to natural disasters focused on risk and vulnerability that uses the concept of the disaster risk management cycle to organize a wide range of interventions. Figure 12 shows the four major phases of a disaster management cycle under ADB's current Disaster and Emergency Assistance Policy.

ADB's approach to disaster risk management is evolving to deal with the effects of climate change. As global temperatures rise, exposure to natural disasters is increasing, and vulnerability remains high for significant parts of Asia's population. Adaptation to extreme natural events and climate change is becoming a vital part of disaster management.

[16] ADB's technical assistance projects entail small-scale grants, usually for capacity development, training, dispatch of technical advisors for policy formulation, and institutional reform.

ADB uses a range of specialized funds and instruments for disaster-related support. Emergency assistance loans were created to fast-track certain procedures to quicken the approval and disbursement of ADB funds. During 1995–2011, some 38 such loans were disbursed totaling around $4.1 billion, the bulk of them being used to rehabilitate water services, power, and transport.

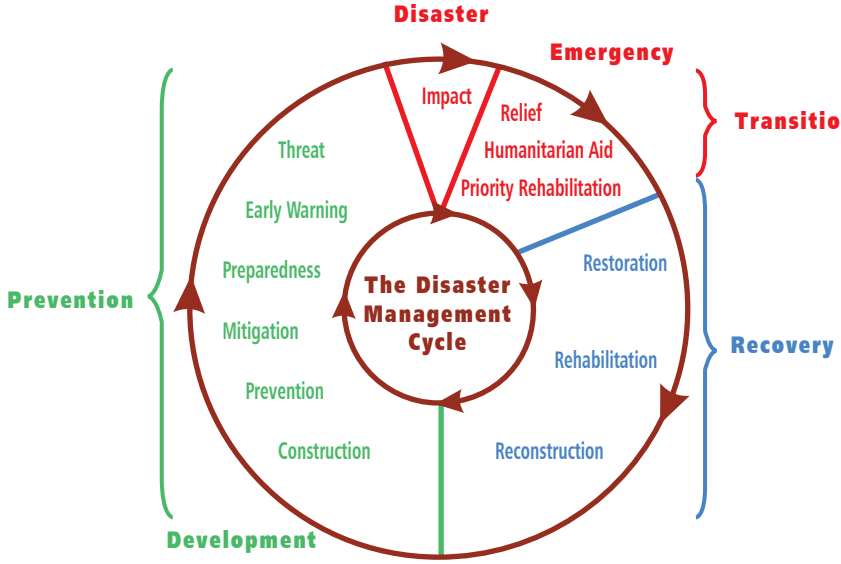
ADB created the $600.0 million Asian Tsunami Fund in 2005—terminated it in December 2010—to meet the financing needs for the medium-term reconstruction of areas affected by the Indian Ocean tsunami. It also created two other disaster-specific funds. The Pakistan Earthquake Fund was launched in response to a 7.6 magnitude earthquake in 8 October 2005 that killed 75,000 people. The Asia Pacific Disaster Response Fund was created in 2009 to provide ADB's developing member countries with grants of up to $3.0 million to meet immediate funding requirements of restoring lifesaving services to affected populations following a major disaster.

Natural Disaster Recovery Projects

Disaster recovery operations have been financed mostly by emergency assistance loans and had a high rate of success during 1995–2011. Based on the ratings for 27 available project completion reports for disaster recovery operations, all were rated successful or highly successful.[17] The success rate—at 100%—was higher than for disaster-prevention projects (79%) and ADB projects overall (69%). Even so, many of these operations projects had problems with sustainability, with 31% assessed less than likely sustainable (the percentage for sustainability for ADB projects overall was 34%).

[17] Independent Evaluation at ADB uses a four-category rating system—highly successful, successful, less than successful, and unsuccessful. Ratings are derived based on four evaluation criteria: relevance, effectiveness, efficiency, and sustainability.

Figure 12: Disaster Management Cycle



Source: Asian Development Bank. 2004. *Disaster and Emergency Assistance Policy.* Manila.

Natural Disaster Prevention Projects

In volume terms, disaster prevention projects grew during 1995–2011, with ADB giving most attention to disaster risk prevention in infrastructure—the main area of support for overall ADB lending. ADB provided almost double the support for structural mitigation, such as flood prevention, than nonstructural ones. But there has been a gradual increase over the years in "soft," nonstructural measures, such as environmental management, early warning systems, and drought-resistant crops.

