

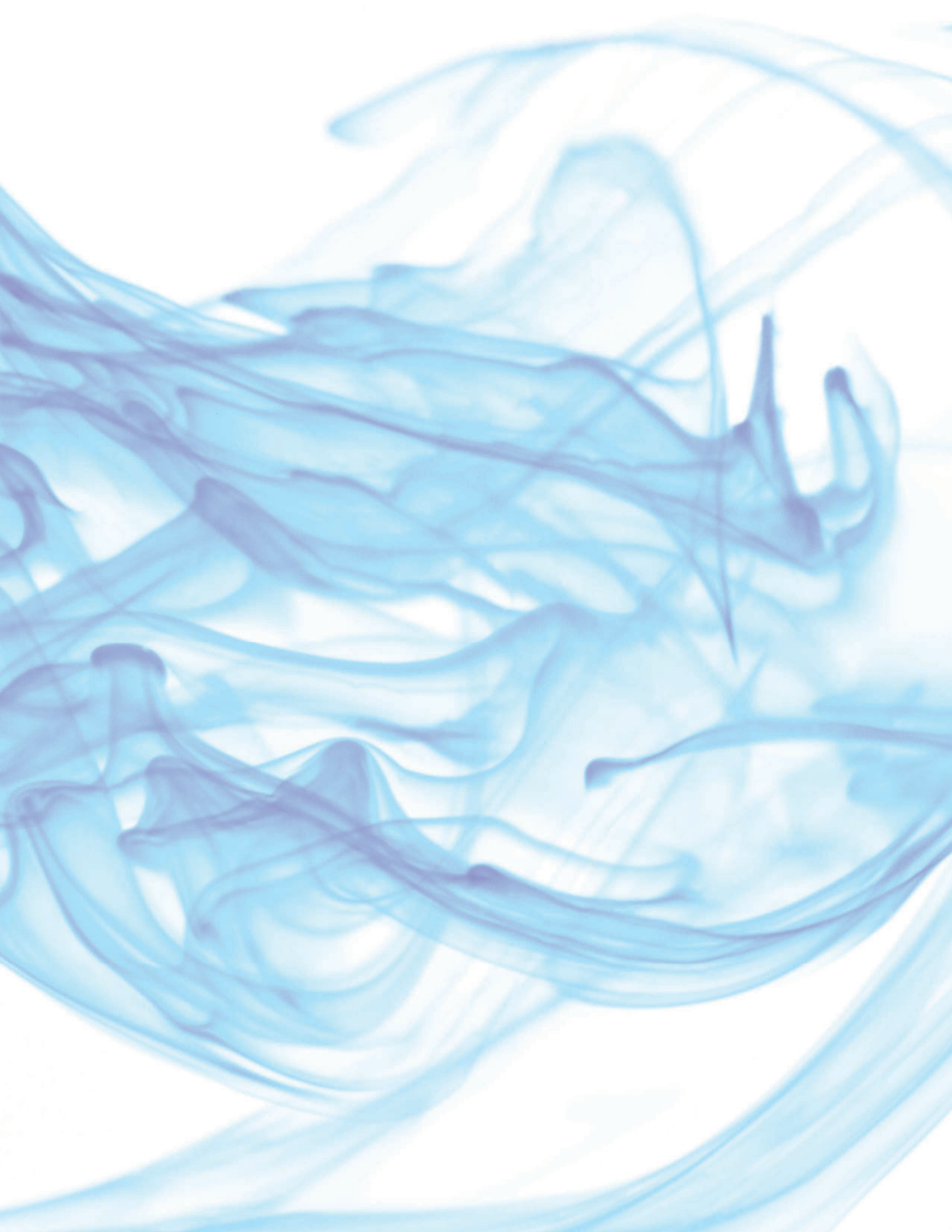
ASIAN DEVELOPMENT OUTLOOK 2019

STRENGTHENING DISASTER RESILIENCE

APRIL 2019



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Strengthening disaster resilience

Over the past half century, developing Asia has transformed from one of the world's poorest regions to its center of economic gravity. Almost all Asian economies are now at least middle income, yet they are also among the most heavily affected by natural hazards that become disasters and the most exposed to the consequences of climate change. More than four in five people affected by such disasters from 2000 to 2018 lived in developing Asia.

Although advanced and developing countries alike are exposed to various types of disaster risk, the consequences tend to be more severe in developing countries, where disasters disproportionately affect the poor and marginalized. Understanding and addressing disaster risk in developing Asia, where it has become a growing threat to development and prosperity, has thus become a critical challenge in research, policy, and practice.

The causes and consequences of disasters do not exist in isolation, however, but are bound up instead in the ongoing dynamics of the economy, society, and environment in which they occur. As such, comprehensively understanding the impact of disasters requires understanding their complexity.

The context in which disasters occur tends to be highly dynamic. Disasters are the result of the complex interactions between human actions and natural hazards. Many of the drivers of vulnerability and exposure to natural hazards can be found in underlying socioeconomic attributes and trends: poverty and inequality, demographic change, urbanization, governance structures, infrastructure investments, and the unsustainable use of natural resources and ecosystems. Climate change and climate variability intensify disaster risk by changing the frequency, intensity, and timing of extreme events, as well as the size of the area affected (IPCC 2012).

This chapter was written by Benno Ferrarini of the Economic Research and Regional Cooperation Department, ADB, Manila; Thomas McDermott of the National University of Ireland–Galway; and Ilan Noy of Victoria University of Wellington. It draws on the background papers listed at the end of the chapter. The contribution from Charlotte Benson of the Sustainable Development and Climate Change Department is gratefully acknowledged. Other contributions are listed in the Acknowledgments section.

The impacts of disasters are highly diverse. They affect different individuals and social groups in different ways, and they may extend well beyond the here and now. When disaster impacts spill across space and time, they may be either restrained or amplified through social and economic networks, migration, remittances, and production supply chains. They may be influenced by market mechanisms that operate through insurance or supply chains; government action in the form of infrastructure investment, early warning systems, and recovery assistance; and the actions of individuals as they relocate and migrate; or of communities as they reinforce social networks and build social capital.

Looking on the bright side in the aftermath of a disaster, the recovery phase is often a window of opportunity to learn from experience, mitigate future vulnerability and exposure, and enhance resilience. It is important, in a world where extreme weather events are expected to become more frequent and severe, that policy makers and affected communities resolve to “build back better.” As this chapter shows, a new approach to opportunity in the wake of a disaster distinguishes four main objectives: building back for a safer community, building back faster to sustain individual and community well-being, building back more inclusively for a fairer society, and building back for more social and economic potential in the future.

Natural hazards putting Asia's prosperity at risk

Developing economies across Asia are among the most dynamic in the world. However, they are also among the most vulnerable to natural hazards, such as storms, floods, droughts, tsunamis, and earthquakes, and to the impacts of climate change, such as sea-level rise, coastal erosion, and extreme temperatures.

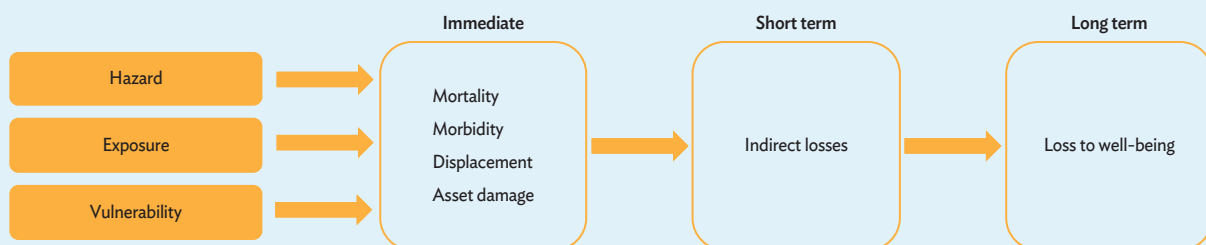
The impacts of disasters—either direct effects that cause fatalities, render people homeless or displaced, and wreak economic damage, or indirect effects that hamper economic growth, development, and poverty reduction—all exhibit distinct relationships with the underlying drivers of disaster risk: hazard types, the exposure of population and assets, vulnerability, and socioeconomic resilience (Box 2.1.1).

2.1.1 Disasters are hazards combined with a society's exposure and vulnerability

A disaster occurs when a hazard interacts with an exposed and vulnerable population, harming people and damaging physical assets such as property and infrastructure (box figure). Hazards can be natural, such as tropical storms and earthquakes, or man-made, such as industrial failures and nuclear accidents. This chapter focuses on disasters that are triggered by natural hazards. They can occur with little or no warning, or they can occur slowly over a span of days, weeks, months, or years. A hazard by itself need not constitute a disaster, as it must combine with a society's exposure and vulnerability to turn into a disaster. As such, no disaster is purely natural.

Disaster impacts can be direct and indirect. Direct impacts include damage to fixed assets and capital, including inventories; lost raw materials, crops, and natural resources; and death, injury, and disease. Indirect impacts are lost economic activity, in particular the production of new goods and services that will not take place following a disaster. Losses can be further divided between the short term, from a few months up to several years, and the long term, until reconstruction and recovery are complete.

Types of disaster impact



Notes: **Hazard** refers to the physical phenomena that can trigger disasters, including such weather-related phenomena as temperatures, rainfall, wind speed, and storm surges, or such geophysical phenomena as seismic activity. **Exposure** refers to the population and economic, social, cultural, and environmental assets located in areas that experience these physical hazards. **Vulnerability** refers to the outcomes experienced in terms of human, social, and economic impacts from a given hazard and degree of exposure to hazards. Higher vulnerability permits a more adverse outcome for the same intensity of hazard and exposure.

Source: Noy, Ferrarini, and Park, forthcoming, based on Noy 2016a.

2.1.2 Indonesia's three large disasters in 2018

In July and August 2018, the island of Lombok in West Nusa Tenggara Province of Indonesia experienced weeks of tremors before suffering a series of devastating earthquakes. Hundreds of people died, and thousands more were injured and displaced. In September, a magnitude 7.4 earthquake in a different part of Indonesia triggered a tsunami that struck the coast of Central Sulawesi. The earthquake triggered landslides and soil liquefaction in several densely populated districts, burying entire villages. In December, Anak Karakatoa, a small volcano in the Sunda Strait, erupted and generated a sudden tsunami that hit the densely populated coasts of Java and Sumatra on either side of the strait.

In these three events, more than 3,000 people were confirmed dead and more than 700,000 people were injured or displaced (box table). Homes, schools, hospitals, irrigation systems, and hundreds of kilometers of roads suffered extensive damage. Along the coasts of Central Sulawesi, Java, and Sumatra, tsunamis destroyed fishing vessels, ports, warehouses, and refrigeration facilities. Initial damage reports from the National Disaster Management Agency indicate damage and losses of \$950 million for Central Sulawesi and \$1.3 billion for West Nusa Tenggara. Damage in the Sunda Strait disaster was estimated at \$22.7 million by Maipark Indonesia Reinsurance Data, a reinsurance company.

Initial estimates suggest that growth in Central Sulawesi's 2018 gross regional product slowed by 3.6 percentage points, cutting growth by half. In West Nusa Tenggara, the effects of the earthquakes are estimated to have cut the gross regional product growth rate by 1.6 percentage points (box figure, left panel). In both cases, the local economies are expected to take several years to recover to pre-disaster trends.

The incidence of poverty is expected to increase in both areas, to 16.4% in Central Sulawesi and 16.8% in West Nusa Tenggara, reversing the trend toward lower poverty incidence in the affected provinces before the disasters (box figure, right panel). The disasters will

Disasters, damage, and losses

Effects	Lombok	Central Sulawesi	Sunda Strait
Deaths	515	2,081	437
Injured	7,733	11,000	14,059
Missing	0	1,309	16
Displaced	431,416	206,494	33,719
Damaged houses	76,765	68,451	2,752
Damaged health facilities	360	45	...

... = data not available.

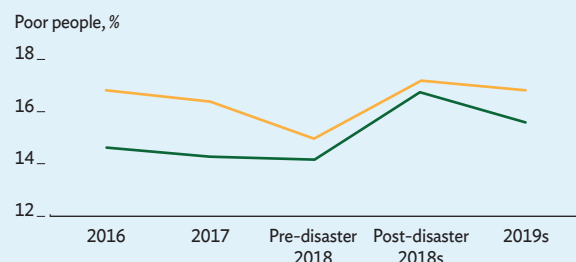
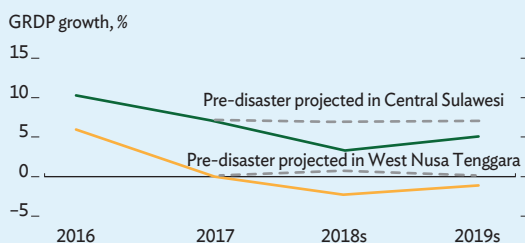
Sources: Asian Development Bank; ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre). <https://ahacentre.org/> (accessed 21 February 2019).

likely push the poor deeper into poverty, as job prospects are significantly reduced in the wake of the disaster. In Central Sulawesi, the number of jobs in agriculture, fisheries, and mining shrank, driving more workers into the informal economy. Primary irrigation channels were damaged, with immediate consequences for farmers. Wide stretches of coastline were rendered unusable for aquaculture, and marine life will be slow to recover. The Lombok earthquakes had major adverse effects on tourism and the people employed in the industry either formally and informally.

Fiscal adjustments will be required nationally and locally to meet disaster recovery needs. The economic and social costs of the recent disasters, which could exceed \$2.8 billion, have significantly intensified fiscal pressure on the Government of Indonesia. It immediately mobilized resources for relief and rescue efforts, but funding recovery in the affected areas will be more fiscally challenging as it competes with other spending priorities. The government is seeking to address a remaining gap in the annual budget allocation for disaster response and is evaluating sustainable options for disaster risk mitigation and financing.

Simulated impact on regional economic growth and poverty rates (%)

— Central Sulawesi — West Nusa Tenggara



GRDP = gross regional domestic product, s = simulation.

Source: Based on ADB 2018a, with updates.

The high human cost of disasters

In absolute terms, disaster impacts are concentrated in larger, higher-income, hazard-exposed economies, where there are greater concentrations of people and economic assets in locations exposed to hazards. However, higher incomes and better-quality institutions tend to reduce vulnerability (Fankhauser and McDermott 2014), with the benefits of higher income particularly pronounced in reduced mortality (Kahn 2005).

While advanced and developing countries alike are exposed to various types of disaster risks, the consequences—particularly in terms of fatalities and economic impacts—tend to be much more severe in developing countries, affecting poor and marginalized people disproportionately. This was borne out most recently through the experience of three Indonesian disasters in 2018 (Box 2.1.2).

These general observations are reflected in the data from the Emergency Events Database (EM-DAT) on recent disaster impacts across developing Asia, which is by far the world region most heavily affected by disasters in terms of human impact (Box 2.1.3). From 2000 to 2018, developing Asia was home to 84% of the 206 million people affected by disasters globally on average each year. It also accounted for almost 55% of 60,000 disaster fatalities worldwide. The most catastrophic disasters since 1990 have caused fatalities in almost every corner of Asia, but especially in East and South Asia (Figure 2.1.1). Even in global aggregates, catastrophes in Bangladesh in 1991, Indonesia in 2004, Pakistan in 2005, Myanmar in 2008, and the People's Republic of China in 2008 account for a disproportionate share of total mortality (Figure 2.1.2). Asia also suffers 26% of the \$128 billion in economic damage recorded annually on average.

2.1.3 The Emergency Events Database

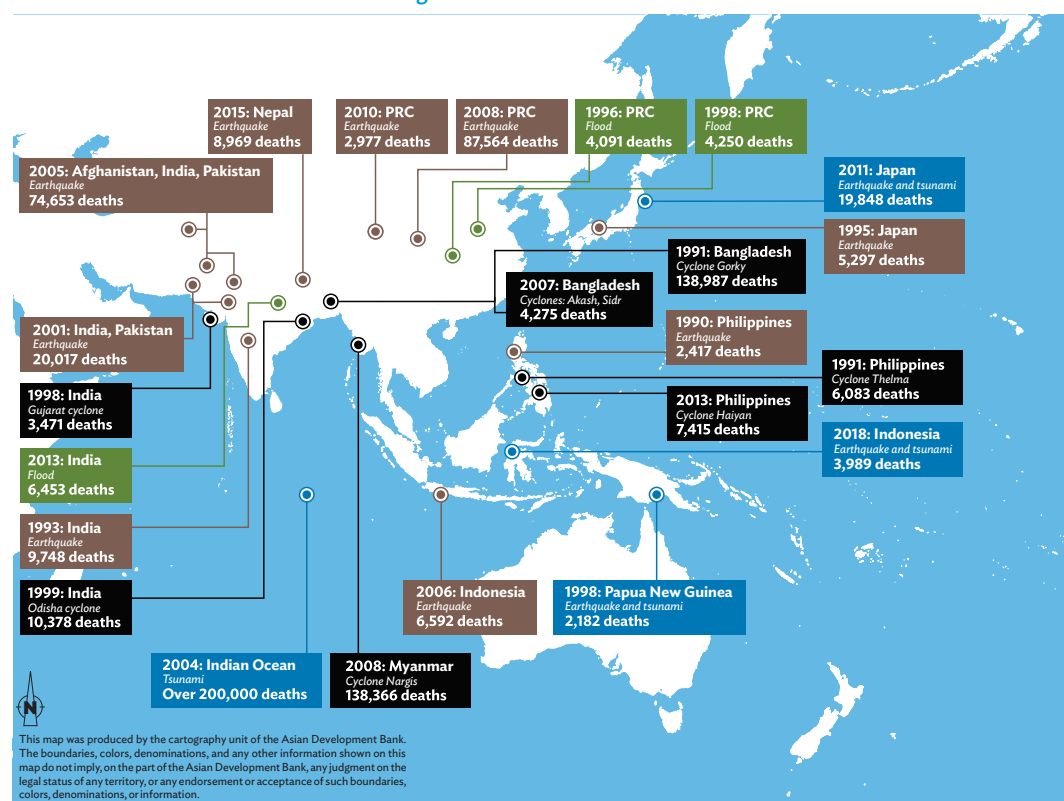
The Emergency Events Database (EM-DAT), compiled by the Centre for Research on the Epidemiology of Disasters, provides comprehensive information about the frequency, type, and intensity of disasters in terms of human and material losses, with nearly global coverage. EM-DAT records the number of people killed by a disaster, the number of people affected, and the amount of direct damage to property, crops, and livestock. “Affected” is broadly defined in the database as encompassing everything from severe physical injury to a temporary need to relocate because of periodic flooding that otherwise does little damage. However, data can be scant, especially on damage, being available for less than 40% of the disasters reported in developing Asia since 1980. More generally, disaster records before 2000 are presumed not to be very reliable, especially in developing countries, because the reporting of events and damage is incomplete and inconsistent across countries and time.

EM-DAT defines “disasters” as situations or events for which at least one of the following criteria holds true: 10 or more people are killed, 100 or more people are reported affected, a state of emergency is declared, or international assistance is requested. Data users are cautioned that these thresholds are the same whether an event reaches a threshold in a territory as vast as India or as tiny as the Marshall Islands. As a result, events of significance to a small country may fall through the cracks and go unreported (Noy 2015).

Included in EM-DAT are disasters triggered by weather-related hazards such as floods, storms, extreme temperatures, droughts, and wildfires; geophysical hazards such as earthquakes and volcanic eruptions; and biological hazards such as epidemics and insect infestations. Also included, but not featured in this report, are wholly man-made disasters such as industrial and transport accidents.

EM-DAT data and a full description can be obtained at <https://www.emdat.be>.

2.1.1 Death toll from the most devastating disasters in Asia since 1990

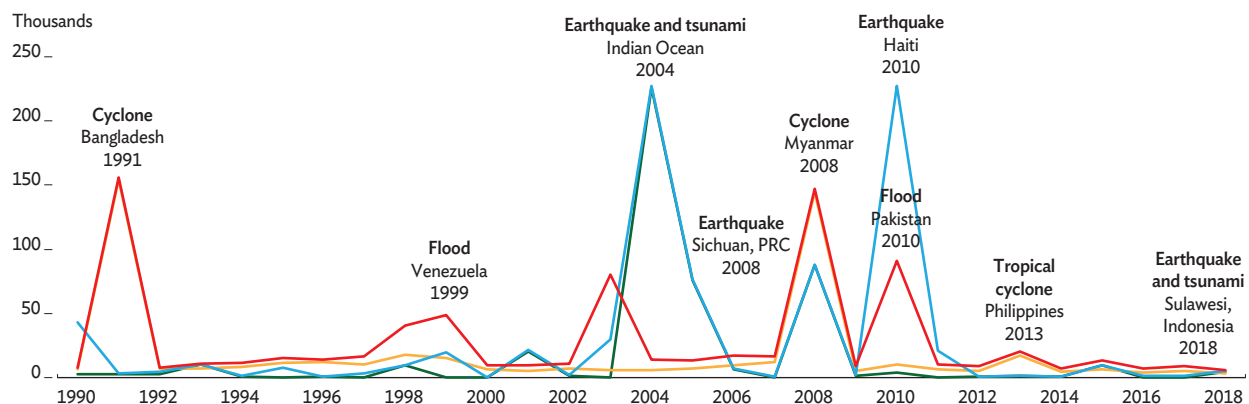


PRC = People's Republic of China.

Sources: Based on ADB. 2019. Recent Significant Disasters in the Asia and the Pacific Region. Infographic. <https://www.adb.org/news/infographics/recent-significant-disasters-asia-and-pacific-region> (accessed 4 February 2019), with updates using Centre for Research on the Epidemiology of Disasters. The Emergency Events Database. <https://www.emdat.be/> (accessed 6 February 2019).

2.1.2 Deaths from disasters, 1990–2018

- Developing Asia—Geophysical (earthquake, volcanic activity, tsunami)
- Developing Asia—Weather related (meteorological + hydrological + climatological)
- World—Geophysical (earthquake, volcanic activity, tsunami)
- World—Weather related (meteorological + hydrological + climatological)



PRC = People's Republic of China.

Source: ADB estimates using Centre for Research on the Epidemiology of Disasters. The Emergency Events Database. <https://www.emdat.be/> (accessed 6 February 2019).

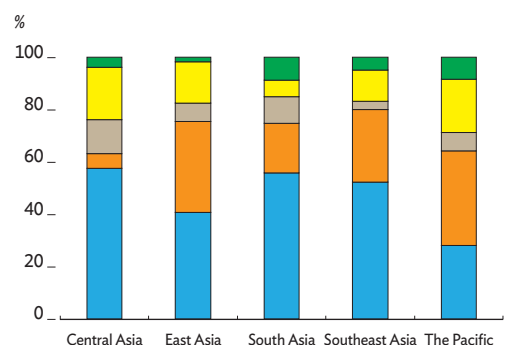
Diverse response strategies for diverse disasters

Hazards and their resulting disasters differ in their frequency and the intensity of their effects. They can thus be seen to represent different risk layers. Weather-related hazards such as storms, floods, and droughts are by far the most frequently recorded hazards in developing Asia, accounting for 82% of all events recorded in the EM-DAT database for the region over the past 2 decades (Figure 2.1.3). Geophysical hazards—including earthquakes, tsunamis, volcanic activity, and movements of dry mass—account for a further 12% of EM-DAT entries for the region. Biological hazards, either epidemics or insect infestations, make up the remaining 6%.

Weather-related hazards were responsible for 97% of people affected in the region since 2000. On the other hand, geophysical hazards caused 61% of disaster fatalities in developing Asia, well more than the 37% of fatalities in weather-related hazards (Figure 2.1.4).

2.1.3 Disaster occurrence by type, 2000–2018

■ Biological: epidemic and insect infestation
 ■ Geophysical: earthquake, tsunami, volcanic activity, and movement of dry mass
 ■ Weather-related: drought, extreme temperature, and wildfire
 ■ Weather-related: storm
 ■ Weather-related: flood and landslide



Source: ADB estimates using Centre for Research on the Epidemiology of Disasters. The Emergency Events Database. <https://www.emdat.be/> (accessed 6 February 2019).

2.1.4 Disaster impact in developing Asia, 2000–2018 (%)

Impact	Share to world total	Disaster type		
		Weather-related ^a	Geophysical ^b	Biological ^c
Death toll 	55	37	61	2
Number of affected 	84	97	3	0
Damage 	26	79	21	...
Total occurrences		82	12	6

... = No data reported in EM-DAT.

Notes:

^a Weather-related hazards include storms, droughts, floods, landslides, extreme temperatures, and wildfire.

^b Geophysical hazards include earthquakes, volcanic activity, tsunami, and movement of dry mass.

^c Biological hazards include epidemics and insect infestations. Data on epidemics are underreported because EM-DAT is not designed to capture events that develop slowly.

Source: ADB estimates using Centre for Research on the Epidemiology of Disasters. The Emergency Events Database. <https://www.emdat.be/> (accessed 6 February 2019).

Of the estimated \$644 billion in damage from disasters across the region from 2000 to 2018, weather-related hazards caused the greatest share, at \$507 billion or 79%, and geophysical hazards accounted for the remaining \$137 billion or 21% (Figure 2.1.4). Weather-related hazards usually have a much bigger footprint than geophysical hazards, which tend to be more localized. This may explain part of the difference in the distribution of damage. However, the differing composition of damage to assets, and of fatalities and the number of people affected, associated with different disaster types may be attributable as well to differing frequency and predictability.

Weather-related hazards are fairly predictable, facilitating preparation and effective early warning. Riverine floods, for example the 2011 flood in Thailand, can be predicted well in advance, sometimes by more than a month, and landfall for a tropical cyclone is usually known days before it happens. In these cases, lives can be saved by evacuating people out of harm's way and using specially constructed shelters. The construction of cyclone shelters and the introduction of early warning systems in Bangladesh, for example, has dramatically reduced the number of casualties in these events (Haque et al. 2012). In principle, deaths in weather-related hazards should be almost fully preventable. Those that occur are appropriately perceived as revealing a policy failure, especially as the costs of prevention are not prohibitive. In many cases, early warning systems have the added benefit of reducing asset damage by enabling people to defend some assets or move them out of harm's way.

Disasters triggered by geophysical hazards are relatively rare, so populations and governments may tend to underappreciate them and underprepare for them. Volcanic eruptions are becoming increasingly predictable, albeit only by several days but enough to allow the authorities to issue evacuation orders before they occur. Earthquakes, by contrast, are essentially unpredictable, even as the general seismic risk profiles of particular geographical regions become known. As such, mortality and damage from earthquakes is largely preventable only to the extent that construction standards are made robust enough for buildings and other infrastructure to withstand ground movement. This is a costly and challenging undertaking.

Early warning systems for tsunamis are feasible, but how much in advance warnings can be sounded depends on the distance of threatened areas from the epicenter of the geophysical event that generated the tsunami. More generally, warnings are conditional on scientists' limited ability to predict tsunamis precisely. The three deadly disasters in Indonesia in 2018 (Box 2.1.2) hit the coast without any advance warning despite the introduction, after the catastrophic 2004 tsunami in Aceh, of an early warning system in the Indian Ocean. While technically more challenging and more costly than early warning systems for weather events, tsunami alert systems date back to 1949, when the

Pacific Tsunami Warning Center was founded in Hawaii and began providing alerts throughout the Pacific Ocean.

Early warning is best done through a collective approach. Regional neighbors establish and maintain an integrated warning system as a regional public good that reduces cost while boosting efficacy. An integrated system can avoid duplication of components and enable effective coordination in the deployment of detection equipment, while participating countries' interdependence and mutual oversight provide incentives to maintain the system.

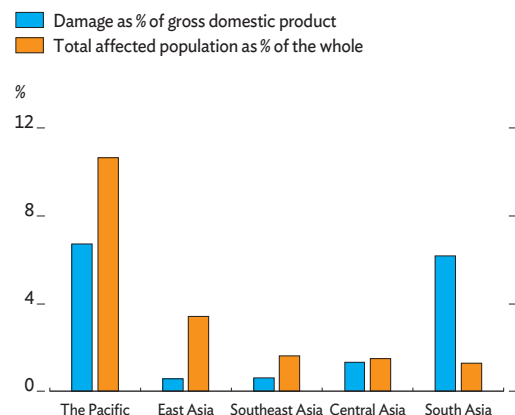
Bigger impact on smaller economies

Even for larger weather events, their geographic scale is typically smaller than most countries they hit, and their direct impacts in terms of human and economic losses are dwarfed by the population, territory, and gross domestic product (GDP) of affected countries. Partly for this reason, the impacts of disasters tend to be more eye-opening in smaller economies, such as those in the Pacific, when expressed relative to national population or GDP. From 2000 to 2018, 11% of the residents of Pacific island economies were affected by disasters, and economic losses equaled 7% of GDP. Economic damage to countries in other subregions of Asia ranges from 1% to 6% of GDP (Figure 2.1.5).

The 15 developing member countries of the Asian Development Bank (ADB) in the Pacific, with a combined population of 12.5 million people, are located in one of the most disaster-prone regions on earth. Many of these countries are exposed to tropical cyclones, frequent seismic and volcanic activity, and recurrent floods and droughts. In addition, they face growing threats from climate change as rising sea levels and deteriorating coral reef ecosystems exacerbate their vulnerability to tropical cyclones and storm surges. Disaster impacts are further compounded by these economies being small, remote, and undiversified.

Since 2000, disasters have affected 5.6 million people in Pacific developing member countries of ADB, causing close to 1,500 reported deaths. They have cost these countries \$1.9 billion in reported damage (EM-DAT). A global estimate of life-years lost per capita to disasters from 1980 to 2012 found Tuvalu and the Cook Islands most badly affected, followed in order by Samoa, Tonga, Vanuatu, and Fiji (Noy 2016b). Less exposed in per capita terms, but nevertheless still very exposed, were Papua New Guinea and the island states in the North Pacific. Tonga, Vanuatu, and several other countries in the Pacific top the World Risk Index, which assesses exposure to natural hazards, structural vulnerability, and coping and adaptation capacity (Heintze et al. 2018).

2.1.5 Disaster impacts normalized by GDP and population, 2000–2018



Note: In EM-DAT, "total affected" is the sum of those injured, left homeless, or otherwise affected after a disaster. "Affected" refers to people requiring immediate assistance during an emergency, either urgent medical assistance and other basic survival needs such as food, water, shelter, and sanitation.

Sources: ADB estimates using Centre for Research on the Epidemiology of Disasters. The Emergency Events Database. <https://www.emdat.be/> (accessed 6 February 2019); World Bank. World Development Indicators online database (both accessed 6 February 2019).

2.1.4 Vanuatu and Cyclone Pam

In March 2015, Tropical Cyclone Pam left a trail of destruction through the South Pacific. The effects of the category 5 cyclone left Kiribati, Solomon Islands, and Tuvalu with significant damage, even though it passed far to the side from them. The worst impact was in Vanuatu, where the cyclone made landfall in the evening of 13 March 2015. Sustained wind speeds were recorded as high as 270 kilometers per hour, with a reported maximum gust reaching 320 kilometers per hour (Handmer and Iveson 2017).

Eleven people were killed during the storm, which was fewer than predicted given the storm's ferocity, in part because of timely and accurate hazard warnings and community responses (Handmer and Iveson 2017). As the cyclone approached, the Vanuatu Meteorology and Geohazards Department sent warnings by text message, direct phone call, shortwave radio, and the internet. Damage was most widespread on the larger islands of Efate, Erromango, and Tanna. Approximately 65,000 people were displaced from their homes. Estimates were that 17,000 buildings had been damaged or destroyed, including houses, schools, public health clinics, and other medical facilities. The tropical cyclone destroyed the vast majority of crops and compromised the livelihoods of at least 80% of Vanuatu's rural population. The tourism industry was badly affected. Arrivals by air from March to June dropped by 26% below the previous year, and cruise ship arrivals by 52%, though arrivals swiftly recovered in the second half of the year (ADB 2016).

Estimated damage and losses to the Vanuatu economy exceeded the equivalent of 64% of GDP (ADB 2016). GDP growth fell from 2.3% in 2014 to

0.2% in 2015, rebounding to 3.5% in both 2016 and 2017 (ADB 2016, 2018b). GDP was initially projected to decline by more, but the large influx of external grants and loans, and accompanying post-disaster operations, softened the impact on the economy, allowing evidence of a significant economic recovery to emerge in less than a year (Mohan and Strobl 2017). The trade deficit in goods and services widened by almost half from the equivalent of 25% of GDP in 2014 to 36%, driven up by cyclone damage to export facilities and higher imports to compensate for domestic shortages and to supply post-disaster operations. The budget recorded a surplus equal to 1.4% of GDP because the bulk of the cyclone reconstruction was financed by development partners, allowing fiscal expenditure to rise only slightly.

Insurance from the Pacific Catastrophic Risk Assessment and Financing Initiative, which pools sovereign disaster risks across several Pacific island economies, paid the national government \$1.9 million within 10 days of the cyclone. Subsequent financing and international support, however, was far more substantial. External grants rose to \$75 million in 2015, and overall financial support from development partners—including ADB, the International Monetary Fund, the World Bank, and bilateral partners—exceeded \$147 million. Recovery financing went predominantly to large infrastructure projects, notably to rebuild airports and roads. As the economy rebounded, recovery and reconstruction projects continued, with many communities still feeling the impact of the cyclone almost 4 years later.

The most severe events can have catastrophic implications for small island countries. For example, Cyclone Pam in 2015, one of the most intense tropical cyclones ever experienced in the South Pacific, caused damage and losses in Vanuatu equal to 64% of that country's annual GDP (Box 2.1.4). More broadly, cross-country growth regressions suggest that severe disasters slowed annual rates of economic growth in the Pacific by 1.4 percentage points on average from 1980 to 2017. Little or no comparable evidence is found for developing Asia as a whole or its other subregions (Dagli and Ferrarini, forthcoming).

Severe disasters can affect the fiscal and external balance sheets of affected countries. Consumption-smoothing in the aftermath of disasters can generate temporary current account deficits. Similarly, disasters often temporarily reduce output growth even as they spur increased public investment for reconstruction and higher public expenditure as well for disaster relief (Obstfeld and Rogoff 1996, Felbermayr and Gröschl 2013).

Samoa experienced a catastrophic tsunami in September 2009 that killed 147 people and affected 5,585 others. International partners provided \$26.7 million for tsunami reconstruction, and Samoa managed to raise \$20.5 million from its own fiscal resources for disaster response. This equaled 9% of all government expenditure in fiscal year 2014 and left a large funding gap. As a report by the Government of Samoa noted, the recovery plan, spread over 3 years, would cost over \$100 million (Noy and Edmonds 2019).

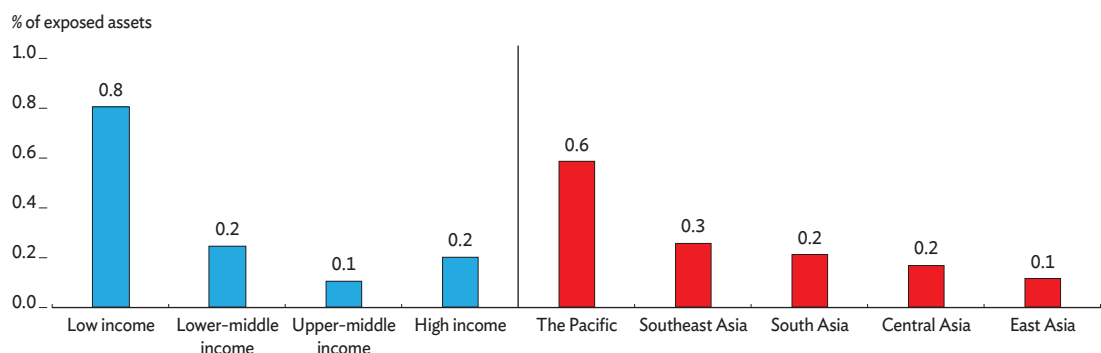
With sufficient funding, recovery efforts are likely to be successful. This is illustrated by Vanuatu's recovery from devastation caused by Cyclone Pam, which triggered substantial international financial support. The disaster proved timely, as it occurred just as the Sendai Framework for Disaster Risk Reduction was being signed in March 2015 by most United Nations member countries in a conference in Sendai, Japan.

Average annual losses view disaster costs over time

The historical record of disaster losses is limited and can fail to capture extremely rare events. A 50-year historical record, for example, may very well not include an earthquake that occurs only once in 400 years. An alternative way of expressing disaster impacts, rather than isolating losses from a particular event or summing up the measured losses over a particular period, is through average annual losses (AALs). These are total expected losses annualized over a projected time frame of up to thousands of years. AALs are therefore the predicted amount that countries would have to set aside each year to cover the cost of future disasters, assuming they received no international support. Another way to put it is that AALs approximate the actuarially fair annual cost of insuring against these disasters.

As with other metrics for measuring disaster impacts, AALs expressed in absolute terms concentrate in larger and higher-income economies that are exposed to hazards. However, expressed as a percentage of exposed assets, they are significantly higher for smaller and low-income countries. AALs are estimated at around 0.8% of exposed assets for low-income countries in developing Asia, compared with 0.2% for those with lower-middle incomes, 0.1% for those with upper-middle incomes, and 0.2% for high-income countries. In terms of regional distribution, ratios of AALs to exposed assets in the Pacific subregion are, at over 0.6%, more than twice as high as those for any other subregion in developing Asia (Figure 2.1.6).

2.1.6 Average annual losses in developing Asia, by income group and subregion



Low income: Afghanistan, Bangladesh, Cambodia, Myanmar, Nepal, and Tajikistan. **Lower-middle income:** Armenia, Bhutan, Federated States of Micronesia, Georgia, Indonesia, Kiribati, the Kyrgyz Republic, the Lao People's Democratic Republic, Mongolia, Pakistan, Papua New Guinea, the Philippines, Samoa, Solomon Islands, Sri Lanka, Timor-Leste, Uzbekistan, Vanuatu, and Viet Nam. **Upper-middle income:** Azerbaijan, Fiji, Kazakhstan, Malaysia, Maldives, Marshall Islands, Palau, the People's Republic of China, Thailand, Tonga, Turkmenistan, and Tuvalu. **High income:** Brunei Darussalam; Hong Kong, China; Singapore; and Taipei, China. **The Pacific:** Excludes Cook Islands and Nauru. **East Asia:** Excludes the Republic of Korea.

Source: UNISDR 2015.

AALs for earthquakes and tropical cyclones affecting Pacific island countries, based on a different risk modeling analysis, are detailed in Table 2.1.1. Also shown are expected losses from events that have a 10% chance of occurring in the next 50 years. Both lists emphasize the elevated risk to these countries in terms of both human and property losses.

2.1.1 Expected losses from earthquakes and tropical cyclones in the Pacific

Country	Average annual losses from earthquakes and tropical cyclones (\$ million)	Minimum cost threshold of events deemed to have a 10% chance of occurring in the next 50 years	
		Losses (\$ million)	Casualties
Marshall Islands	3.0	>160	>150
Fiji	79.0	>1,500	>2,100
Solomon Islands	20.0	>520	
Tonga	15.8	>437	
Palau	2.7	>247	>175
Vanuatu	48.0	>540	>2,150
Kiribati	0.3	>40	>200
Timor-Leste	5.9	>530	>2,100
Tuvalu	0.2	>9	>50
Nauru	0.0 ^a	>0.2	= 0
Papua New Guinea	85.0	>1,400	>11,500
Cook Islands	4.9	>268	
Samoa	10.0	>315	
Federated States of Micronesia	8.0	>470	>600

^a \$20,000.

Source: Pacific Catastrophic Risk Assessment and Financing Initiative. http://pcrafi.spc.int/documents/?limit=100&offset=0&doc_type___in=presentation (accessed 23 November 2018).

Bringing ‘extensive disaster risk’ out of the shadows

Globally, most disaster mortality is concentrated in very intensive disasters, as noted above (Figure 2.1.2). More than 45% of global disaster mortality since 1990 has been concentrated in just six events. However, the United Nations Office for Disaster Risk Reduction has argued that mortality associated with what is referred to as “extensive disaster risk” is almost unmeasured but also on the rise (UNISDR 2013).