All types of disaster prevention projects registered good success rates. Based on ratings provided by 29 available project completion reports, almost 80% of these projects were rated either highly successful or successful.

But sustainability was also a problem. Only 45% of projects were rated likely sustainable or better. Sustaining outputs and outcomes in disaster prevention is proving difficult because governments in the receiving countries see it as a luxury that needs to compete with more immediate development priorities.

Relevance, Responsiveness, Results

Independent Evaluation rated ADB's response to natural disasters and disaster risks in terms of relevance, responsiveness, and results.

Relevance

The large number of natural disasters in the 2000s increased attention to disaster response, but the mainstreaming of a systematic approach has been irregular. Some ADB country partnership strategies—Cambodia and Nepal, for instance—have taken up natural disasters as a threat to economic development, but most have not (including developing countries at high risk).

Given ADB's prominent standing in the region, ADB could have played a more central role in aid coordination. Technical assistance support in disaster prevention was usually a one-off undertaking, not linked to long-term programs. Many ADB developing member countries at high risk from natural disasters have not received technical assistance from ADB for disaster management or climate change.

The type of disaster prevention ADB practiced was rated less than relevant; disaster recovery efforts were relevant, although more attention is needed on sustainability and livelihood restoration.

Responsiveness

ADB focused on sectors in which it is already involved and has expertise, and its portfolio has been gradually focusing more attention on disaster prevention measures, particularly flood prevention in Bangladesh, the People's Republic of China, and Indonesia. But these still comprise only a small share of the organization's total disaster portfolio.

More technical assistance operations are dealing with climate change adaptation, which can help address disaster risk mitigation through support to environmental agencies and hazard-risk planning. Major ADB disaster-related loans are often accompanied by technical assistance to strengthen the capacity of governments to forecast and moderate the impact of natural disasters through such things as early warning systems and land zoning.

However, far more attention is needed on disaster prevention and preparedness. ADB's disaster prevention efforts were rated less than responsive to the region's emerging needs; ADB's disaster recovery management was rated highly responsive.

Results

ADB's disaster recovery support during 1995–2011 achieved the intended results—the rehabilitation or reconstruction of damaged infrastructure—to a very high degree. But the objectives, which focused on infrastructure rehabilitation, paid rather less attention to "connecting the dots" (the vital role links play in the patterns of development) with livelihood restoration and disaster resilience improvement.

Disaster recovery support. All completed disaster recovery operations were rated successful or highly successful. The 100% success rate compares with 69% successful or better for all ADB's operations over the period reviewed. The percentage of completed disaster recovery operations rated likely sustainable was 62%, around the average for ADB's overall portfolio.

Disaster prevention support. Close to 80% of completed disaster prevention operations were successful, with the rest split almost evenly between less than successful and unsuccessful. The most worrisome finding was, again, a low rating for sustainability—only 45% of operations were rated likely sustainable or better. This may be because of the high requirements that need to be met for such projects to do well over time.

Lessons for Raising Awareness of Disaster Risk Reduction

The rising frequency of natural disasters across Asia and the Pacific makes it imperative to recognize the very considerable risks to economic development, particularly from disasters caused by extreme hydrometeorological events in densely populated areas.

The evaluation study draws attention to the need to raise the current low awareness of disaster risk reduction measures in developing countries. ADB, for one thing, does not regularly receive requests from client governments in this area. However, useful regional risk-reduction initiatives have been launched,

such as by the Association of Southeast Asian Nations on monitoring weather and volcanic activity. But such concern is not widespread in the region.

Knowledge support needs to be consolidated in national development agendas. This has been a rather piecemeal effort in many countries, undertaken by local initiatives monitoring hazardous weather or natural geophysical conditions, for example. But they are generally directly linked to or embedded into national policies or economic development platforms. In ADB's support, technical assistance for disaster risk reduction should be linked to existing natural disaster coordination platforms and strategies in countries across the region.

Key Lessons from Disaster Recovery Projects

ADB's approach to disaster recovery remains focused on infrastructure rehabilitation and has not extended to major livelihood restoration projects (although this was addressed in ADB's support for tsunami recovery in Indonesia). The evaluation study urges ADB to give "special attention" to targeting disaster victims and other vulnerable groups. Involving communities is also vital for identifying and prioritizing project activities—and many ADB disaster recovery projects indeed highlighted the importance of community participation.