Events that pose extensive risk are not very dramatic or severe but happen frequently: mainly flash floods, landslides, urban flooding, storms, and other localized weather events. Electrical storms and lightning are notable for increasingly causing losses from extensive risk, by sparking wildfires (UNISDR 2015).

Global risk modeling rarely captures extensive risk. The losses incurred from extensive risk are rarely reported internationally but simply absorbed locally by low-income households, small businesses, and municipal governments (UNISDR 2009). Yet deaths and economic losses from extensive risks are mounting in low- and middle-income countries, as measured on the database of the United Nations Office for Disaster Risk Reduction. In the past decade, losses to extensive risk in 85 countries and territories came to \$94 billion.

Extensive disaster risk typically worsens inequality and poverty by slowly eroding development assets such as houses, schools, health facilities, roads, and other local infrastructure (Gall, Borden, and Cutter 2009). As is intensive risk, it is made worse by the usual adjuncts of inequality and poverty: weak governance, badly planned and managed urban development, and rural livelihoods made even more vulnerable by environmental degradation. As extensive risk rises, it undermines efforts to reduce poverty and to achieve many of the Sustainable Development Goals, while the accumulating losses associated with extensive disaster risk highlight that understanding and practicing disaster risk reduction has not been effective at avoiding risk generation and accumulation (UNISDR 2015).

Evidence is mounting about the social and economic costs of widespread, high-frequency natural hazards such as changing rainfall patterns and temperature fluctuations. They constrain human mobility (Barrios, Bertinelli, and Strobl 2006; Henderson, Storeygard, and Deichmann 2014) and human capital accumulation (Maccini and Yang 2009, Hyland and Russ 2019), and can even cause conflict (see literature cited in Dell, Jones, and Olken 2014).

These different types of disaster risk call for different response strategies that follow a “risk layering” approach. For example, financing response to disaster risk through insurance may be the most viable mechanism for large residual risks that cannot be reduced or managed otherwise. In the case of extensive risk, the most effective responses may be investment in improved and disaster-resilient infrastructure, education and social strengthening to build community resilience, and improved access for vulnerable groups to market mechanisms such as finance and remittances. Generally, disaster risk reduction is the most effective first action to tackle disaster risk, both extensive and intensive. These are central themes in the remainder of this chapter.

Escalating risk of disaster losses

Across developing Asia, losses from disasters are substantial and continue to impede development. They would seem to indicate that rising incomes and efforts toward adaptation and disaster risk reduction have been insufficient to balance the worsening of hazards and greater community exposure to them.

Exposure to disaster risk in developing Asia is rising rapidly. This is partly just a function of population and economic growth, as there are more people and built structures in harm’s way, but it is also a function of trends that concentrate population and assets in high-risk locations, such as the spread of coastal megacities. Some of these trends are particularly pronounced in developing Asia.

The most striking recent illustration of such trends and their consequences was flooding in the second half of 2011 that hit Thailand, specifically Greater Bangkok. According to EM-DAT, this was the costliest flood ever recorded globally. World Bank (2012) estimated that there were 800 fatalities and \$46.5 billion in losses. The direct loss of property and infrastructure to the flood was estimated to equal nearly 13% of the annual GDP of Thailand. The flood affected many provinces, including commercial and industrial districts outside of Bangkok. It started with very heavy rains in late July and early August. Flooding started in the north of the country, causing the south-flowing Chao Phraya, the main river bisecting Greater Bangkok, to overflow its banks. Most of the flood impact was experienced in the last quarter of 2011, with the high water bulge reaching Greater Bangkok in early November. While the wet monsoon of 2011 was indeed exceptional, a lot of the damage was traceable to the recent construction of many industrial estates in flood-prone areas on the edges of Bangkok and the consequent lack of flood-water retention areas (known in Thai as *kaem ling* or monkey’s cheeks).

In addition to rising exposure, worsening disaster risk can be traced to the effects of climate change and the rise in sea level that is threatening coastal cities and island states across Asia and the Pacific. Many coastal cities in the region are experiencing increased flood risk from other causes as well, notably from land subsidence, in part a result of uncontrolled water abstraction; upriver deforestation, which reduces the capacity of the soil to hold water; and the paving of once-permeable surfaces in urban areas.

Many studies project large increases in economic damage from disasters in the near future. Some studies project annual global damage from floods to increase ninefold from \$6 billion in 2005 to \$52 billion by 2050, this increase arising from projected socioeconomic change alone (Hallegatte et al. 2013). Recent research into the effects of future sea-level rise on coastal cities highlights the potential economic and population losses for global megacities. One dramatic prediction for Ho Chi Minh City is that it will lose 41% of its area, 22% of its population, and 22% of its real gross regional product (Desmet, Nagy, and Rossi-Hansberg 2018). Other metropolitan areas that stand to lose an important share of their population include Bangkok, Shanghai, and Tianjin. Similarly, studies of future damage to coastal cities around the world from storm surges predict very large losses in absolute terms, concentrated in large Asian megacities. Many Asian cities risk losses equal to 2% or more of their GDP from events that threaten each city with a 5% probability of occurring by 2030 (Abadie, Galarraga, and de Murieta 2017).

Projections of future global losses from tropical storms indicate large increases in economic damage caused mainly by increased exposure arising from socioeconomic trends. In some cases, higher intensity comes from higher temperatures in the ocean. Economic damage from tropical cyclones in countries that are not wealthy members of the Organisation for Economic Co-operation and Development (OECD) is forecast to be doubled or trebled by 2100 by socioeconomic change alone, soaring from the current \$6.7 billion per year to \$13 billion–\$18 billion by 2100. The projected increase reflects the estimated historical positive elasticity of cyclone damage with respect to incomes (Bakkensen and Mendelsohn 2019).

Factoring in the effects of climate change increases the projection for cyclone damage in non-OECD countries by a further 8% on average. By contrast, fatalities from cyclones are projected to decline by as much as three-quarters with socioeconomic change, dropping from 8,000 per year currently in non-OECD countries to just over 2,000 per year by 2100. The decline reflects the estimated historical trend toward fewer cyclone fatalities with rising income, as well as significant improvements in early warning systems.

Disaster impacts and how they propagate

Local effects

Some large, geographically widespread disasters are particularly memorable. In 2013, Typhoon Haiyan swept from the Federated States of Micronesia through Palau, the Philippines, Viet Nam, the People's Republic of China, and Taipei, China. More often, though, disasters are localized events with economic impacts largely concentrated in the affected area. Studies that rely on regional or national indicators to estimate the economic impacts of disasters are therefore often prone to underestimate the true local impact in the localities hardest hit.

The immediate impacts of disasters on local economic activity can be significant. New analysis of the local economic impacts of tropical cyclones in the Philippines showed that the local effects of these storms could be substantial (Box 2.2.1).

2.2.1 The local economic impacts of tropical cyclones in the Philippines

Much of the existing literature on the impact of tropical cyclones has tended to focus on national or regional effects. While insightful, these macroeconomic studies provide little useful information for formulating policies to build resilience locally. More specifically, tropical cyclones are, like most natural hazards, inherently local in nature, but local impact becomes diluted if averaged out over a large regional unit of analysis. A number of recent papers investigated this aggregation problem when measuring the impact of tropical storms and found that aggregate data tended to underestimate the true impact of these extreme weather phenomena on local economies (Strobl 2011, Elliott, Strobl, and Sun 2015).

Strobl (forthcoming) used nightlight intensity derived from satellite images, illustrated in box figure 1, as a proxy for economic activity (Henderson, Storeygard, and Weil 2012) and combined it with actual storm tracks and a wind field model to investigate the local economic impact of typhoons in the Philippines. The Philippines is one of the most storm-prone countries of the world, with an average of 7.5 typhoons having made landfall annually since 1970 (Blanc and Strobl 2016).

Results from this analysis show that exposure to tropical cyclones significantly disrupts economic activity in the Philippines. After a storm of average intensity in the sample, local economic activity was

1 Night light intensity in the Philippines in 2013



Source: Strobl, forthcoming.

2.2.1 Continued

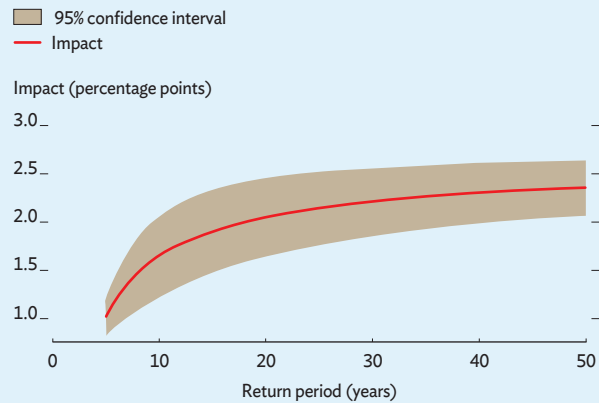
reduced by 2%. After the most severe storm in the sample, local economic activity was reduced by 23%. On average, these effects on local economic activity appeared not to persist beyond the year of the storm.

The findings can be used to construct a distribution of losses using the full set of storms hitting the Philippines from 1950 to 2013. This enables an estimate of expected damage from typhoon intensities with different return periods, or from storms occurring with different probabilities. The results of this exercise are illustrated in box figure 2 for national losses.

Relatively frequent storms, those with a 5-year return period, should be expected to produce losses equal to about 1% of national economic activity. This rises as one considers less frequent events. For example, a storm with a 50-year return period is expected to cause a reduction of national economic activity exceeding 2% in the year of the storm.

At a regional level, the expected losses vary substantially. For instance, in Region VIII on the southern island of Mindanao, typhoons with 50-year return periods caused losses in economic activity exceeding 20%. In contrast, losses were relatively modest in the National Capital Region and northern Luzon. For the capital, a storm with a 20-year return period is not likely to cause more than a 1% reduction in economic activity. The regional analysis, and the variation of results across regions, underlines the need to take into account the local and regional impacts of disasters in disaster risk management and disaster preparedness, to identify hot spots for expected damage and stress-test response and recovery plans against more extreme scenarios.

2 N-year return period national losses



Source: Strobl, forthcoming.

These estimates illustrate the magnitude of losses that should be expected from tropical storms occurring in the Philippines, both nationally and regionally. However, the expected losses estimated here are based on historical observations. The impacts of tropical storms may be expected to increase in the future as storms likely become more severe under climate change and as communities become more exposed. Moreover, approximating GDP using nightlight intensity reflects only some forms of economic activity, such as services and manufacturing, and likely underrepresents other activities, particularly agriculture, which is very vulnerable to weather.

After a storm of average intensity in the sample, local economic activity was reduced by 2%; after a storm of the highest intensity, local economic activity was reduced by 23%. The cumulative impact of these events in the Philippines since 1992 is estimated to have exceeded \$11.6 billion.

These findings on the Philippines correspond to other recent evidence on the local economic impacts of flooding, which found that large floods in urban areas reduced local GDP by 2%–8% in the year of the event (Kocornik-Mina et al. forthcoming). As is observed with cyclones, GDP in affected cities appears to be fully restored in the year following the flood.

It is important to note that GDP, even when measured locally, is itself an aggregation and may therefore obscure impacts on particular groups or individuals. This is especially problematic if the impact is not distributed evenly across various groups and affects specific groups more intensely.

Further, by focusing on measures of economic activity, this analysis omits any social, cultural, or environmental impacts that do not materially affect the economy.

The relatively quick restoration of economic activity observed in these studies may partly reflect that, in many cases, households that temporarily migrate away in the aftermath of disasters subsequently return to their land and livelihoods. Of course, this rapid restoration of population and economic activity to affected areas may or may not be interpreted as a sign of disaster resilience. In particular, if disasters tend to reoccur, hitting the same locations with high frequency—as for example with monsoonal flooding—then restoring activity to these vulnerable locations may simply put people and economic assets back in harm’s way.

These concerns are reinforced by the anticipated effects of climate change on the risk of extreme weather events. Climate change will increase natural hazard risk for particular locations. An important part of adaptation to climate change, at least in the long run, may involve moving people away from locations with worsening hazards, with consequent reductions in productivity (Desmet and Rossi-Hansberg 2015, Desmet, Nagy, and Rossi-Hansberg 2018).

The evidence available to date indicates that such adjustment is likely to be slow because current and future patterns of spatial development tend to follow paths laid down by earlier development, and it is costly to deviate from them (Bleakly and Lin 2012, Michaels and Rauch 2018). Cities in particular have been found to persist even in the aftermath of devastating shocks, including wartime devastation (Davis and Weinstein 2002, Miguel and Roland 2011) and large-scale flooding (Kocornik-Mina et al., forthcoming).

Persistent effects of disasters

Empirical evidence of the effects of disasters on growth is strongest in relation to small island developing states, where major events can wipe out a large part of the economy and destroy critical infrastructure such as airports and harbors (Heger, Julca, and Paddison 2008, Lee, Zhang, and Nguyen 2018, Dagli and Ferrarini, forthcoming). However, the broader empirical literature on disasters and economic growth is far from conclusive.

While most disaster impacts on economic activity appear to be short-lived, in some cases the effects may persist for a long time. (Recent empirical evidence on the short- and long-run impacts of disasters in developing countries is reviewed in Sawada and Takasaki [2017].) For example, a decade on from the 1995 Kobe earthquake in Japan, local income per capita in Hyogo Prefecture was still depressed by 12% because of lost employment opportunities. This reflected a regional shift

from manufacturing to services that was directly attributable to the earthquake. A significant share of heavily damaged factories failed to resume operations in Kobe, and there was a shift in employment from Kobe to nearby Osaka. As a result, the earthquake caused a permanent loss of economic opportunity (duPont et al. 2015, Cole et al. 2018).

There is also evidence that poor countries can experience prolonged, slow, and incomplete recovery in the aftermath of severe disasters. In particular, small island states are the most vulnerable because of their diminutive size relative to the hazards' footprint, their geographic isolation, and their lack of economic diversity. These factors mean not only higher aggregate damage but less hope of recovery in the short or long term (ADB 2018c). The 2010 earthquake in Haiti, for example, was so catastrophic that it was found to have undermined the long-term development prospects of the Haitian economy (Best and Burke 2017).

Macro impacts through market prices

Disaster effects can spread across time because of permanent shifts in market forces. They can, for example, cause lasting distortions through market concentration and collusive price hikes. Recent research on the impact of the 2011 Thailand flood on the hard disk drive industry, for instance, suggests that the disaster enticed market-distorting collusion in certain segments of the industry (Box 2.2.2).

Disasters may affect location choices for households and businesses, thus influencing real estate prices. In efficient real estate markets, prices provide market signals about property value and its many determinants. However, there is substantial evidence that real estate markets are far from efficient in reflecting disaster risk in their prices. A large number of empirical investigations in several countries demonstrated how past experience of floods and flood risk affected house prices relatively little and not for long. Meta-analysis established price effects ranging from -7% to +1% (Beltrán, Maddison, and Elliott 2018).

The weak sensitivity of real estate markets to disaster risk has been attributed to their lack of liquidity, which limits price movements. This and other frictions in land and real estate markets kept commercial and residential land prices from declining despite substantial damage from the 2011 flood in Thailand (Sawada et al. 2018, Wong 2008).

By contrast, there is ample evidence that, where market frictions are small, real estate rental and asset prices may reflect disaster risk well. Research on earthquake risk aversion in the Tokyo metropolitan area, for example, found that housing rents were substantially lower in risky areas than in safer ones (Nakagawa, Saito, and Yamaga 2007).

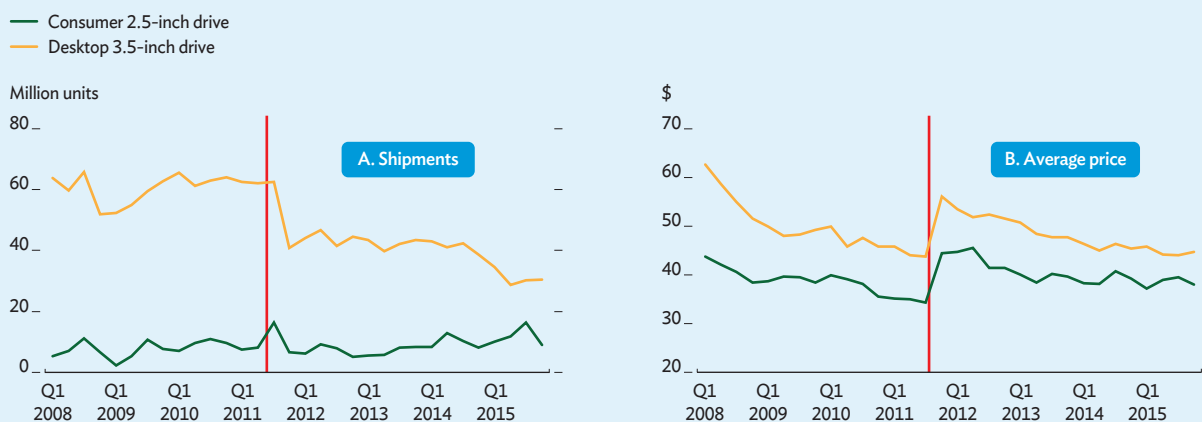
2.2.2 Impact of the 2011 Thailand flood on the hard-disk drive industry

To examine the impacts of the 2011 Thailand flood on the hard disk drive (HDD) industry, Nakata, Sawada, and Wakamori (2019) analyzed the quarterly data of individual firms on HDD shipments and the average prices for the nine market segments of the HDD industry from the first quarter of 2006 to the fourth quarter of 2015. In relation to the consumer 2.5-inch segment, it found evidence that the three biggest manufacturers colluded after the floods. The evidence was higher shipments after the production plunge caused by the floods (box figure 1a). Meanwhile, the average price declined by only a limited extent and remained higher than it was before the flood (box figure 1b).

By contrast, shipments of the desktop 3.5-inch segment did not recover from the large drop triggered by the floods, and the average price returned to its previous level. Even in this segment, the study could not preclude that HDD manufacturers became more collusive after the flood by collectively controlling shipments.

The 2011 Thailand flood was thus found to have had an impact on the HDD market structure against the interests of consumers. This evidence illustrates the need for public policy intervention to keep firms from unduly benefiting from disasters and thereby restore their incentive to invest in risk prevention.

Hard disk drives shipments and average price



Source: Nakata, Sawada, and Wakamori 2019.

Similarly, there was evidence of a 20% discount on nonresidential land prices for every kilometer closer to the Uemachi fault line passing east of Osaka Prefecture in Japan, after the 1995 Kobe earthquake highlighted for residents and policy makers earthquake risk along faults (Gu et al. 2018).

A study on companies' location choices following the 2011 Thailand flood shows that firms in affected regions became more aware of flood risk following the event, but some were unable to relocate for one reason or another (Sawada et al. 2018). Land prices in unflooded areas increased relative to those in flooded areas, but this was driven mainly by new entrants choosing less risky locations. While industrial land prices were affected, there was no evidence of effects from flooding on residential or commercial land values.

Other studies found similar short-term moderate price declines for houses that were associated with earthquake risk (Hidano, Hoshino, and Sugiura 2015, Timar, Grimes, and Fabling 2018a).

Real estate markets may fail to reflect disaster risk for a number of reasons. One is incomplete information on existing risk, as suggested by studies showing sharpened risk perceptions following extreme events. For example, Gallagher (2014) found that insurance take-up in the US spiked the year after heavy floods and steadily declined thereafter. Another is the moral hazard associated with government interventions to provide protective infrastructure and disaster recovery. A typical trade-off involves public money spent to reduce risk to people living in flood-prone areas, which makes them more reluctant to relocate away from risky areas (Kocornik-Mina et al., forthcoming).

It is notable that, despite limited liquidity and other frictions in the real estate market, once the government intervenes to clearly define and constrain the risk, the impact on real estate prices can be significant. For example, prices for buildings in Wellington, New Zealand, fell by an average of 45% after they were officially declared earthquake-prone and in need of remediation to meet earthquake safety standards (Timar, Grimes, and Fabling 2018b).

Macro impacts through small businesses

Disasters can disrupt businesses by, for example, increasing costs for their inputs. Smaller firms in particular will struggle to cope with direct damage to their buildings, equipment, and inventory and with other interruptions to their operations. In the aftermath of flooding in Mumbai in 2005, for example, a survey was carried out on a randomly selected group of 627 retail outlets in six flood-prone wards. Only 2% of surveyed businesses filed insurance claims for flood-related losses, and the average compensation received by those that did was only about ₹35,000. Insurance claims compensated for no more than one-third of the losses on average, and only for the small minority of businesses that filed insurance claims (Patankar, forthcoming).

Further evidence from surveys and interviews with flood-affected small and medium-sized enterprises (SMEs) in Chennai found that the businesses worst affected were those with annual turnover of less than ₹100 million (Idicheria and Neelakantan 2016). Most of the losses incurred by these businesses were damage to fixed assets like physical infrastructure, with manufacturers the worst affected. Many lost as well important business documents, including electronically stored documents along with the electronic equipment. Business services were disrupted by flood damage to infrastructure. On average, firms made do without electricity for 13 days and without water supply for 12 days. Solid waste and sewage issues persisted for more than 15 days.

The flood exposed how very much smaller businesses rely on informal financing channels like friends and unlicensed moneylenders. Most smaller businesses had invested their own money or borrowed from private sources to set up their enterprises. They typically had slim profit margins and limited credit. Losses to the flood were amplified for such businesses by their lack of access to emergency funds or additional finance through official lending institutions. Although some had insurance, the payouts were very low and in some cases were not paid for months. With production shut down, perhaps for lack of inputs and clients, many firms suffered significant financial distress. Many could not repay their loans and were forced to shut down and sell their assets (Patankar, forthcoming).

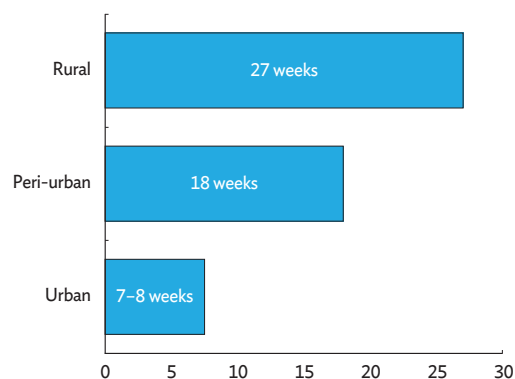
Low insurance penetration is a problem not only for firms in developing countries. Disaster insurance uptake by firms is low even in developed countries like Japan, where the participation rate for disaster insurance is only 47% for SMEs (Sawada et al. 2017).

Micro impacts on households and health

The direct effects of disasters disproportionately hit poorer households and the more vulnerable members of society, as is well recognized. Particularly in rural areas, disasters can trap households in poverty, rendering them unable to take advantage of opportunities for growth. In many cases, poorer households are forced to migrate to cities in the hope of escaping an adverse economic shock. Responding to community surveys conducted in areas vulnerable to flooding across five Asian countries, 90% of rural households surveyed reported that they had suffered loss of life or significant damage to assets from flooding within the past decade. These rural households took more than three times longer than urban households to recover financially from damage caused by flooding, 27 weeks versus 7–8 for urban households (Figure 2.2.1) (Laurien and Keating, forthcoming).

Household surveys following severe flooding in Indian cities showed that, in the absence of social protection, disaster-hit families used up savings or borrowed at high interest rates from informal lenders, pushing them further into indebtedness and poverty. Poor households were disproportionately affected by disasters in that they are more likely to be hit by a disaster than wealthier households and, when hit, suffered greater losses relative to their income (Box 2.2.3) (Patankar, forthcoming; see also Winsemius et al. 2018, Hallegatte et al. 2016a and 2017, Sakai et al. 2017). Compounding these vulnerabilities, poorer households had difficulty accessing the mechanisms that were typically used to cope with income shocks, notably financial services such as insurance and credit (Castells-Quintana, Lopez-Urbe, and McDermott 2018).

2.2.1 Financial recovery time from last severe flood



Source: Laurien and Keating, forthcoming.

2.2.3 The impact of floods on households—evidence from India

Mumbai

In a case study of severe flooding in the Indian city of Mumbai in 2005, the administrative wards worst affected by flooding featured high population density, at 4–5 times the city average of 27,150 per square kilometer, and many households in tenements, slums, and other poor living conditions. The percentage of slum-dwelling households in these wards was 21%–46%. Of the households randomly selected in affected wards for inclusion in the survey, 71% were classified as poor and 16% as living below the poverty line. Most households surveyed lived in badly constructed dwellings.

Poorer households reported higher intensity of flood impacts, and the losses they reported were more substantial relative to income (box figure 1). Families below the poverty line suffered losses exceeding a year's income from damage to assets they owned, while the losses of households classified as poor equaled about 5 months of their income. Others reported the cost of repairing or replacing damaged assets equal to 1–2 months of income. Almost all surveyed families covered losses out of their own pockets.

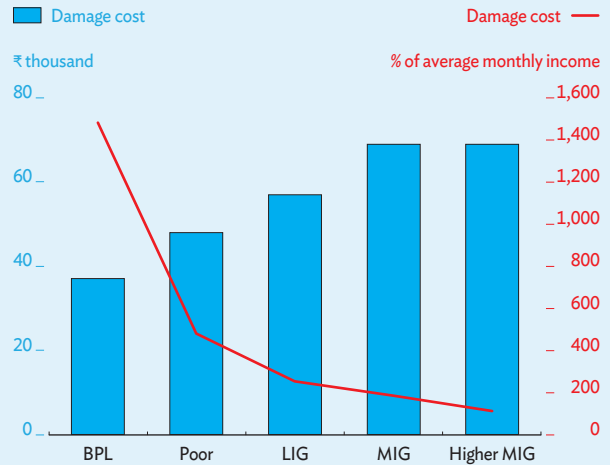
In the absence of adequate support mechanisms such as social protection or insurance coverage, disasters have the potential to push poor families into debt traps and chronic poverty. Reported indirect impacts suggest potential knock-on effects from the disaster on household welfare, health, and ability to access basic services. For example, many households surveyed in the aftermath of the flooding reported fuel shortages, garbage inside their homes, problems getting electricity and clean water, food shortages, price rises, and a lack of transport (box figure 2).

Compensation for damage from flooding came through government relief in what it called gratuitous relief assistance, amounting to ₹5,000 for affected families to cover such immediate requirements as food and clothing. The amount was uncorrelated with actual losses reported by families, and it covered only a small proportion of losses: 13.5% for families below the poverty line and 10.4% for poor families. In fact, the government carried out no needs assessment after the disaster to capture information about losses suffered by families. Compensation per capita was slightly lower for the poorest households than for others because they tended to have larger families.

Chennai and Puri

When Chennai and Puri suffered severe flooding in late 2015, the houses of many poor and migrant families were washed away or partly damaged. Most families reported work losses ranging from 15 to 45 workdays and an average loss in wages at

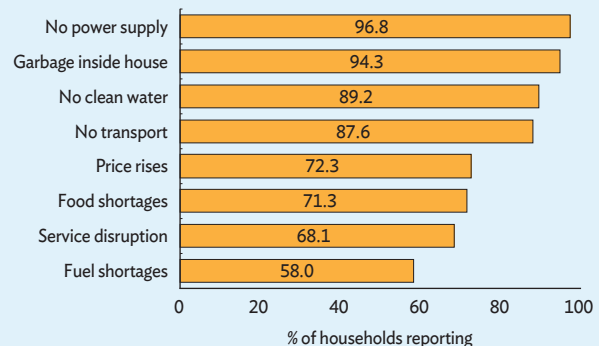
1 Cost of asset repair and replacement after flooding in Mumbai



BPL = below poverty line of ₹5,000, Poor = ₹5,000–₹15,000, LIG = lower-income group earning ₹15,000–₹30,000, MIG = middle-income group earning ₹30,000–₹45,000, Higher MIG = earning more than ₹45,000.

Source: Patankar, forthcoming (calculations based on primary data).

2 Indirect impacts of floods (% of households)



Source: Patankar, forthcoming (calculations based on primary data).

₹250–₹500 per day. Some lost their jobs because they could not report to work for more than 2 weeks, including families working as domestic help in richer homes in Chennai. Many people had to temporarily leave their damaged homes, sheltering in the homes of relatives or returning to their villages and so losing workdays or their jobs altogether.

Families reported that they lost important identification, bank, or insurance documents and certificates. Identification documents were required to claim relief for damage or establish ownership of houses and other assets. In addition, migrant families were denied shelter and relief by government officials if they lacked voter or ration cards to establish their identity as residents.

A growing body of evidence documents how the long-term effects of disasters that occurred during victims' childhood and infancy, or even when they were in utero, affected their subsequent achievements in adult life (Almond and Currie 2011, Almond 2006). Considering drought, for example, rainfall in the year and location of birth significantly correlated with adult outcomes for Indonesian women born in 1953–1974, with more bountiful rainfall in infancy associated with better health and higher educational attainment and household wealth in adulthood (Maccini and Yang 2009). In the Philippines, typhoons were linked to higher infant mortality for baby girls up to 2 years after a typhoon (Hsiang and Anttila-Hughes 2013). Hurricane risk appeared to have a significantly negative impact on educational achievement in the Caribbean (Spencer, Polachek, and Strobl 2016). Among children who lost parents in Indonesia to the 2004 Indian Ocean tsunami, the older ones subsequently completed fewer years of school, either because they had to assume parental responsibilities or because of trauma associated with the loss (Cas et al. 2014). Younger children were less affected.

Even more troubling are findings from studies on the potential for intergenerational transmission of adverse disaster impacts. Research showed that women who were exposed in utero to a catastrophic Peruvian earthquake in 1970 bore children decades later who suffered lower educational attainment than their peers whose mothers had not been similarly exposed (Caruso and Miller 2015).

Another recent study found that women in sub-Saharan Africa who were exposed to drought in rural areas during their early childhood received fewer years of formal education, were significantly less wealthy as adults, and, if the drought was extreme, grew to be shorter in stature (Hyland and Russ 2019). Moreover, evidence in this study suggested again that effects might be transmitted to the women's offspring, with the children of affected women more likely to be born with low birth weight.

As can be seen from these examples from Peru and sub-Saharan Africa, the vulnerability of the poor is compounded by marginalization along various dimensions, including gender. Existing patterns of discrimination against women can be exacerbated by climate stress transmitted through income shocks (Miguel 2005, Sekhri and Storeygard 2014).

Natural hazards can stymie the formation of human capital through their effects on health. Extremes of both flooding and drought have been associated with higher incidence of malaria and with outbreaks of other vector-borne diseases such as plague, Lyme disease, and hantavirus pulmonary syndrome, as well as outbreaks of various waterborne diseases including cholera, typhoid, and other diarrheal diseases (Hales, Edwards, and Kovats 2003).

Epidemics in particular arise from complex interaction between physical, ecological, and social mechanisms. The trigger can be an extreme weather event that leaves in its wake deficient or contaminated water supplies, malnutrition because of disrupted food supply, human displacement, increased pressure on local infrastructure and health care facilities, or physical conditions favorable for pathogens and their carriers to breed.

Reported health impacts affecting households surveyed in the aftermath of severe flooding in India included a notable rise in reported cases of diseases such as gastroenteritis and leptospirosis, as well as increased incidence of malaria, dengue, and typhoid. These impacts came immediately following the flood, measurably exceeding their already high prevalence during a normal monsoon season (Patankar, forthcoming).

Thus, while disasters may usually appear to deliver transient shocks at the macroeconomic scale, their effects at the micro scale may persist over the long term, with potential to disrupt markets, push poorer households into debt and poverty, and diminish educational attainment, future earning potential, and long-term health outcomes.

Impact on institutions, governance, and conflict

Disasters may similarly have indirect effects on longer-term development trajectories through their effects on institutions, governance, and conflict, though the evidence is difficult to establish and suggests heterogeneous effects (Castells-Quintana, Lopez-Urbe, and McDermott 2017). In some cases, disasters can actually improve institutions and governance by generating dissatisfaction with the status quo.

There is a growing literature on the relationship between weather shocks and conflict. It generally finds that weather shocks—particularly droughts, extremely high temperatures, and deviation in rainfall patterns—can make conflict more likely and, when it occurs, more intense (Dell, Jones, and Olken 2014). Most of the studies linking climate and conflict focus on the effect of weather shocks on rural incomes. A drought, for example, that removes jobs and hurts rural incomes may increase the supply of willing combatants.

It has been suggested as well that disaster shocks can create windows of opportunity for democratic development as affected populations become more motivated to contest power (Burke and Leigh 2010, Brückner and Ciccone 2011). Some historical accounts suggest that the Meiji Restoration in Japan, for example, was triggered by a series of devastating earthquakes in 1854–1855 (Clancey 2006). However, disaster shocks are also associated with a higher likelihood of irregular or extralegal leadership transitions, including military coups, setting back democratic development and economic growth

(Dell, Jones, and Olken 2012). The Islamic revolution in Iran, which caused a dramatic decline in incomes, may have been triggered by the devastating 1978 earthquake in the southern city of Tabas (Cavallo et al. 2013).

The findings from the literature remain controversial because the determinants of conflict are highly complex, and the potential effects of weather shocks or disasters on institutions, for better or worse, appear to depend heavily on the socioeconomic, political, and institutional characteristics of the affected country (Waldinger 2016, Castells-Quintana, Lopez-Uribe, and McDermott 2017).

Pervasive effects of disasters

Disaster effects can spread across wide geographic areas through, for example, damage to market mechanisms, such as disruption to supply chains, and the movements of employers, employees, or affected populations more generally. When disaster strikes and impacts propagate through production networks or supply chains, the shock is felt not only by companies in the affected region, but also by those outside it and sometimes very far away. This happened in the aftermath of the Tohoku earthquake in March 2011, for example, and the Thailand flood later that year. Both events imposed severe shortages on firms in the US and Europe that used inputs from the affected regions in their production processes. The customers of the Japanese and Thai firms directly hit by the disaster had to slow or even stop their own production for lack of parts and components.

Negative spillover through supply chains

Recent empirical literature has found strong evidence of these supply-chain ripple effects, using data on firms in Japan and the US and on multinational companies in global supply chains. For example, research on idiosyncratic shocks from disasters to firms in the US since the mid-1980s found that affected suppliers imposed heavy output losses on downstream users, especially when they produced unique inputs (Barrot and Sauvagnat 2016). This then translated into significant losses that spilled over to other suppliers within production networks. Similarly, studies on the upstream and downstream impacts of the 2011 Japan earthquake and tsunami on suppliers and consumers found that the transmission of the shock through input–output linkages caused a 1.2% decline in Japan’s gross output in the year after the earthquake (Carvalho et al. 2016).

Supply-chain interdependencies, especially if coupled with cost-effective just-in-time delivery of components, potentially create greater indirect exposure to natural hazards for firms not directly exposed or even located in hazard zones.

Moreover, the propagation of impacts can occur quickly and widely in modern supply chain networks (Inoue and Todo 2018). But the role of supply chains in either propagating or mitigating business disruptions from disasters appears to depend on the characteristics of the supply chain. Specifically, the propagation effect is larger when inputs are more specific and cannot be easily substituted (Barrot and Sauvagnat 2016).

Some research looking at international spillover found that these supply chain effects were typically confined within the affected country. Several studies observed neither downstream nor upstream propagation beyond national borders. For instance, using firm-level and supply-chain data on more than 100,000 major firms around the world, Kashiwagi, Todo, and Matous (2018) found the propagation effect on US firms to be smaller for larger firms and for those linked into international supply chains. International firms can find substitutes for damaged suppliers and customers more easily than can firms with purely domestic supply chains, which may explain why the international propagation of shocks is less likely.

Other studies, however, do find evidence that the interruption of supply chains can reverberate internationally. Philippine imports of automobiles and parts from Thailand, for example, were observed to decline by more than 35% from January 2011 to November 2011, after floods disrupted supply chains in Thailand, than in the same period in 2010, when there was no such disruption (Haraguchi and Lall 2014). Sales of new automobiles in the Philippines in the period consequently decreased by up to 140,000 units, a 4.0% decline from the first 11 months of 2010.

The interconnected nature of supply chain networks hints at the potential for government responses to disasters—targeted, for example, at affected firms—to prevent spillover on unaffected firms and regions. Governments can leverage market mechanisms to minimize disruption to supply chains by facilitating and supporting the reconstruction of damaged production facilities, particularly those of smaller enterprises, and by fostering greater cooperation among firms and redundancies in their supply chains.

A role for targeted subsidies?

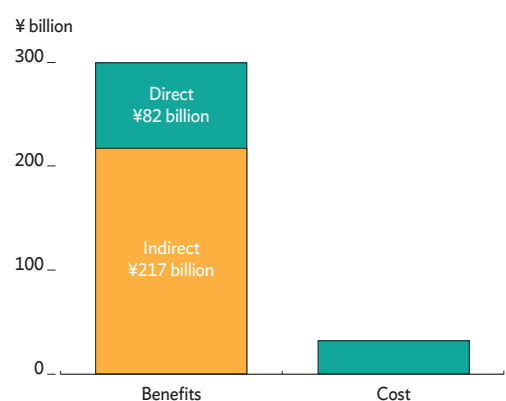
Firms have incentives to prepare business continuity plans and to cooperate with each other to find substitutes for damaged suppliers after a major disaster, but room still exists to actively encourage and facilitate such cooperation. Government intervention can mitigate the propagation of disaster shocks by, for example, organizing emergency trade fairs to ease supply chain disruptions in both affected and unaffected areas. Similarly, governments may choose to subsidize damaged firms' recovery of key capital goods if those firms are crucial nodes in production supply chains.

One prominent example of this was a policy intervention by which the Japanese authorities funded 75% of costs to repair or reinstall the damaged capital goods and facilities of groups of SMEs after the 2011 earthquake and tsunami. For greater impact, the subsidy was provided only to groups of firms linked through supply chains and located in the same industrial or commercial area. Group subsidy disbursements started within 6 months of the disaster. By 2018, ¥504 billion had been granted through this program to 705 company groups.

Kashigawa and Todo (forthcoming) evaluated the impact of this subsidy and how it filtered through supply chains. The study found that group subsidies particularly benefitted small recipient firms—manufacturers with no more than 20 employees or service providers with no more than 5 employees, in both cases counting employees after the disaster. Crucially, research found that, within the four disaster-hit prefectures, the subsidies also benefitted firms that received no subsidy but had supply chain connections to recipient firms. By contrast, no impact was found for larger recipients, possibly because these medium-sized firms benefited more from the support of stronger industrial, financial, and commercial networks. Nor did the study find indirect supply chain effects beyond the disaster-hit prefectures, possibly because those links entailed support from a larger network of partners.

A simple cost–benefit analysis for this subsidy program, for small firms only, estimated total benefits in excess of ¥299 billion against a total cost of ¥31.8 billion. Considering that ¥217 billion in benefits accrued indirectly to the suppliers of inputs to firms that received the subsidy, these results seem to highlight the need for policy makers to incorporate supply chain considerations when devising disaster recovery policies (Figure 2.2.2).

2.2.2 Cost and benefits of the subsidy program



Source: Kashigawa and Todo, forthcoming.

Migration as an effective coping strategy

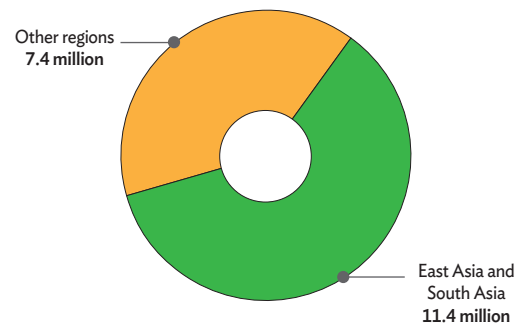
From the dawn of humanity, people have coped with risk by migrating away from it. Nowadays, one in three migrants comes from Asia, and the countries with the highest ratio of outward migrants are the hazard-exposed Pacific economies (ADB 2018d). Both international and internal rural–urban migration is often driven by economic pressures and the search for more opportunity. Every year, millions of people around the world are forced to leave their homes after disasters render them unable to sustain themselves in their homes. These pressures are particularly pronounced in developing Asia.