Realistic assessments of the institutional capacity of executing agencies need to be made during project design. For complex multisector projects, it is crucial that monitoring implementation is done through a central steering committee or similar entity at a relevant ministry.

Interventions for natural disasters insufficiently recognized gender concerns. In recent major natural disasters in Asia, it was observed that fatality rates for women were substantially higher than for men. Women are often more vulnerable due to lower access and control over key survival and recovery resources, including shelter, transport, and food. Women comprised 91% of Cyclone Gorky's victims in Bangladesh, and 67% of tsunami victims in Banda Aceh in Indonesia in 2004.

In exploring ways for ADB to improve its response to natural disasters and disaster risks, the evaluation study made the following recommendations:

Move beyond infrastructure. ADB should apply an integrated approach to disaster recovery operations that goes beyond infrastructure restoration. The primary focus on infrastructure restoration, as noted, should be complemented by activities directed at livelihood restoration, and improving the resilience of infrastructure and economic activity to disasters.

Conduct vulnerability assessments with country partners. ADB's country partnership strategies for developing member countries should include disaster vulnerability assessments, with the risks addressed by the investment programs planned. This is also important for ensuring that considerations of disaster risk are mainstreamed into ADB operations.

Coordinate more with development partners. ADB should coordinate more regularly with other development partners on disaster risk management, and take a more leading role in countries where its natural disaster interventions are more substantial. Through strong, long-standing ties with client governments, ADB and other multilateral development banks have an advantage in policy dialogue that can provide an important entry point for influencing land-use planning and regional economic plans. Yet, many countries do not have a regular forum. ADB could enhance its information sharing for more tangible prevention investments with outside bodies, such as the Global Facility for Disaster Reduction and Recovery.

Review the disaster-related financing products and models of others. ADB should review the risk finance products and models developed by other disaster risk financing institutions, including those working with private sector operators. One area in which ADB and others have a role to play is to discuss and evaluate with countries the risk estimates that insurance industries and think tanks conduct.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Chapter 5
The Challenge Ahead

For countries in developing Asia and the Pacific, investing in disaster preparedness is a wise economic choice. As this report makes clear, the rising frequency of extreme natural disasters has the potential to wipe out years of hard-earned development progress. This is as true of floods and storms in densely populated areas, as it is of geophysical events in areas where earthquakes are common.

Yet, awareness of disaster risk reduction measures remains disturbingly low, as does the understanding that many of these threats afflict the whole region, not just individual countries. Some groups have initiated valuable regional initiatives, such as the Association of Southeast Asian Nations' monitoring of weather and volcanic activities. But developing countries in Asia and the Pacific have not regularly sought out ADB's expertise or the accumulated knowledge of the various government agencies that have specialized in disaster risk reduction. They have also not widely acknowledged the commonality of the threats they face.

This is an area where ADB, as the region's development bank, could make a bigger difference. By raising risk awareness through policy dialogue with client governments and showing concerned agencies how to address such

risks, ADB and its development partners can help change the perception that prevention is a luxury or something that needs addressing only after calamity strikes. Governments can recognize the increasing threat, and that risk can be systematically mitigated, contributing to more sustained economic development.

ADB has various avenues for supporting developing countries in the region. Disaster risk reduction is a cross-sectoral issue that can be tackled as a specialized theme, through policy advice, institutional reform, and the transfer of technology or knowledge through specialized agencies. Alternatively, ADB can provide support using more conventional project loans and technical assistance in infrastructure or governance and public sector management, disaster risk management, or value additions such as climate-change-adapted road design, disaster-resilient structural design, and financial contingency planning.