In 2017, more than 18.8 million people were displaced internally (many only temporarily) by sudden-onset disasters worldwide, with East and South Asia accounting

for 11.4 million, or over 60% of the total (Figure 2.2.3) (IDMC 2018). At the same time, concern is rising over slow-onset disasters, especially as they relate to climate change. The World Bank has predicted that there will be by 2050 some 140 million internal climate migrants, 60 million of them in South Asia alone, fleeing water scarcity, crop failure, sea-level rise, and more frequent storm surges (Rigaud et al. 2018). IDMC (2019) estimated that the cost of internal displacement associated with Typhoon Haiyan in the 6 months following the storm was \$816 million in the Philippines, where Haiyan was named Yolanda.

Not always a stay-or-go dichotomy, migration is often temporary or seasonal, and it is an integral part of household strategies for coping with risk. Migrants often remain closely tied to the home region, for example through remittances. Population movements in response to disasters similarly span a spectrum from forced displacement to voluntary migration, and from temporary and local to permanent and long distance (Figure 2.2.4). For this reason, numbers can be contentious, but it is clear that large numbers of people move in response to disasters. Regardless of the precise numbers, it is who moves and on what terms that is more important in determining the consequences of disaster-related movement.

2.2.3 New internal displacement from disasters, in 2017



Source: IDMC 2018.

2.2.4 The spectrum of human mobility and immobility

MOBILITY			IMMOBILITY	
Migration	Relocation	Displacement	Stay	Trapped
People choose to migrate permanently to a distant location, maybe abroad.	People permanently relocate with government assistance to what is hoped is a less risky area.	People evacuate a devastated area and may choose to go back.	People choose to stay.	People cannot move.

Source: Adapted from Ober (forthcoming), originally from Rigaud et al. 2018.

The benefits of migration arise from its use as a mechanism to diversify and smooth household income. In the aggregate, migration can raise average labor productivity—and consequently incomes—when people move to locations where productivity is higher than at home. This is typically so in cities, which are generally more productive than rural areas. In this context, migration more generally has been shown to offer potentially large welfare gains to migrants and their families, as in Gröger and Zylberberg (2016), studying households hit by typhoons in Viet Nam.

Disasters usually motivate internal, localized, and short-term movement. During sudden-onset disasters, people often make decisions quickly and under duress. The decisions whether to move—and who moves, how, when, and to where—are determined by the exposure, vulnerability, and resilience of each household, as well as by the assets they own and can use to finance such decisions. Unfortunately, the people who end up displaced by disasters are often among the most disadvantaged.

On average, the poor are more likely to migrate than other groups when hit by disaster. However, the poorest of the poor may be unable to migrate because they lack the necessary social connections or the resources including credit necessary to finance such a move. They thus becoming trapped and even more vulnerable to future disasters (Black et al. 2011). Droughts in rural Bangladesh, for example, mobilized many households that were not directly affected, while the worst affected were less likely to migrate because their already meager financial resources had been further decimated (Gray and Mueller 2012). The most severe disasters tend to inhibit mobility, as the capacity to move is reduced by the adverse shock to income, credit, and wealth (Robalino, Jimenez, and Chacon 2015). Other factors may stifle the desire to migrate in response to adverse environmental pressures, such as the decision of people in Tuvalu to stay put and advocate change (Noy 2017).

In sum, migration can benefit resilience, and when migration does not happen, the barriers to migration may further victimize those who are unable to move. Support for greater voluntary mobility—specifically to empower individuals and households to move on their own terms—thus constitutes an important but largely neglected policy response to disaster risk.

Risk of unplanned migration and forced displacement

Disasters often displace populations and destroy physical capital including buildings and other infrastructure, heightening vulnerability to the next disaster and creating exposure to other risks. When disasters cause people to migrate to urban areas, for example, they may face additional exposure to flooding, heat stress, and epidemics, particularly in marginal and suburban shantytowns where basic shelter, infrastructure, and sanitation were lacking even before the migrants arrived.

Globally, the observed increase in disaster-exposed populations is being driven, at least in part, by high migration to areas at risk, particularly urban areas in flood-prone coastal zones. Moreover, evidence suggests that migrant families newly arrived in urban areas are particularly vulnerable to hazards. When severe flooding hit the Indian city of Chennai,

the houses of poor and migrant families were damaged or even washed away, yet migrant families were denied shelter and compensation for lack of official documentation. Some of the affected migrant families had resettled from other areas vulnerable to hazards (Box 2.2.3). This suggests a role for government in planning and directing voluntary migration toward areas with lower disaster risk, even if only by providing information to migrants on the relative risk at various locations (Waldinger 2016).

Disasters that push migrants to urban areas can create additional problems in the receiving localities if, for example, congestion worsens or competition intensifies in labor markets or for basic amenities, potentially sparking social disorder (Bhavnani and Lacina 2015, Castells-Quintana and McDermott, forthcoming).

Disasters can have diverse impacts on social cohesion. Especially where deep schisms already exist in a society, disasters and migration pressures generated by them can perpetuate these schisms or exacerbate them (Aldrich 2010). Sometimes, though, disasters can improve social relations. Examples of these dynamics are much more prevalent than of worsening schisms, the most notable example in recent times in Aceh, Indonesia. A peace accord between the Government of Indonesia and the Free Aceh Movement in 2005, after 30 years of conflict, came as a direct consequence of the destruction in Aceh wrought by the tsunami of December 2004.

The importance of appropriate policy support

Policy support can make migration more inclusively available as a mechanism for coping with risk. It can minimize the potential for negative spillover caused by displacement. In particular, information on the potential costs and benefits of migration, and on job opportunities at destinations, can help individuals make more informed choices and improve the outcomes of migration (Bryan, Chowdhury, and Mobarak 2014, Munshi 2003). Lowering other barriers—including credit constraints and institutional issues related, for example, to land tenure security—can help potential migrants make better decisions that are more likely to improve their welfare (Deininger and Jin 2006).

Policy intervention is required to mitigate any negative impacts in both the sending and the receiving region. In urban areas, additional strains on urban labor markets and infrastructure can alarm local residents when a rapid increase in population occurs, particularly if it is caused by a large number of migrants appearing suddenly, as can happen, for example, when drought hits a nearby rural area.

Where arriving migrants have difficulty accessing labor markets, public services, accommodation, and other amenities, economic and social problems can ensue (Castells-Quintana and McDermott, forthcoming). Government policies that aim to manage the flow of displaced people and strengthening absorptive capacity at migrant destinations can help ensure that migration is a risk coping strategy that broadly enhances the welfare of all concerned.

More fundamentally, policy responses that build disaster resilience promise to reduce the extent of forced displacement and enable individuals and households to make choices about migration that are informed and voluntary—choices that improve outcomes in terms of livelihoods and well-being today and that strengthen disaster resilience in the future.

Investing in development with disaster resilience

Resilience begins with risk reduction, which alleviates vulnerability and exposure to natural hazards that threaten to become disasters, ranging from localized events to major catastrophes. Disaster risk cannot be eliminated entirely, though, and unavoidable disasters can place significant budgetary pressure on governments, businesses, and individual households. Mindful of the social and economic costs imposed by the disasters discussed above, this section turns to the roles that governments and their international partners can play in building disaster resilience.

Tackling the underlying drivers of disaster risk and vulnerability requires a shift in approach toward disaster risk management strategies that emphasize preventative and systemic investments. Resilience is a useful concept in the field because it has the potential to facilitate a shift in perspective and practice toward more forward-looking, comprehensive, and integrated approaches.

In addition to a conceptual shift toward resilience, a parallel need is to explore risk management options available for local communities and individuals. After all, it is within communities that disaster impacts are felt most strongly and a lot of detailed knowledge resides. Therefore, community action to tackle growing disaster risk and mitigate impacts can be very effective.

Much progress has been made on these fronts in recent years, with developing Asia leading the way. Governments should continue to integrate disaster risk reduction (DRR) into broader development policies and public investment strategies. They can seek to build resilience from the ground up by supporting the development of market mechanisms such as insurance and credit facilities, by investing directly in communities, and by emphasizing climate-change adaptation and disaster resilience in infrastructure development.

Progress in dealing with disaster risk

Asia has made substantial progress in mainstreaming disaster risk into development plans. Over the past few decades, governments, populations, and the international community have increasingly recognized the need to reduce risk and enhance financial preparedness for disasters in countries across developing Asia. The Sendai Framework for Disaster Risk Reduction 2015–2030 articulates this need and sets out key goals to this end. It identifies its four priority areas for action as (i) understanding disaster risk, (ii) strengthening disaster risk governance, (iii) investing in DRR, and (iv) enhancing disaster preparedness.

2.3.1 Asian Development Fund financing of disaster risk reduction

Growing international awareness of the need for DRR is illustrated by the establishment of a DRR financing mechanism under the 12th replenishment of the Asian Development Fund (ADF), covering 2017–2020. The ADF is the fund from which ADB provides grants to its 18 lower-income developing member countries.

The DRR financing mechanism was established to strengthen disaster resilience and help spur further investment in DRR by enhancing awareness of disaster risk and opportunities to address it. ADF donors agreed to allocate up to \$200 million for this mechanism under the 12th replenishment of the ADF, including grants for lower-income countries normally eligible only for concessional loans.

Additional concessional loans have been made available for DRR with the requirement that recipients provide matching funds, to encourage countries to invest in and mainstream DRR into their broader expenditure. The DRR funds are used to support standalone DRR projects with disaster resilience as their primary objective, DRR components of other grant and loan projects, and the incremental cost in strengthening the disaster resilience of other development infrastructure.

Source:
Asian Development Bank 2019a.

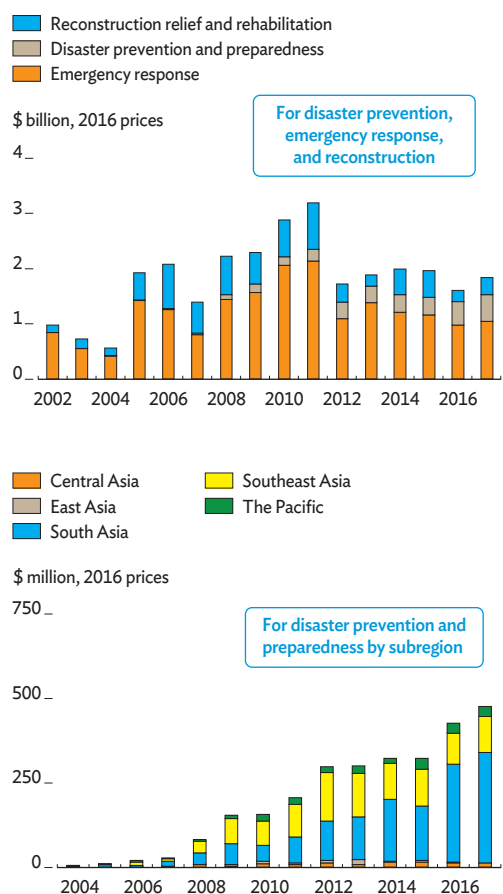
Improved data availability and risk analysis provide the modern knowledge base from which to design effective solutions and inform practical action both to address underlying risk and to enhance financial preparedness. Efforts to address underlying disaster risk center on better mainstreaming of disaster resilience measures into broader development investments (Box 2.3.1). For example, from 2010 to 2018, ADB approved 240 new development projects incorporating measures to strengthen disaster resilience.

Despite recent progress, a large difference remains in disaster spending between ex-post crisis response and ex-ante investment. Globally, assistance to governments in developing countries is about seven times larger for responding to disasters after they occur than for preparing in advance to prevent them from happening (Kellett and Caravani 2013). In Asia, spending on disaster prevention and preparedness has risen in recent years, but the gap is still large between this and spending on emergency response and reconstruction relief and rehabilitation. While data on disaster risk reduction is sparsely available, a rising trend of preventive spending can be observed in relation to humanitarian aid, especially to Southeast Asia and the Pacific (Figure 2.3.1). Further closing this gap will yield multiple dividends, especially when investments have development benefits beyond disaster risk reduction.

Disaster resilience and development

While substantial funds are spent on dealing with disasters, the burden imposed by these events remains heavy in many places, particularly in Asia. Despite ample evidence of disasters' adverse development impacts and of the benefits of reducing risk, it often remains difficult to motivate

2.3.1 Humanitarian aid to developing Asia



Note: Humanitarian aid is emergency and distress relief in cash or in kind, including emergency response, relief food aid, short-term reconstruction relief and rehabilitation, and disaster prevention and preparedness.

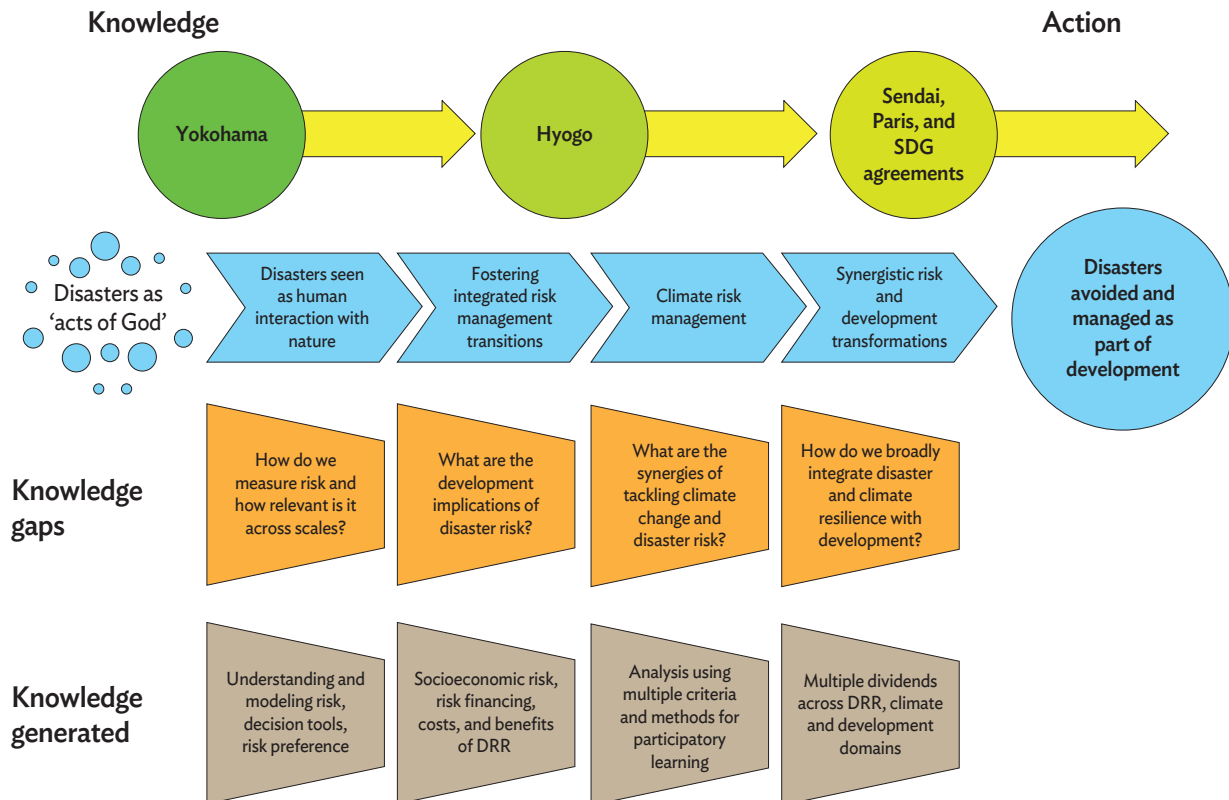
Source: OECD. Query Wizard for International Development Statistics. <https://stats.oecd.org/qwids/> (accessed 20 February 2019).

decision makers in the public sector, private business, and civil society to increase their investments in disaster risk reduction.

International policy debate has made strides since the first and second global conferences on reducing disaster risk in Yokohama and Kobe and has been shaped by three key global agreements in 2015: on DRR in Sendai, on climate change in Paris, and on the Sustainable Development Goals adopted at a United Nations summit in New York. These compacts all emphasize the need to integrate disaster and climate risks with development concerns and thus promote approaches that concurrently reduce disaster risk, adapt to climate change, and pay development dividends.

Figure 2.3.2 shows how international disaster risk discourse has moved over the years, from early perceptions of disasters as “acts of God” to the current understanding of risk in terms of shaping development challenges and opportunities. At the same time, decision makers have been requesting actionable information to close knowledge gaps and generate metrics for grasping the benefits generated from managing risk, fostering climate adaptation, and building resilience (Mechler and Hochrainer-Stigler, forthcoming).

2.3.2 Evolving approaches to disaster risk management



DRR = disaster risk reduction, SDG = Sustainable Development Goal.

Source: Mechler and Hochrainer-Stigler, forthcoming.

The “triple resilience dividend framework” has captured this alignment of discourse and presents a broad business case for DRR, suggesting three types of dividends associated with investments in disaster risk management (DRM): The first dividend is reducing damage and loss of life, livelihoods, and assets; the second is unlocking development; and the third is garnering development co-benefits (Surminski and Tanner 2016). Illustrative examples of each of the three dividends are presented in Box 2.3.2 and its table.

Policy and investment have started to build on the multiple dividend framework, and the DRM and development policy domains are becoming increasingly integrated. In practice this has meant that donor institutions are embedding disaster and climate risks into development projects and programs.

Examples of investments with multiple dividends are becoming more commonplace, and international development nongovernment organizations (NGOs) have taken up this agenda. NGOs that participate in the Flood Resilience Alliance, for example, have reported engaging in various community-led projects across Asia that generate additional dividends in addition to reducing flood risk. One example integrates into early warning systems weather boards that improve preparedness for extreme weather but also generate more routine benefits from better weather forecasting, including improved crop-sowing decisions. Other examples are water resource management that integrates flood risk considerations, the construction of disaster-resilient multipurpose evacuation and community centers, the reestablishment of mangrove forests against storms and coastal erosion, and hydroponics projects that stabilize incomes in normal times and safeguard food security when disaster strikes.

Little detailed information is available about national projects designed to have synergistic multiple dividends. The few countries that release such information rarely take it beyond the first risk reduction dividend. Donors and some NGOs have reported synergistic spending on DRR integrated with climate and development concerns, and countries should follow suit. Some evidence on national spending can be evinced from a recent review of national DRR expenditure in the Lao People’s Democratic Republic, Thailand, and Viet Nam in the 4 years to 2014. It found that average DRR-relevant expenditure in the three countries ranged from the equivalent of 0.2% of GDP to 1.7%, and from 4.6% to 8.9% of central government total expenditure (Abbott 2018).

Figure 2.3.3 demonstrates nascent reporting practices by analyzing the reporting done through the Sendai Monitor and as required by all signatories to the Sendai Framework for DRR. Reporting covers only 2017 and the first half of 2018. Countries are required to measure their progress against a benchmark established using 2005–2014 aggregates. Most countries in Asia have yet to establish this benchmark.

2.3.2 Assessing returns on ex-ante investment into disaster risk management

Mechler and Hochrainer-Stigler (forthcoming) reviewed the findings of a global database of 65 cost-benefit analyses of DRR investments, of which 15 studies (11 on Asia) can be considered to have taken a multiple resilience dividend approach, though only one explicitly builds on the triple resilience dividend framework. The dividends, presented as cost-benefit ratios, appear substantial and in line with estimates of benefits across other studies that do not consider benefits beyond the first dividend (with cost-benefit ratios of 2–5:1 on average for various hazards). However, the quantification of benefits in these studies tends to be unreliable, which undermines confidence in their estimates of the multiple resilience dividend.

A focus beyond the first dividend, for which probability-based risk calculations are required, often inspires broader-brush estimates in response to the need to gauge benefits across a number of risk and development variables and to aggregate them. Further, multiple dividend approaches require assessments of interventions with indirect or intangible outcomes, such as recreational, ecological, and social benefits, for which a quantitative cost-benefit analysis (CBA) may be less suitable. The second resilience dividend, indirect economic co-benefits through unlocked development potential, has not been assessed as frequently because data on development processes are collected over longer periods of time, requiring additional effort and resources that are only rarely available.

CBA remains attractive as a tool for deciding technical points in well-defined DRR interventions, such as how high to build flood embankments. Indeed, potential exists to integrate the decision tool with the multiple-dividend logic. IPCC (2012) differentiated between “hard infrastructure-based responses and soft solutions such as individual and institutional capacity building and ecosystem-based responses.” Soft investments are even more difficult to assess, especially using CBA. Other tools for specialists, such as cost-effectiveness analysis, and robust decision-making approaches may help with the challenge of monetizing intangible benefits.

Rising demand for “softer” DRM investments has brought to the fore decision support tools with stronger participatory assessments and more inclusive processes for decision-making. Approaches that measure resilience may be used to support actions and decisions at every stage of the project cycle, in contrast with decision-support tools limited to evaluating and selecting options. These approaches focus on capacity, not outcome. Such capacity assessments can serve as decision support for organizations working in local communities to scope out the interactions between development and disaster risk, fostering their understanding of the strengths and weaknesses of existing resilience before actual events, helping them gauge resilience after events, and facilitating affected communities’ participation in formulating solutions.

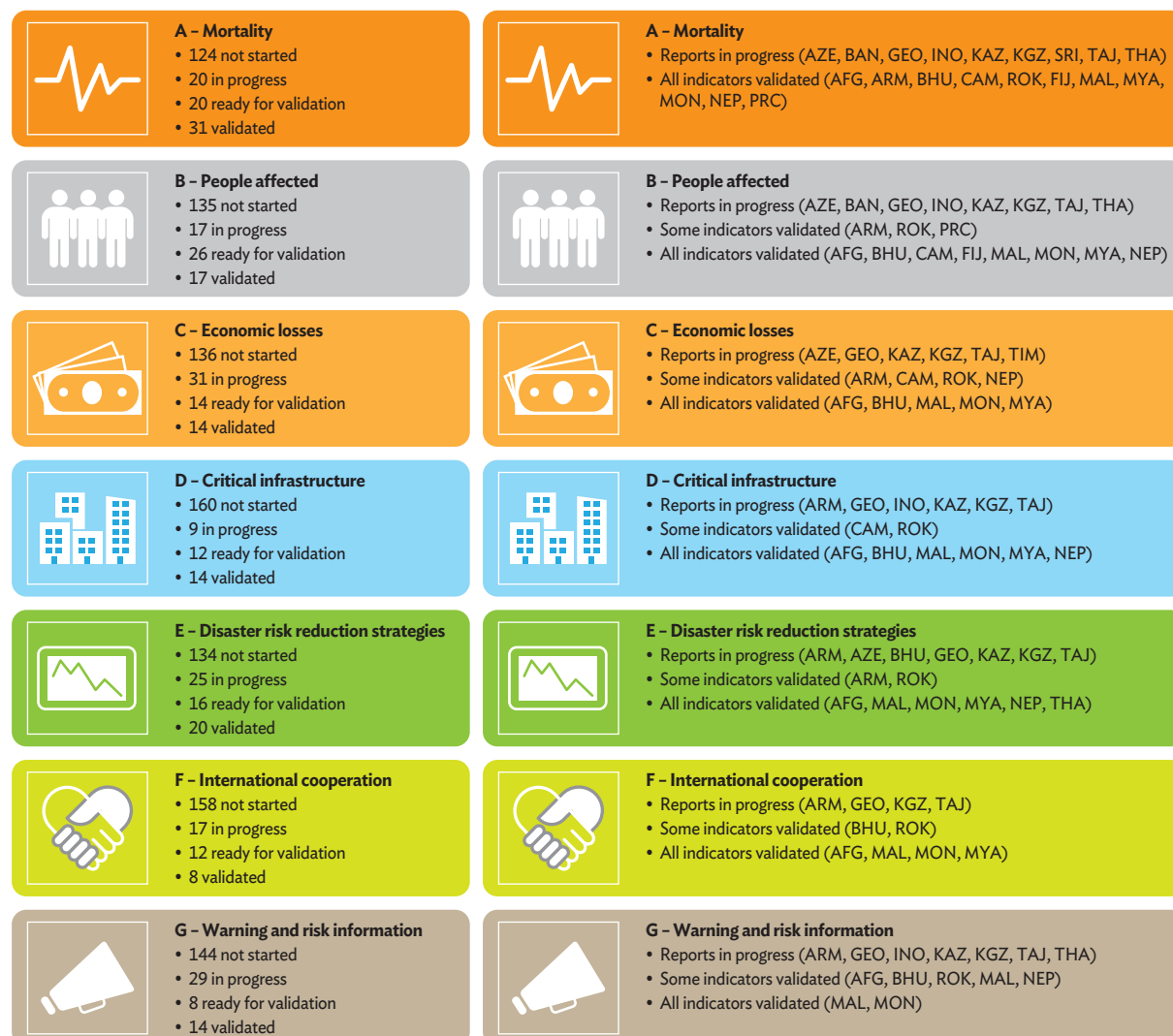
Reported resilience dividends in representative cost-benefit analyses following the 3 dividends framework

Risk management intervention	Dividend 1: Losses and damage avoided and reduced	Dividend 2: Unlocking development	Dividend 3: Co-benefits
<i>Meteorological services</i>	Avoided mortality, improved preparedness from weather extremes		Utility from weather predictions: improved crop-sowing decisions
<i>Alternative flood control approach</i>	Avoided economic, social, and environmental impacts		Recreational benefits, improved public safety, landscape and nature conservation, benefits of system functions of wetlands.
<i>Flood management under climate change</i>	Reduction in damage to crops, livestock, housing, assets, public infrastructure, health, and wages, but suffering costs from waterlogging	Agricultural productivity enhanced	Community grain and seed bank
<i>Drought risk management</i>	Reduced relief expenditure	Stabilization of income and consumption	Benefits from installed irrigation infrastructure
<i>Mangrove afforestation against coastal flooding</i>	Avoided direct and indirect flood damage	Economic benefits to planters’ income, increased yields	Ecological benefits: carbon value, nutrient retention, sediment retention, biodiversity habitat
<i>Earthquake-proof construction using straw bale</i>	Reduction in lives lost		Reduced price of building materials, reduced heating and cooling costs, decrease in the child labor common in brickmaking, improved air quality

2.3.3 Overview of 2017 target reporting in the Sendai Monitor

195 countries total

Progress of target reporting of developing Asian countries, 2017



AFG = Afghanistan, ARM = Armenia, AZE = Azerbaijan, BAN = Bangladesh, BHU = Bhutan, CAM = Cambodia, FIJ = Fiji, GEO = Georgia, INO = Indonesia, KAZ = Kazakhstan, KGZ = Kyrgyz Republic, MAL = Malaysia, MON = Mongolia, MYA = Myanmar, NEP = Nepal, PRC = People's Republic of China, ROK = Republic of Korea, SRI = Sri Lanka, TAJ = Tajikistan, THA = Thailand, TIM = Timor Leste.

Source: UNISDR. <https://sendaimonitor.unisdr.org/> (accessed 20 February 2019).

Disaster-resilient infrastructure

Significant investments in infrastructure projects are currently under way or planned in countries across developing Asia.

Infrastructure investment needs in developing Asia are estimated at \$26 trillion from 2016 to 2030, or \$1.7 trillion per year including necessary investments in climate-change mitigation and adaptation (ADB 2017, ADB 2019b). These investments need to take into account disaster risk for two reasons. First, some of the projects are themselves likely to be subject to disaster risk, which affects their expected return on investment.

Second, infrastructure investments can influence future exposure to disaster risk by, for example, altering spatial development patterns, especially with the construction of new roads, ports, or other transport infrastructure (Dietz, Dixon, and Ward 2016).

The large scale of anticipated investment needs underscores the potential for these investments to influence future exposure and vulnerability to disaster risk in developing Asia. Many infrastructure projects are irreversible to a greater or lesser extent. This is clearly the case with major physical infrastructure projects designed for long use and bearing a large initial price tag, making them costly to reverse. But it may be true as well for other investments that influence long-term development patterns by creating path dependencies. This is often the case, for example, with urban planning and development, making such investments very expensive to undo (Dietz, Dixon, and Ward 2016, Kocornik-Mina et al., forthcoming).

Greenfield infrastructure investments are natural entry points for including disaster resilience in the planning process from the outset. With such investments, accounting for the likely effects of future exposure to disaster risk promises to be highly cost-effective. A recent study of road investments in Viet Nam, for example, showed that the tendency to favor already densely developed coastal areas had significant costs (Balboni 2018). While the returns on coastal road investments from 2000 to 2010 were positive, a greater concentration of investment inland would have offered higher returns. The risk posed by future sea-level rise further underscored the inefficiency of coastal investments. Welfare gains of some 72% could have been achieved by investment that avoided the most vulnerable regions.

The types of infrastructure investments for which disaster and climate risk assessment is most relevant can be identified using a simple framework that considers the following: the scale of the project; the extent to which the investment can be expected to affect disaster and climate risk by worsening community exposure and vulnerability, either directly or through its outputs; the time horizon of the investment, as longer-term investments require greater scrutiny; and the extent to which the investment is considered irreversible (Ranger and Garbett-Shiels 2012). The framework should also take into account the expected impact of an investment that attracts further development investment into a hazard-prone area. Examples of investment projects that most urgently require consideration of disaster and climate risk include energy generation, urban greenfield developments, water supply and irrigation systems, and transport infrastructure.

While returns on infrastructure investments are substantial, especially in developing Asia, public investment in infrastructure projects generally raises the thorny issue of decision-making rendered deeply uncertain by climate change.

Such uncertainty presents an additional motivation for policy makers to prioritize building adaptive capacity into human resources that is likely to strengthen disaster resilience under a wide range of future climate scenarios. Uncertainty about the effects of climate change on future disaster risk generally shifts the balance of DRM portfolios toward these soft investments, which are less uncertain (see e.g., McDermott 2016, Watkiss 2016).

Financial management of disasters

Delays and financing shortfalls can considerably exacerbate the economic and social consequences of direct physical damage from disasters, extending the time required to bring infrastructure back into use and restart service delivery, as well as stymieing efforts to rebuild for greater disaster resilience and to revitalize livelihoods and the economy—that is, to “build back better,” as the literature discusses it. Spending plans and goals can go awry when delayed recovery and reconstruction combine with deteriorating balance sheets caused by unplanned spending on disaster relief, with adverse consequences for long-term development.

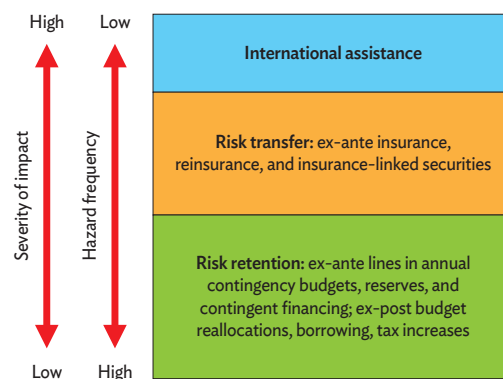
Governments are therefore working to enhance financial planning for disasters, seeking to ensure that sufficient financing is available to support timely relief, early recovery efforts, and reconstruction, as well as to promote enhanced financial preparedness in the private sector and the population at large.

Governments can draw on an array of instruments to enhance financial preparedness. A risk-layered approach to disaster risk financing is widely advocated, breaking disaster risk down according to hazards’ frequency, or probability of occurrence, and the magnitude of associated losses to identify the most appropriate instruments for each layer of risk (Figure 2.3.4).

These begin with risk retention instruments for more frequent but less damaging events, including annual contingency budget allocations, disaster reserves, and contingent financing arrangements, all of which are established before disasters strike (Benson 2016). In the aftermath of a disaster, governments can reallocate budget lines or increase their borrowing to provide additional resources.

Risk transfer solutions are typically more cost-efficient sources of financing for medium-range risks generating relatively large but less frequent losses. These instruments include insurance and insurance-linked securities, such as catastrophe and resilience bonds, and are taken out in anticipation of potential disasters. In the event of a major disaster, though, risk transfer instruments are rarely sufficient,

2.3.4 Layered approach to disaster risk financing



Source: ADB.

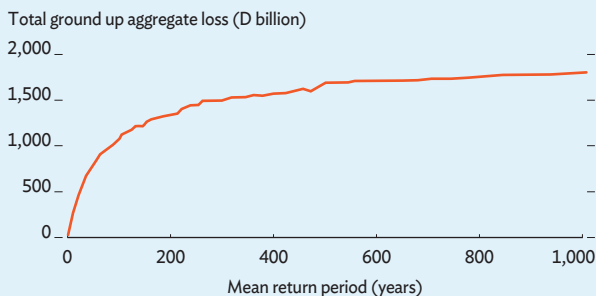
leaving governments to turn to the international community for assistance. For these solutions to be effective, they need to be accompanied by strong and effective recovery planning and post-disaster budget execution, to ensure that available resources can be mobilized quickly and effectively.

Finally, it is essential that disaster risk financing strategies be designed within a broader context of disaster resilience, placing primary emphasis on risk reduction to stem the trend of rising disaster losses. If not, the cost of post-disaster response will place mounting pressure on government budgets, and disaster risk could ultimately become neither insurable nor transferable. In line with this, opportunities should be exploited to design insurance and other instruments to encourage investments in risk reduction (Box 2.3.3).

2.3.3 Steps to developing a comprehensive disaster risk financing strategy

Steps to enhance financial preparedness begin with disaster risk modeling to quantify the scale of the disaster risk and express it in monetary terms (see e.g., Strobl, forthcoming; Box 2.2.1). Historical records of past disasters provide a starting point but typically extend back over just a few decades and therefore offer no instances of infrequent events not experienced recently. Hazard models overcome these shortcomings, combining the latest scientific knowledge on natural hazards with the historical record to generate catalogs of potential events over many years. These catalogs are then combined with data on the assets and infrastructure exposed to the hazards, and on their vulnerability, to generate loss curves expressed in monetary terms. These loss curves plot probable maximum losses for hazards with varying return periods, ranging from annual events to rare extreme events that occur perhaps only once in 500 years and therefore have a very small probability of 0.2% in any given year. The box figure depicts a typhoon loss frequency curve for the city of Hue in Viet Nam.

Loss frequency curve for typhoon risk in Hue, Viet Nam



Source: ADB 2015.

With this loss frequency information, governments can determine their associated explicit and implicit contingent liabilities. These liabilities include the repair and reconstruction of public assets and the fulfillment of public guarantees to provide, for instance, financial backing for insurance programs or for lending institutions that are in danger of failing because of disaster-induced defaults. Further, governments sometimes act in the aftermath of a disaster to alleviate poverty, provide housing, or stimulate economic recovery. Predicting and quantifying all these liabilities provides to the government a full account of them and enables it to adequately plan for them.

The most appropriate bundle of instruments for each country and risk profile depends on a range of factors:

- the scale of resources required at each layer of loss;
- the required speed of disbursement;
- the costs and tradeoffs of different financing instruments for particular layers of loss;
- associated incentives or disincentives to address underlying risk and accept residual risk;
- government appetite for risk and expected goals and priorities after a disaster, such as to channel additional resources through social protection programs or to support the recovery of small businesses;
- individual country circumstances, such as indebtedness;
- broader government economic and fiscal goals and objectives;
- access to global credit markets; and
- the market cost of borrowing.

Financial preparedness nationally

In terms of financial preparedness, governments typically make only limited use of disaster risk financing instruments set up in advance for disaster response, beyond practical limits on regular budgetary provision for relief and early recovery and for other unforeseen events (for the first risk layer). In some cases, governments purchase indemnity insurance to cover a portion of public assets (the second layer). Such arrangements have proved to be far from adequate when a major disaster strikes, inevitably requiring unplanned budget reallocations. Such reallocations can take time to secure, particularly if budget realignment can be considered only during scheduled midterm budget reviews and annual budget formulations. Ad hoc arrangements for disaster risk financing, and related uncertainties regarding budget availability, hinder post-disaster planning and the effective use of resources.

Recognizing these limitations, governments have begun to strengthen options for both risk retention (first layer) and risk transfer (second layer) to enhance their financial preparedness. The Sendai Framework specifically calls for the promotion of “mechanisms for disaster risk transfer and insurance, risk sharing and retention and financial protection, as appropriate, for both public and private investment in order to reduce the financial impact of disasters on governments and societies, in urban and rural areas” (UN 2015).

These efforts have included the increased uptake of contingent financing arrangements, under which pre-negotiated lines of financing can be rapidly disbursed in the aftermath of a disaster (Box 2.3.4). Contingent financing arrangements target in particular the layer of disaster risk beyond which a government’s own contingency budget lines and reserves are exhausted but before insurance become cost-efficient. The use of sovereign and nonsovereign insurance mechanisms is also growing, though they remain relatively limited.

Governments increasingly recognize the importance of positioning the various initiatives and instruments in a broader strategy for disaster risk financing. In developing Asia, the Government of the Philippines was the first to establish its DRM financing strategy, in 2015. This strategy recognizes that local governments and individuals, as well as the national government, require sound disaster risk financing arrangements. The Government of Indonesia also launched a disaster risk financing strategy, in 2018, and such strategies are under development in Myanmar and Pakistan, both with support from ADB.

It is important to note that disaster risk financing is not a responsibility only for the government. Toward developing a comprehensive financing strategy, action needs to be considered to stimulate commercial insurance markets, including for homeowners, businesses, and agriculture.

2.3.4 Contingent disaster financing and other financing instruments

Contingent disaster financing establishes preapproved lines of credit and grants that can be disbursed in the immediate aftermath of a disaster to provide timely budget support and alleviate fiscal pressures. They come conditional on monitorable actions to enhance long-term disaster resilience, thereby ensuring that underlying disaster risk is addressed. The achievement of required prior actions enables disbursement. However, funds are disbursed in part or in full only in the event of an agreed trigger event, typically the declaration of a state of disaster in accordance with national legislation. Funds can then be spent through the national budget.

ADB has supported the establishment of disaster contingent financing arrangements through policy-based instruments in five island countries in the Pacific to date, with coverage for another four countries expected by the end of 2019. Tonga's \$6 million disaster contingent financing from ADB, disbursed in full just 3 days after the country was struck by Tropical Cyclone Gita in February 2018, demonstrated the rapid-disbursement feature of this instrument. The World Bank has supported the establishment of similar arrangements in the Philippines, Samoa, and Sri Lanka. Along similar lines, the World Bank has introduced in a number of its projects contingency emergency response components into which

uncommitted project funds can be reallocated to finance urgent needs in the event of a crisis or emergency, including a disaster triggered by a natural hazard.

Development partners have formulated financing instruments to make more resources available for more traditional emergency assistance loans and grants offered in the aftermath of disaster. In Asia and the Pacific, ADB piloted the Disaster Response Facility under the eleventh replenishment of the Asian Development Fund, 2013–2016 and regularized it under the twelfth replenishment. It provides countries eligible for only concessional assistance up to twice their annual country allocation for use in response to disasters triggered by natural hazards. The World Bank offers similar support, including in response to disasters, to the same set of countries through its crisis response window. The International Monetary Fund offers support to the balance of payments, including after a disaster, to all its member countries through its rapid financing instrument and its corresponding rapid credit facility for low-income countries.

Sources:

Asian Development Bank 2019a; IMF 2018, 2019; and World Bank 2017.

This can be achieved through legislative and regulatory measures, improved supervision, financial literacy campaigns, and in some cases direct subsidies. Also useful is support for underlying disaster risk modeling and for technical structuring of insurance products.

Enhancing financial capacity in poorer households

Access to formal financial services remains limited in many economies in developing Asia, especially for the poor. Problems the poor face in accessing financial services impede their adoption of efficient risk coping strategies, with implications for poverty reduction and development more generally, as well as for vulnerability to natural hazards.