Appendixes

APPENDIX 1: Natural Disasters in the Country Partnership Strategies: 1995–2012

Country	Hot spots[1] Ranking (Mortality)	Hot spots Ranking (GDP)	Total Disaster Projects	No. of Projects by Disaster Type	Approved Amount ($ '000)	Hazards Mentioned in the CPS	Disaster-Related Issues/ Challenges	Activities
Afghanistan	8		3	2/flood, 1/earthquake	90,400	Flood, drought.	Famine/food security/food assistance, decline in agricultural production.	Watershed management, water resources development program; irrigation; river flood protection.
Armenia						Earthquake.	Unstable and denuded slopes used for grazing, slow recovery from 1988 earthquake, nuclear plant safety.	
Bangladesh	1	2	22	14/flood 1/sea level rise 7/multi-hazard (flood, drought, cyclone, earthquake, storm, extreme	876,930	Flood, cyclones.	Livelihood, poverty, food security, water and energy scarcity, climate change, health impacts, environmental degradation, unplanned urbanization, rural–urban migration, settlement in waterways, and gender.	River basin and flood management, climate change capacity development, knowledge management and pilot programs, disaster microinsurance, regional cooperation with India for sharing of flood information.
Cambodia		14	8	6/flood 2/multi-hazard (flood, drought)	172,725	Flood.	Food security, livelihoods, climate change, poverty, environmental management.	Flood protection, improvements in water resource management, climate change adaptation, mainstream climate change in design of agriculture, water and infrastructure investments, adaptation financing, climate-resilient planning, partnerships with civil society, community-level adaptation.

[1] Hotspots ranking is relative to other developing countries in Asia. Mortality and GDP hotspots ranking are based on percent of population and GDP in areas at risk from two or more hazards. In Tables 1.2 and 7.2 in Maxx Dilley, Uwe Deichmann, Robert S. Chen, and Arthur L. Lerner-Lam, and Margaret Arnold. 2005. *Natural Disaster Hotspots.* Washington, DC: World Bank..

Country	Hot spots[1] Ranking (Mortality)	Hot spots Ranking (GDP)	Total Disaster Projects	No. of Projects by Disaster Type	Approved Amount ($ '000)	Hazards Mentioned in the CPS	Disaster-Related Issues/ Challenges	Activities
China, People's Republic of	11	7	39	28/flood 3/earth-quake 2/drought 2/storm-surge 1/landslide 2/flood and landslide 1/forest fire	2,686,955	Flood, drought, earthquake.	Desertification, land degradation, water scarcity, rural-urban migration, deteriorating urban quality.	Floodplain management, flood control, water resource management projects (lakes and rivers), urban development, urban flooding, wetlands protection, land use planning.
Indonesia	6	6	20	7/flood 1/flood and drought 1/flood and landslide 1/forest fire and drought 1/earthquake 9/earthquake and tsunami	631,775	Floods, droughts, landslides, earth-quakes, volcanoes and forest fires.	Poverty and vulnerability to disasters, poor water quality, environmental degradation.	River basin management, flood control, flood management, conservation of watersheds and wetlands, flood forecasting and early warning, community-based disaster risk management, climate change adaptation, disaster risk financing, reconstruction and rehabilitation.
Kiribati						Sea-level rise, storms, drought.	Salt-water intrusion, poorly planned sea defenses, environmental degradation, environmental damage.	
Lao People's Democratic Republic	15		5	4/flood 1/multi-hazard (flood, drought)	65,000	Flood, drought, landslides.	Poverty, water supply reliability, food security, environmental sustainability, health impacts, livelihoods.	Crop insurance, water management, irrigation, reforestation.
Nepal	2		5	1/flood 2/flood, drought 2/earth-quake, landslide	98,738	Drought, flood, earthquake, glacial lake outburst, landslide.	Land degradation, water shortage, climate change, environmental fragility, food security, livelihoods, poverty, gender equity, social inclusion.	Capacity building, climate change and disaster management screening to consider risks in investments, flood damage rehabilitation, climate change adaptation, urban drainage, solid waste management, seismic strengthening of schools.

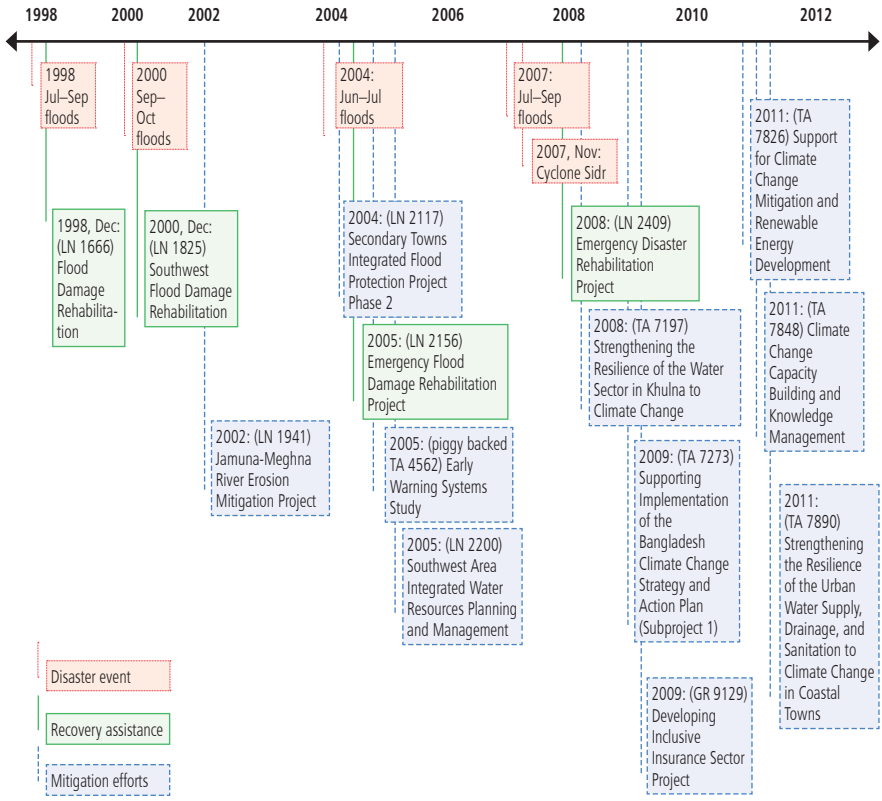
Country	Hot spots[1] Ranking (Mortality)	Hot spots Ranking (GDP)	Total Disaster Projects	No. of Projects by Disaster Type	Approved Amount ($ '000)	Hazards Mentioned in the CPS	Disaster-Related Issues/ Challenges	Activities
Pakistan	7	11	24	12/flood 6/earthquake 2/drought 2/flood, drought 1/flood cyclone 1/landslide	2,261,170	Drought, flood, earthquake, glacial lake outburst, landslide.	Land degradation, water shortage, climate change, environmental fragility, food security, livelihoods, poverty, gender equity, social inclusion.	Public sector capacity building, water resource management, irrigation, land use, building codes, earthquake reconstruction and rehabilitation (education, health, power, and road sectors, and technical assistance including support for financial management support for housing reconstruction).
Sri Lanka			12	8/tsunami 3/flood 1/multi-hazard (flood, monsoon, extreme temperatures)	338,135	Flood, drought, storm.	Impacts of climate change in water sector.	Improving water access, climate change adaptation, mainstreaming climate change concerns in urban, water, drainage and sanitation.
Thailand	20	4	5	3/tsunami 2/flood	5,225	Flood, drought, tsunami.	Deforestation, destruction of critical watersheds, environmental protection.	River basin development, integrated water resource management, watershed management, Greater Mekong flood and drought risk management.
Viet Nam	4	1	15	11/flood 2/flood, drought 1/multihazard (extreme weather, extreme temperature, flood) 1/drought	480,380	Flood, drought, coastal storms, sea-level rise .	Urban management, poverty.	Coastal mangrove, watershed protection, institutional strengthening of public sector, climate-resilient road infrastructure, coastal cities management, climate change adaptation.

CPS = country partnership strategy, GDP = gross domestic product.

Source: Independent Evaluation at the Asian Development Bank.

APPENDIX 2: ADB Natural Disaster-Related Support and Disaster Risk Management Systems in Bangladesh, Indonesia, and Pakistan