While many advance risk management strategies, such as investment in disaster-proof housing or disaster insurance, are cost-effective ways to contain disaster losses (World Bank and United Nations 2010), these mechanisms are often absent in developing countries, or they are available only to people who are better off.

Where advance protection is unavailable, households attempt to smooth consumption following disasters, using a range of coping responses dependent on their own resources and those of their community (Sawada and Shimizutani 2008, Sawada 2007). Self-reliance can mean reducing nonessential consumption expenditure, spending previously accumulated savings, selling physical assets, taking any additional work that is available, using informal credit, obtaining emergency public transfers, and receiving private transfers and credits from the extended family network, friends, and neighbors.

Informal, community-based coping mechanisms are often well developed in poorer communities (Collier, Conway, and Venables 2008, Ligon 2008). These informal risk-coping mechanisms have been shown to be effective in dealing with isolated shocks to individuals, as evidenced by data on households in Viet Nam (Sawada, Nakata, and Kotera 2017).

Similarly, remittances can allow consumption smoothing and finance home reconstruction. In general, remittances are transferred more rapidly and efficiently than formal relief efforts, allowing households to recover more quickly, as illustrated in a number of case studies, including in Pakistan after an earthquake in 2005, in Samoa after a tsunami in 2009, and in Sri Lanka after the 2004 Indian Ocean tsunami. Some of these gains can be substantial, with one study finding that financial remittances compensated for nearly 65% of income lost to rainfall shocks in the Philippines (Yang and Choi 2007).

However, informal coping mechanisms tend to fail in the face of the relatively widespread destruction caused by larger disasters. This is especially true if the coping mechanism relies on neighbors or other households who were similarly hit by the disaster. Some studies found that remittances often reinforced existing inequality, as most remittances reached those in the community who were already better off (Le Dé et al. 2015).

Studies in India, Pakistan, and Thailand showed that financially constrained households employed various coping strategies after disasters struck, some of which were inefficient, such as selling productive assets (Dercon 2002), providing more paid labor only to force down wages (Kochar 1999), sending children to work rather than to school (Jacoby and Skoufias 1997, Sawada and Lokshin 2009), or borrowing at high interest from informal lenders (Banerjee and Duflo 2011). These risk management strategies undermined investment and growth and aggravated poverty (Elbers, Gunning, and Kinsey 2007).

In addition to challenges poorer households face in coping with risk, disasters can affect individual risk perceptions and risk aversion, with consequent effects for long-term development. A number of studies have shown how disaster-hit populations became more risk averse following, for example, the direct experience of a flood or earthquake in Indonesia

(Cameron and Shah 2015) and the 2004 tsunami in Thailand (Cassar, Healy, and von Kessler 2017). Similarly, studies using data from diverse locations and situations—a village in the Philippines that was hit by flooding in 2012 and a city in Japan following the March 2011 earthquake and tsunami—found that being hit by disaster made individuals significantly more focused on the present than were those unaffected by the disaster, favoring payoffs that came sooner out of doubt for the future (Sawada and Kuroishi 2015a, 2015b).

The effects of disasters on individual preferences suggest that one-off shocks can have long-lasting consequences for development and poverty (Sawada 2017). Relaxing credit and financial constraints on the poor could therefore do more than help them cope better with risk, encouraging them to take on riskier investments that have potential to be more productive (Castells-Quintana, Lopez-Urbe, and McDermott 2018). These findings underline the scope for policy intervention to improve access to financial services and to support temporary labor migration, toward distributing more widely the benefits of these effective market mechanisms.

Disaster insurance to manage disaster risk

Insurance against disasters arising from natural hazards is a useful tool to manage climate risk and could, if carefully implemented, make poor and vulnerable communities more resilient. However, access to commercial insurance against disasters is limited and unevenly distributed for several reasons, including the technical challenge of designing insurance products that are affordable and suitable.

In low-income countries, more than 95% of all losses from weather and climate hazards were uninsured (Golnaraghi, Surminski, and Schanz 2016). Just 6% of losses in floods in Kerala in 2018 were insured, for example, while payouts after the 2018 earthquake and tsunami in Sulawesi were reported as negligible despite substantial damage (Aon Benfield 2019). Similarly, more than 90% of the affected families surveyed after floods in Mumbai, Chennai, and Puri did not have any form of insurance, and those who did suffered long delays for paltry settlements (Patankar, forthcoming).

The benefits of insurance are clear: pooling and transferring risks to financial markets, enabling fairly risk-free investment, providing incentives for risk reduction, preventing hardship, and making post-disaster support more predictable. These features of insurance can alleviate the immediate welfare impacts caused by disasters and contain disruption to state budgets (Hallegatte 2014, Clarke and Dercon 2016).

Recent years have seen the introduction of new insurance designs, especially across developing Asia, and a shift from traditional indemnity-based policies toward indexed insurance (Box 2.3.5). Microinsurance and the bundling of insurance with credit can confer additional advantages, as they not only enable better risk management but also render individuals more creditworthy and promote investment in productive assets that may otherwise be too risky.

At the same time, advances in disaster risk modeling facilitate more accurate pricing of risk transfer instruments. As margins of uncertainty built into insurance premiums become narrower, premiums become more affordable. Innovations in parametric insurance—which pays compensation following the tripping of agreed triggers that are readily measured, such as maximum wind speed or millimeters of precipitation, rather than for actual loss—mean lower costs for damage assessment and therefore further reductions in premium prices, as well as quicker settlements.

Progress is being made in establishing regional parametric insurance pools, which offer opportunities to reduce premiums through a number of mechanisms (ADB 2018e):

- (i) Diversifying risk reduces volatility in losses experienced by the group.
- (ii) Absorbing the first layer of loss from pool reserves reduces the cost of the reinsurance required to protect the pool, as does collective bargaining when negotiating reinsurance.
- (iii) Shared administrative costs make the creation and management of the pool more affordable.

A regional sovereign disaster insurance pool was launched under the second phase of the Pacific Catastrophe Risk Assessment and Financing Initiative in 2017. A pool is planned for several countries under the Southeast Asia Disaster Risk Insurance Facility. A city disaster insurance pool is currently under development in the Philippines with support from ADB. Some subnational governments have entered into contracts directly with insurance companies, an example of which is Swiss Reinsurance Company Limited parametric insurance issued to PRC provincial governments in Guangdong and Heilongjiang.

A range of nonsovereign products is also being piloted and launched. The PRC, which has subsidized agricultural insurance since the 1980s, is now one of the world's largest agricultural insurance markets, and a substantial subsidized agricultural insurance market exists in India as well. In Indonesia, insurance companies' compulsory cession of earthquake risk to a specialist earthquake reinsurer has been in force since 2004.

Remaining challenges to greater disaster insurance penetration

While observed trends indicate a growing role for insurance as part of broader DRM strategies, a number of challenges remain. Most straightforward are the standard concerns of traditional indemnity insurers over moral hazard and adverse selection. For example, Adachi et al. (2016) found that commercial property insurance subscription before the 2011 Thailand flood was systematically higher among firms located in the areas directly affected by the flood than elsewhere, indicating adverse selection. Moreover, the study showed that insured firms and those receiving business interruption payouts had lower production and employment after the flood, suggesting a moral hazard. Concerns about adverse selection and moral hazard may be particularly pronounced when coverage for small policyholders, such as farmers and smaller businesses, makes observing mitigation efforts and assessing losses expensive.

Indexed insurance, under which claim payments are triggered by an indexed event such as precipitation below some predefined threshold for drought insurance, offers an alternative as it overcomes concerns about moral hazard while reducing monitoring costs (Clarke and Grenham 2013). Indexed coverage can also facilitate accelerated claim payment, which is important especially for poor households.

Indexed insurance is beneficial, though, only if the index correlates closely with actual damage. Basis risk—a mismatch between the triggering index and actual damage—can be significant, making insurance more like a lottery than a mechanism to transfer risk.

An especially problematic situation is when indexed microinsurance for vulnerable households leaves them uncompensated for damage and disappointed, because the index did not trigger a payment. Significant basis risk of this kind can erode trust in insurance companies and suppress demand for their insurance products.

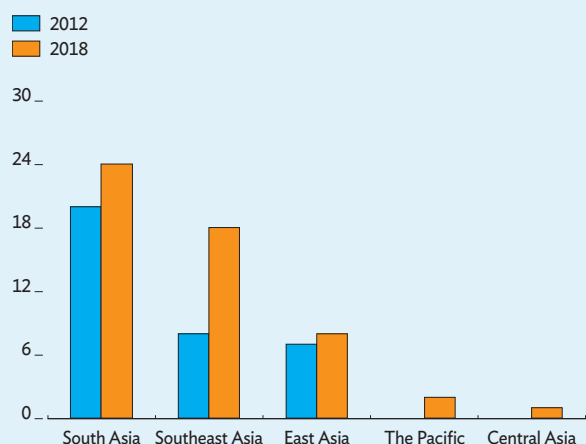
As disaster insurance takes on large regional risks rather than smaller individual ones, risk can be spread, or reinsured, across wide geographical areas with varying disaster risk profiles. One suggested solution is to combine indemnity and indexed insurance. Community mutual insurance groups could provide indemnity insurance against individual shocks, the system backed by indexed insurance for the community, offering protection against aggregate shocks by transferring the risk to reinsurers (Clarke and Grenham 2013).

2.3.5 Snapshot of active disaster insurance schemes in developing Asia

Surminski, Panda, and Lambert (forthcoming) reported on data from the Grantham Disaster Risk Transfer Scheme Database to describe the landscape of insurance for natural hazards throughout developing Asia. Each entry in this database was referred to as a “scheme,” and each scheme was defined by two key properties: the transfer of risk away from entities in low- or middle-income countries, and the use of one or more ex-ante market-based risk transfer instruments. Commercial insurance was sold and purchased, but most schemes in the database included some government involvement.

There were 35 schemes actively transferring risk in 2012, since expanded to 53 schemes operating today. Increases have been notable in Southeast Asia and the Pacific in this period, rising from 8 schemes in 2012 to 22 in 2018 (box figure 1). Many countries in developing Asia now boast multiple disaster insurance schemes, including 15 in India, 8 in the PRC, 8 in the Philippines, 6 in Bangladesh, and 5 in Indonesia.

1 Number of active risk transfer schemes in 2012 and 2018, by subregion



Note: The Pacific Catastrophic Risk Assessment and Financing Initiative in the Cook Islands, the Marshall Islands, Samoa, Tonga, and Vanuatu is the scheme for the Pacific. The one for Central Asia is in Kazakhstan.

Source: Surminski, Panda, and Lambert, forthcoming.

continued next page

From the demand side, reaching poorer household with greater insurance penetration is a notable challenge because of some tough constraints: such households' limited perception of risk and willingness to disregard it, particularly risk for events with low probability; the budget constraints that deter poorer households from purchasing insurance; and the tendency among the poor to view insurance as an investment rather than a hedge against risk, encouraging underinsurance. Relatively low take-up for novel indexed insurance by smallholder farmers in particular has been highlighted, for example in Carter et al. (2017) and Surminski, Panda, and Lambert (forthcoming).

In theory, demand for formal insurance may be crowded out by the informal community risk-sharing mechanisms prevalent in many developing countries, for example among groups of smallholder farmers. However, it has been shown that informal risk-sharing can complement formal indexed insurance, with the informal network protecting households from basis risk—which is, as noted above, the mismatch between actual losses and payouts from indexed policies (Mobarak and Rosensweig 2013).

Successful disaster insurance programs implemented to date have tended to rely on some form of public subsidy (Box 2.3.5). Development partners have participated in a number of financing solutions for disaster risk, seeking to provide associated public goods such as data collection and helping to cover fixed establishment costs.

2.3.5 Continued

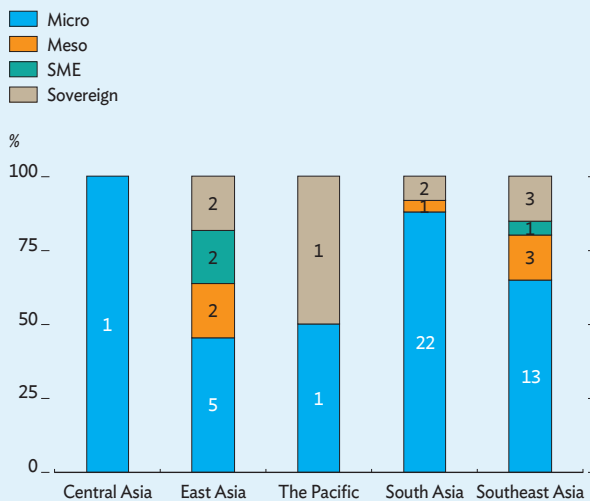
Of the active schemes, 70% offer microinsurance (box figure 2), and 12% are larger sovereign risk arrangements. The coverage of the schemes ranges from a single country, such as earthquake insurance bonds issued by the Government of the PRC, to regional schemes such as the Pacific Catastrophe Risk Assessment and Financing Initiative, which pools sovereign disaster risks in five Pacific island countries.

Most of the schemes included in the database are delivered by private entities, with international public entities providing 11%, national public entities 30%, and NGOs 5%. Over 80% of the schemes include subsidies or other financial support, and 13% are fully subsidized and free for those covered.

Most active schemes, or 62%, cover agricultural losses. Among these, 74% are indexed, with the risk transfer determined by weather indexes or other indexes such as average crop yield.

A third of the insurance schemes are bundled with credit and compulsory, with loans disbursed only in combination with insurance. The major benefit of credit-linked insurance is the reduced possibility of debtor default as debtors are insuring against catastrophic shocks. In the Philippines, the three most prominent microinsurance schemes are all credit-linked.

2 Number of disaster insurance schemes, by subregion and type

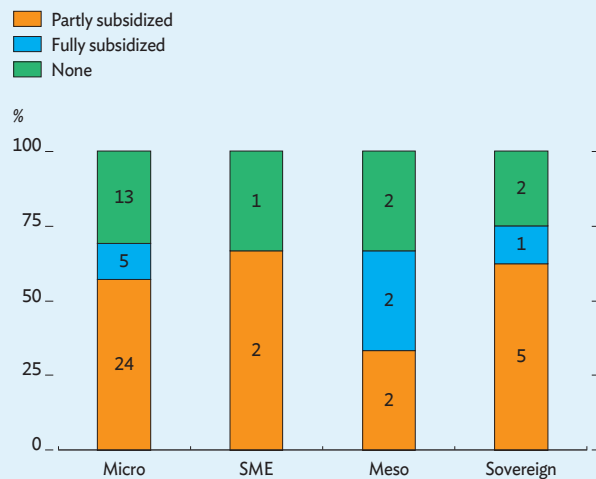


SME = small and medium-sized enterprise.

Notes: Micro schemes facilitate access to disaster insurance for individuals, often to protect the livelihoods of the poor against extreme events. SME schemes are for homeowners, small- and medium-sized enterprises, and public entities. Meso schemes provide cover for risk aggregators such as banks, microfinance institutions, agribusinesses, and municipal actors such as water authorities. Sovereign schemes aim to increase the financial response of governments in the aftermath of disasters while protecting their long-term fiscal balances through risk transfer instruments including insurance. Six schemes span two insurance types, such as microinsurance and meso insurance for farmers and microfinance institutes, and are thus double counted.

Source: Surminski, Panda, and Lambert, forthcoming.

3 Schemes with government financial support, by scheme type



Development partners have provided technical inputs and financing for designing products, developing the underlying disaster risk models, capitalizing insurance pools, and, in some cases, granting subsidies for premiums. The challenge for government is to create new insurance markets, rather than simply replace insurance previously sold by private providers.

Finally, disaster insurance can be designed to encourage risk reduction in addition to its primary goal of transferring risk.

Providing incentives for risk reduction is possible when insurance premiums can be linked accurately to risk, so that premium discounts motivate risk reduction. Measuring the effects of insurance on resilience and risk outcomes remains difficult (Surminski, Panda, and Lambert, forthcoming). Some examples indicated resilience benefits, however, such as indexed livestock insurance in Mongolia, which subsidized insurance for herders and was found to have improved survival rates for the livestock of policy-holding herders (Bertram-Huemmer and Kati 2015).

Strengthening disaster resilience is increasingly important as exposure to natural hazard risk rises, and as climate change continues to alter risk profiles. Risk reduction is necessary to keep some insurance programs viable in the future (Surminski, Panda, and Lambert, forthcoming). Without risk reduction, unviable insurance programs may impose, when they fail, explicit or implicit liabilities on governments. Today, more and more providers of disaster insurance recognize this and include risk reduction targets and objectives. Surminski, Panda, and Lambert (forthcoming) found that explicit support for risk reduction has become more widespread, offered by only one-third of providers in 2012 but by two-thirds in 2018.

A comprehensive approach to disaster risk

Disaster insurance generally requires public backing to provide both financial support and risk modeling. The longer-term sustainability of programs and their success in reaching the poorest and most vulnerable requires coordination with broader risk management and development policies to limit any worsening of exposure to disaster risk and to improve access to credit and financial services.

An integrated approach includes investing directly in disaster resilience within communities, because local residents are the first responders in disasters, often with little or no external support, and are key to ensuring sustained recovery and reconstruction. Thus, strengthening communities' resilience goes some way toward the ultimate goal of strengthening societal resilience.

Quantifiable measures of social and community resilience are critical for multiple reasons: They allow community progress to be tracked over time in a standardized way. They enable the prioritization of measures most needed by the community. And they generate evidence for identifying what characteristics contribute most to community disaster resilience before an event strikes, and what can be done after it strikes.

New evidence from flood resilience surveys shows that community investments can build resilience while delivering broader development benefits, such as better education, transportation, and food supply (Box 2.3.6). Proper waste management, for example, keeps rivers and drains unclogged and reduces the spread of disease after a flood, while benefiting a community more broadly by improving public health and well-being in normal times.

2.3.6 Measuring community resilience—what gets measured gets managed

New evidence from Flood Resilience Measurement for Communities, a conceptual framework and assessment tool developed by the Zurich Flood Resilience Alliance, is beginning to shed light on the factors that contribute to disaster resilience in communities while facilitating the design of innovative DRM strategies.

In developing Asia, this tool has been applied in Afghanistan, Bangladesh, Indonesia, Nepal, and Timor-Leste by five NGOs in seven country programs. Communities were selected based on their flood risk and such socioeconomic indicators as poverty and vulnerability, prioritizing poor or otherwise vulnerable communities perceived to be at high risk of flooding. Baseline studies were conducted in 88 communities in 2016–2017, directly involving more than 4,000 households and indirectly 220,000.

The data show socioeconomic factors such as educational attainment and the type and diversity of livelihood strategies closely correlated with flood resilience. Approximately 20% of sources of flood resilience studied in the framework overlap with sources of community development, the other 80% being more flood-specific. This overlap between community flood resilience and general community development indicators—such as education, transportation, and food supply systems—suggests significant potential for investment with significant collateral benefits.

The survey further found that rural households face greater resilience challenges, with 90% of those surveyed having suffered loss of life or significant damage to assets from flooding in the past decade. Rural households took longer to recover financially from floods than their urban counterparts. The assessment of resilience indicators, aggregated by community type, suggests greater room for improvement in rural areas (box figure 1). Coping strategies appear to be significantly stronger in urban communities, in part because urban residents in the sample are on average wealthier and are less dependent on the local environment, both natural and social, for their livelihoods as a result of higher livelihood diversification.

Across all communities, the factor contributing to flood resilience with the highest grade is often human capital, while financial capital is graded very low. Education, transportation, and water supply are typically among the greatest strengths identified. This may be because NGOs see these services as easy wins and useful entry points for building community flood resilience. It may also be because these services are traditional targets for community development investment.

1 Distribution of flood resilience scores, by settlement type



Source: Laurien and Keating, forthcoming.

Another common strength, identified across the communities in the sample, is knowledge and awareness of flood-exposed areas. In fact, this is one of the highest-graded sources of resilience: tenth in urban communities, first in peri-urban, and second in rural communities. It is encouraging to note that efforts by local authorities, community organizations, and NGOs to increase knowledge and awareness of flood risk are found to have enjoyed some success.