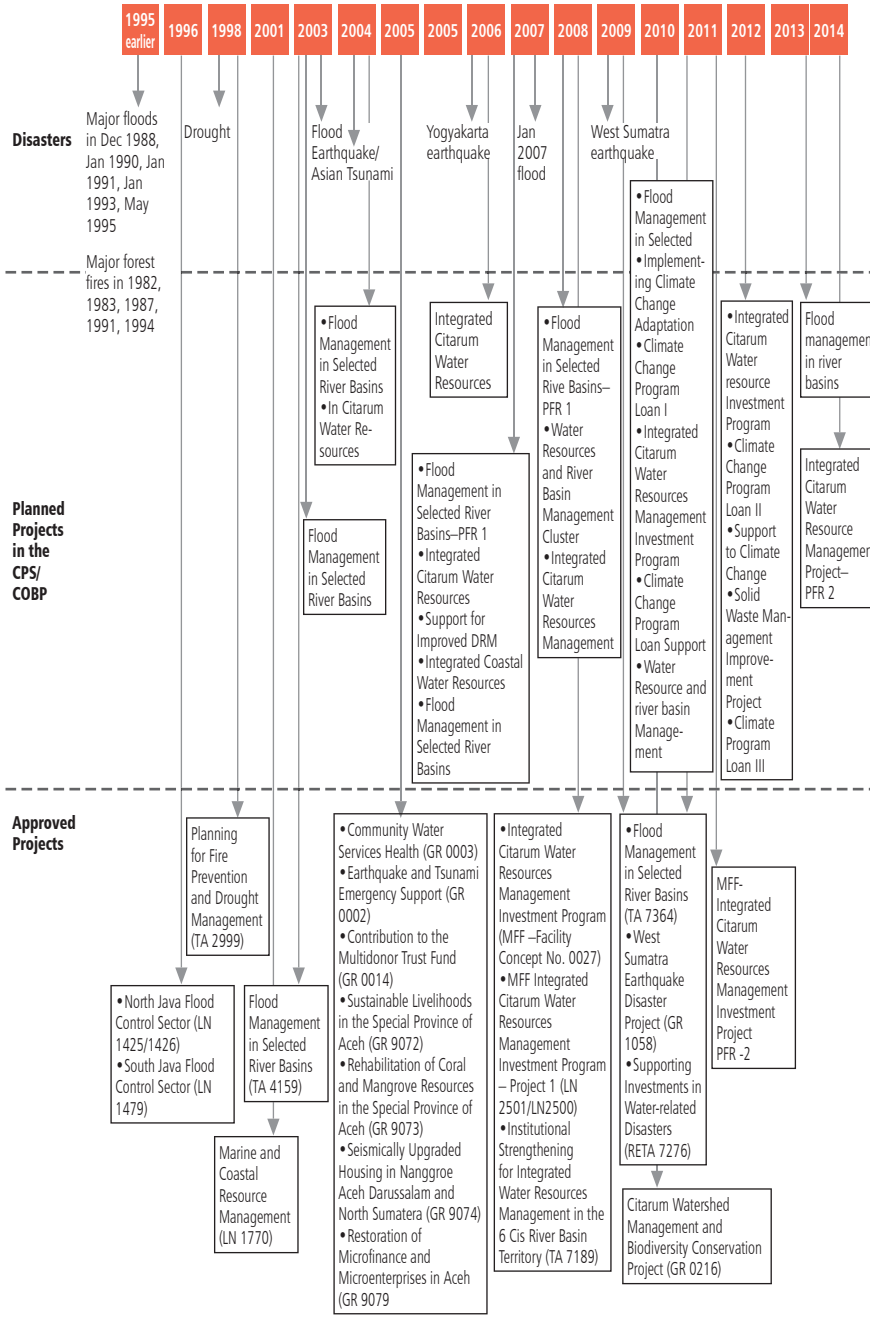
1. Bangladesh



GR = grant, LN = loan, TA = technical assistance.

Source: Independent Evaluation Departmnt.

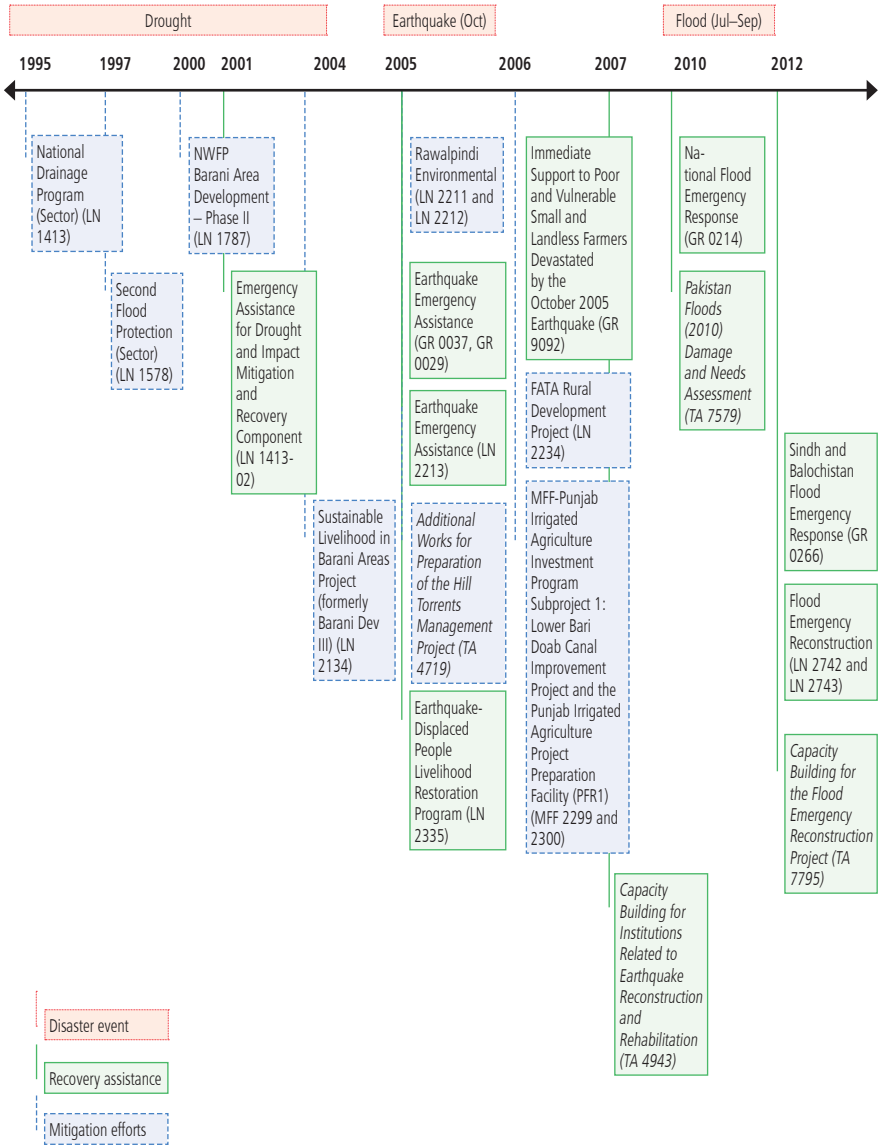
2. Indonesia



COBP = country operations business plan, CPS = country partnership strategy, DRM = disaster risk management, GR = grant, LN = loan, MFF = multitranche financing facility, PFR = periodic financing request , TA = technical assistance.

Source: Independent Evaluation Department.

3. Pakistan

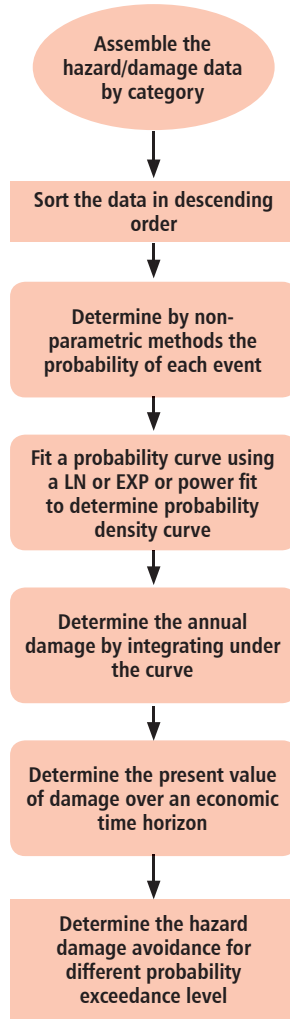


GR = grant, LN = loan, NWFP = North-West Frontier Province, PFR =periodic financing request, TA = technical assistance.

Source: Independent Evaluation Department.

APPENDIX 3: Methodology of Determination of Risks

The methodology used to determine risk is based on historical hazard events. Hence, the basis is on real events and not on possibilities. Although this has its weakness, it is in many cases more realistic than other methods.[1] The figure below describes a step-by-step approach for the probability of risk of damage by a hazard:



EXP = exponential of, LN = natural logarithm.

[1] The material in Appendix 3 is excerpted from Daniel Gunaratnam. 2012. Supplementary Appendix B: Special Evaluation Study on ADB's Support for Natural Disaster: Quantitative Risk Assessment Vulnerability and Risk Assessment of Natural Disasters in Asia. pp. 10–13. Manila.

Statistical Tools Used Non-Parametric Methods

The main statistical method to determine the probability is the plotting position methodology which gives the probability of an ordered set of events. There are several plotting positions (Harris, Hazen, Beard, Weibull, Gringorten) that can be used to define the probability. The Weibull plotting position was chosen because it has been tested to give the best non-parametric probability value for natural disaster type events.[2] Each method has a way of estimating the return period, which is the inverse of the probability of occurrence. If one compares a set of data (e.g., 21 years) and compares the return period for the highest value the table below shows the return period by each method.

Method	Proponent	Return Period Years	Error
m/(N+1)	Weibull (1939)	22.0	0
(m-0.31)/(N+0.38)	Beard (1943)	31.0	41
(m-0.44))/(N+0.12)	Gringorten (1963)	37.7	71
(m-0.5)/N	Hazen (1914)[2]	42.0	91
Numerical Method	Harris (1996)[3]	37.9	72

All the formulas overestimate the return period R and underestimate the risk when compared with the Weibull formula.

Another way at looking at the estimation of probability is if there is a variable 'x' that has a probability density of f(x) and cumulative probability density of F(x). The probability density f(x) from the smallest (m=1) to the largest (m=N) value is:

$$f_m[F(x_m)] = N!/[(m-1)!(N-m)!]*[F(x_m)]m-1*[1-F(x_m)]----------(\text{Eqn } 1)$$

It has been shown by Gumbel[5] (1958) that the expected value of this distribution is

$$E[F(xm] = m/(n+1)----------(\text{Eqn } 2)$$

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[2] See Ray K. Linsley, Joseph L. Paulhus, and Max A. Kohler. 1974. Hydrology for Engineers. McGraw-Hill Companies.

[3] A. Hazen. 1914. Storage To Be Provided in Impounding Reservoirs—*Trans. Amer. Soc. Civ. Eng.* Pap., 1308 (77), 1547–1550.

[4] R. I. Harris. 1996. "Gumbel Revisited—A New Look at Extreme Values Statistics Applied to Wind Speeds." *J. Wind Eng. Aerodyn.*, 88, 119–131.

[5] E. I. Gumbel. 1958. *Statistics of Extremes.* Columbia University Press.

This shows analytically that the Weibull method estimates the correct mean value of probability. The Weibull probability of an event ranked as the "m^{th}" event out on "n" events the probability is defined as

$$m/(n+1).$$

The probability values are determined for the whole series and the series is plotted to show the probability density. This methodology is used by all UNESCO Water and Hydrology Series papers; hydrology text books, flood frequency papers and books, and so on.

Probability Distributions Used

Using the series of values for flood, earthquake, and other damage, these are plotted on a graph and probability curves are fitted the points to give a continuous distribution so that intermediate probability points can be determined. Since the best data on the probability distribution exist for the probability of 20% and less, it was best to use a simple curve to fit to the tails rather than a full-blown probability distribution. Distribution curves consisted of a selection of one of three curves to fit the tails of the probability curve:

a. power curve
b. exponential curve
c. natural log curve

The regression coefficient (R^2) was determined to ensure that the curves fitted explained 90% or more of the actual events.

Definition of Catastrophic Risks Hazard Events

Catastrophic risks are unusual events that occur very infrequently. Generally, events such as these have low probability of occurrence which is much less than 1% probability of occurrence. These events generally occur at least once in 100 years (1% probability) or 0.5% (200-year recurrence) or at an even smaller probability. However, it must be understood that although these events are rare, they can occur at any time.

Damage due to these infrequent hazards events can have significant impact on an economy. In 1986, for example, a major earthquake caused damage of about 700%–800% of Armenia's gross domestic product. What this means is that the entire economy can be destroyed by one catastrophic event. This also indicates the need to take appropriate measures to avoid such damage. Generally, the investment of every dollar in flood management reduces damage by $4–$7. Similarly, investments to reduce earthquake damage through better structures, retrofitting of existing structures, and so on, will in the long term pay off significantly. In addition, insurance and other measures can spread the risk of these damages up to about 15%–20% of overall damage and reduce the fiscal impact.

The Rise of Natural Disasters in Asia and the Pacific
Learning from ADB's Experience

This report looks at findings from the Independent Evaluation of the Asian Development Bank's Response to Natural Disasters and Disaster Risks. The 2012 evaluation highlights some of the successes and shortcomings of disaster risk reduction in Asia and the Pacific, particularly through case studies of Bangladesh, Indonesia, and Pakistan, and identifies areas for improvement.

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ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.7 billion people who live on less than $2 a day, with 828 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

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Independent Evaluation at the
Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org/evaluation

ISBN 978-92-9254-194-1

Printed on recycled paper

Printed in the Philippines