A number of significant gaps in flood resilience are also identified, with differences seen across community types. These differences were highlighted in two case studies, one on urban communities in Semarang, Indonesia, and the other on rural communities in the Yawan District in Afghanistan (box figure 2). Both communities showed improvement across all resilience categories over time. Comparing communities, capacity improvement was assessed as stronger across all five types of capital in urban communities in Indonesia than in rural communities in Afghanistan. Financial capital appeared to be the worst weakness in rural Afghan communities, while weak social and natural capital were larger areas of concern in urban Indonesian communities.

These types of findings can inform decisions for DRM, resilience, and well-being by helping to prioritize intervention investments into community or regional programs that, for example, leverage human capital or prioritize financial coping strategies.

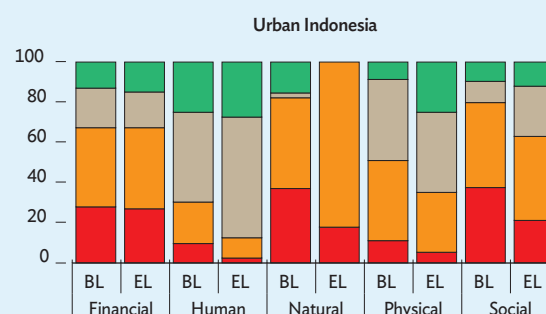
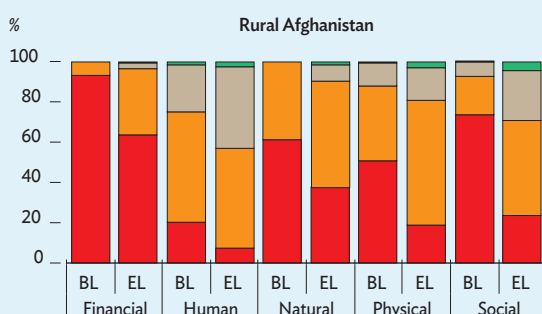
2.3.6 Continued

The utility of this kind of study is illustrated by the innovative disaster resilience initiatives it has facilitated and by the old adage “what gets measured gets managed.” For example, the performance of waste management systems in the event of a disaster, highlighted in Semarang City, and the need to engage in prospective risk reduction were not previously well understood as important by NGOs working in community development and disaster resilience, but became better understood through the use of the tool Flood Resilience Measurement for Communities.

Similarly, in Yawan District in Afghanistan, surveys highlighted vulnerability to transitory disaster-induced food and water insecurity when fuel became unavailable for cooking and boiling water. In response, solar cookers were distributed to the poorest and most vulnerable households in the communities studied. While supporting food and water security, the cookers offered additional benefits by promoting gender equality and environmental sustainability.

2 Distribution of grades of resilience

■ A ■ B ■ C ■ D



A = best practice in community resilience, B = good resilience standard, no immediate need for improvement, BL = baseline, C = deficiencies, evident room for improvement, D = significantly below good standard, potential for imminent loss, EL = end line.

Source: Laurien and Keating, forthcoming.

The value of local indigenous knowledge

Recent experience after major earthquakes and tropical cyclones in Asia further demonstrates the role of local communities and indigenous groups as custodians of local knowledge and experience relevant to effective DRM. In particular, indigenous groups, with their long history in their home locations, possess better information about severe but very low-frequency events, catastrophes that are all but invisible to modern modeling techniques and observations using short time periods. The most striking recent example of this is from the Indian Ocean tsunami of 2004 and is described in McAdoo et al. (2006).

Examples abound of the ways in which indigenous knowledge and practice was, is, or can be used proactively in DRM. For example, Kelman, Mercer, and Gaillard (2012) identified in communities in the Philippines and Papua New Guinea several ways in which indigenous knowledge pointed to vulnerabilities that were not recognized through more modern scientific knowledge. Another example is traditional building techniques, such as those used to build hazard-resilient vernacular housing in Nepal.

Three observations pertain to indigenous or traditional knowledge:

- (i) Context is important, and this knowledge is only sometimes transferable.
- (ii) Building on knowledge already accepted within an indigenous community helps to align actions with the things that the community values and understands, empowering them to recognize what they can do for themselves.
- (iii) Even indigenous communities are rarely homogeneous, and neither is their body of knowledge. As such, no nugget of knowledge necessarily applies to all members of a community. In any case, even indigenous communities with traditional knowledge may have only limited experience of recovering from catastrophic events over the long term.

These challenges notwithstanding, harnessing indigenous knowledge can help to mainstream disaster risk reduction policies and practice, as well as contribute to their integration with all disaster-related policies and processes, from prevention to recovery.

Prepared to build back better after a disaster

Almost all measurement and discussion of disaster risk focuses on the immediate impact of disasters and the emergency phase. Researchers and practitioners alike pay little attention to the longer-term consequences of these events: how they affect long-term economic trajectories; the longer-term political, cultural, and social perspectives; and their impacts on public health and the environment. In line with the dearth of research on long-term outcomes, policy frameworks and implementation plans almost always emphasize only the short-term and expend less effort planning for the long-term.

In contrast with these gaps in detailed policy research and implementation discussions, the literature is full of aspirational plans to “build back better” and to facilitate recovery from disaster that is more than complete, adding improvements that go beyond the situation before the disaster. The United Nations General Assembly adopted in 2016 a definition of build back better (BBB) that was developed by an intergovernmental expert working group convened by the United Nations Office for Disaster Risk Reduction (Box 2.4.1). In this definition, BBB aims to strengthen resilience in nations and communities and to revitalize livelihoods, economies, and the environment (UN 2016).

As Oscar Wilde observed: “A map of the world that does not include Utopia is not worth even glancing at, for it leaves out the one country at which Humanity is always landing. And when Humanity lands there, it looks out, and, seeing a better country, sets sail. Progress is the realization of Utopias” (Wilde 2009).

2.4.1 What is ‘build back better’?

The Sendai Framework for Disaster Risk Reduction was signed in 2015 and endorsed by all ADB members in the Ulaanbaatar Declaration of 2018. Priority 4b.4 in the Sendai Framework calls on its signatories to “institute or strengthen policies, laws, and programs that promote (incentivize), guide (ensure), and support Build Back Better (BBB) in Recovery, Rehabilitation, and Reconstruction.”

The United Nations Intergovernmental Expert Working Group on Indicators and Terminology was tasked with clarifying the central concepts that guide the Sendai Framework priorities.

The working group defined build back better as “the use of the recovery, rehabilitation, and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment.”

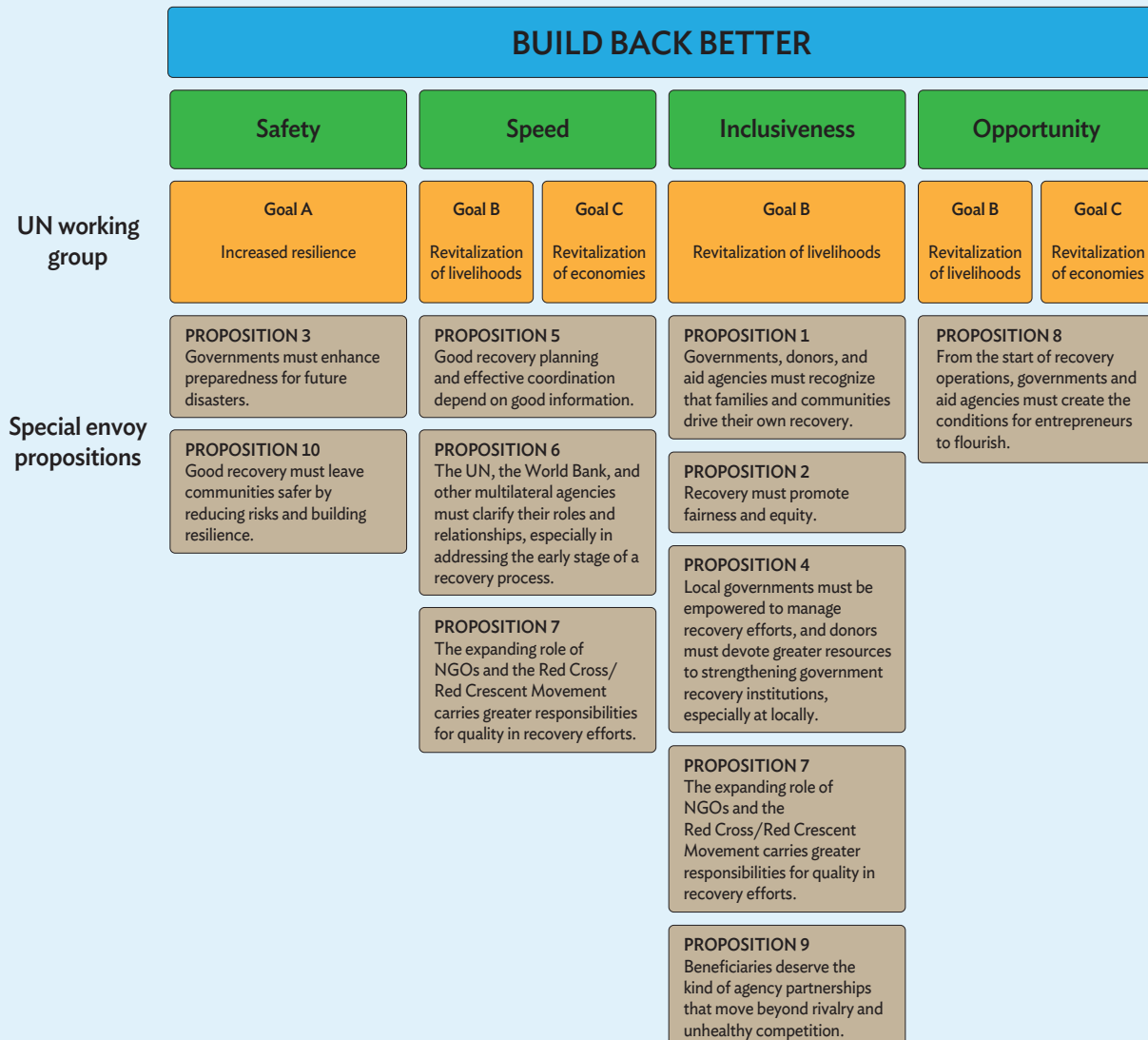
In this definition, agreed after wide consultation, there are four goals for building back better: increased resilience, revitalization of livelihoods, revitalization of economies, and revitalization of the environment.

2.4.1 Continued

Resilience—maybe the thorniest term of all—is defined by the same working group as “the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, adapt to, transform, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.” As such, resilience focuses on what happens over time to a system, community, or society after it has been exposed to a hazard.

The build-back-better paradigm first achieved some prominence after the 2004 Indian Ocean tsunami and was frequently mentioned in recovery planning after that catastrophe. The former US president Bill Clinton was the UN secretary general’s special envoy for tsunami recovery, a position he later held in Haiti during and after the earthquake there in 2010. The special envoy outlined 10 *Key Propositions for Building Back Better* (Clinton 2006). Based on the definition from the UN working group and the special envoy’s propositions, the concept of build back better can be operationalized through four easily identifiable and distinct aims: safety, speed, inclusiveness, and opportunity (box figure).

The build-back-better paradigm



While the previous section focused on what is being done, and what more can be done, to reduce the cost of disasters and their immediate aftermath, here the focus is on the aspirations behind BBB. These aspirations may sound utopian, but they are nonetheless achievable, even if only rarely so far. To turn utopia into policy, operationalize BBB.

Governance challenges

Beyond a better definition of BBB, and before any attempt to define the path leading to BBB, it is necessary to address the governance challenges that are typically posed in the aftermath of a disaster.

The recovery phase can be a very fluid time with opportunities poised against the many barriers and obstacles that seem to dominate the landscape. A demand surge for specialized construction services after an earthquake, for example, can nurture the emergence of a thriving seismic engineering knowledge industry that can become a future service export when this knowledge is required elsewhere. However, many of these potential benefits require active policy decisions and mechanisms that facilitate useful developments. Without them, such nascent opportunities will be missed. More fundamentally, overcoming the many barriers and obstacles that are always present in post-disaster recovery equally demands active management of these challenges.

Often, post-disaster financing is at the forefront of planning for reconstruction and recovery. However, such a focus does not adequately address the implementation challenges associated with post-disaster operations. Past experience amply demonstrates that a lack of access to finance is not the only barrier to a swift return to normality (Hallegatte, Rentschler, and Walsh 2018, Mochizuki, Hallwright, and Handmer, forthcoming). Even with financing available, governments, firms, and households often struggle to reconstruct and recover.

The efficient and productive use of disaster risk finance, when it is available, is frequently stymied by the complex governance landscape of post-disaster operations and its multiple actors. Even when agreements clearly define responsibilities, local administrative capacity may be overwhelmed by the due diligence and reporting requirements of a highly fragmented response community.

Overcoming these obstacles requires comprehensive disaster risk financing strategies. They should go beyond developing disaster risk financing instruments by also enhancing budget execution capacity so that financing can be used promptly and effectively. Adequate procedures for appropriating, disbursing, and monitoring the use of post-disaster funding, and capacity to implement them, are essential for successful mobilization and recovery. Adequate emergency procurement regulations and capacity, including advance contracting arrangements, are also key.

In other cases, partly because of failure to consult with local entities, stakeholders, and the people directly affected, governments may underestimate the obstacles and opportunities in the post-disaster environment. Population movements, skills bottlenecks, and inflation in a construction boom can all delay procurement and rebuilding.

In general, it helps tremendously to have the roles and responsibilities of external and internal actors clearly codified in formal frameworks and policy guidelines. That said, without experiential knowledge gained from past recovery processes, and without mutual trust, any predetermined plan for reconstruction and recovery is prone to implementation failure in the chaos of post-disaster operations. If no such plan exists, and the actors lack experience, the governance challenges posed by this process are immense.

One crucial need for building experiential knowledge is to institutionalize lessons from previous events. Disasters are opportunities to develop this knowledge toward better managing the next disaster. Quantitative evidence shows that countries that have experienced frequent smaller disasters are better able to handle large ones.

Preparing for recovery funding

Overcoming all these governance challenges requires enablers that are both explicit and tacit. Explicit enablers facilitate setting up appropriate institutions, getting access to recovery financing, and establishing with clarity participants' roles and responsibilities by drafting pre-disaster plans and frameworks. Tacit enablers provide opportunities for building trust, gaining experiential knowledge through joint simulation exercises, and fostering the operational knowledge and capacity local staff need to handle the complex administrative demands of the post-disaster period. Explicit and tacit enablers are equally important to the success of BBB.

Governing post-disaster operations is a complex undertaking in under-resourced environments. This is partly because the availability of sufficient external assistance is unpredictable, but also because multiple external and domestic actors must be mobilized and coordinated despite varying and potentially conflicting recovery priorities and disagreements over them.

While immediate humanitarian needs are fulfilled through a large variety of funding sources, formal channels for the funds necessary for long-term recovery and reconstruction are typically the product of a post-disaster needs assessment and conferences called in response to requests for external assistance and support from the national government.

Immediate humanitarian relief is typically coordinated nationally and supported internationally through an established protocol using a cluster approach, as was done in Nepal through the National Disaster Response Framework (Box 2.4.2). In contrast, long-term recovery and reconstruction is primarily led by national, subnational, and local governments. These bodies typically operate in a less coordinated fashion, reflecting their limited capacity and experience in designing and implementing complex rebuilding projects (Lloyd-Jones 2006). Clarifying the respective roles of the various government entities, with clear demarcation of responsibilities and decision-making roles, is key to their successful collaboration.

2.4.2 The 2015 earthquake in Nepal—challenges to rebuilding homes and livelihoods

The 2015 earthquake in Nepal, striking on 25 April with an initial shock of magnitude 7.8, caused over 8,790 deaths and 22,300 injuries. It displaced 2.8 million, and the 8 million people who were affected in one way or another amounted to a third of the country's population (Government of Nepal 2015). Fourteen of Nepal's 75 districts were classified as "crisis hit" and received targeted support for rescue and relief (IMF 2015).

Strong international support

On 29 April, a UN flash appeal launched by 78 participating organizations made an initial request for \$422 million to use in the following 3 months. A post-disaster needs assessment released 2 months after the initial earthquake estimated that damages and other losses could add up to some \$7 billion, equal to a third of Nepal's gross domestic product. Half of the damage was to private homes (Government of Nepal 2015). In the months following the earthquake, the value of remittances increased by 20%–35% (UNOCHA 2015). The International Monetary Fund (IMF) forecast that higher remittances would be offset by lost income from tourism and higher imports needed to supply recovery efforts and reconstruction. The IMF subsequently approved the disbursement of \$49.7 million in direct budgetary support under its Rapid Credit Facility (IMF 2015). Within 2 months of the initial shock, ADB approved \$200 million in emergency assistance to rebuild and restore schools, roads, and public buildings.

In June, the Government of Nepal hosted an international conference on Nepal's reconstruction. The international community pledged \$4.4 billion in grants and loans to support the country's recovery and reconstruction (IMF 2015). This was more than twice the amount requested in the government's initial

call for support, but actual disbursement would prove to be much lower and delayed. To facilitate home reconstruction in the hardest hit 14 rural districts, the Nepal Earthquake Housing Reconstruction Program Multi-Donor Trust Fund was established with support from the international community.

In May 2016, the government published a 5-year post-disaster recovery framework outlining five strategic focuses: restore and improve disaster-resilient buildings, strengthen the disaster resilience of communities and individuals and foster social cohesion, restore and improve access to services, restore and develop livelihoods, and build the state's capacity to respond to future disasters (NRA 2016).

Need for better coordination

The National Disaster Response Framework, created in 2013, was tasked with aligning the international humanitarian cluster coordination structure with national line ministries, designating each national ministry as cluster lead and an international humanitarian agency as the co-lead of a streamlined structure with 11 clusters. The framework further provided a detailed timeline and assignment of responsibilities for 62 actions to be taken immediately following a disaster. Surveys conducted after the earthquake revealed that 30 of 62 mandatory emergency operations were performed in accordance with the framework (Bisri and Beniya 2016).

While these pre-disaster activities have certainly helped coordinate immediate response, a number of concerns were raised, one pertaining to a rapid surge of new actors in the cluster system. The shelter cluster, for example, had 10 agencies that regularly participated in it before the earthquake, but the cluster now had 120 agencies that needed to be coordinated (IASC 2016). Another concern was the very limited

2.4.2 Continued

inclusion of national NGOs and local actors in the official coordination mechanisms. Of \$422 million in the consolidated humanitarian appeal made by 78 organizations, only 0.8% of the funds were directed to Nepali organizations. Further, the National Disaster Response Framework did not address coordinating with the needs of national NGOs and local actors, leaving smaller organizations to continue to work outside of the formal cluster system.

On the ground, relief efforts were hampered by other factors such as a dearth of local knowledge; a lack of local leadership to convey needs from locals and support from international participants; administrative inefficiency; sporadic implementation of national policies that were considered irrelevant in particular local contexts; border tensions, which increased prices for fuel and other goods; and discrimination by social caste. In many instances, isolated by complex topography and bedeviled by implementation challenges, participants had to learn to help themselves (Auerbach 2015, Cook, Shrestha, and Bo 2016, Dahal 2016, Grunewald and Burlat 2016, Hall et al. 2017).

Funding challenges

Despite generous pledges from the international community, Nepal's reconstruction faced numerous funding challenges. As of April 2018, almost 3 years after the earthquake, only 16% of reconstruction pledges had actually been disbursed. Against the official goal of rebuilding 400,000 homes by the end of fiscal 2018 in mid-June of last year, only a quarter had been completed. As is quite typical in post-disaster recovery in many countries, including wealthy ones, the 3-year mark was when frustration with delays started to boil over and trust in the authorities started to erode.

Even when funding was secured nationally, reconstruction projects faced local implementation challenges: a lack of skilled personnel, skills mismatch in labor markets, disputes over eligibility for reconstruction grants, price increases for construction materials and transportation, unclear land tenure, delays in channeling funds through providers of financial services, and even the absence of bank accounts to facilitate transactions.

Two years after the earthquake, more than 60% of people in severely affected districts still lived in temporary shelters. These challenges persisted despite progress in streamlining reconstruction and the publication of guidelines for settlement development, subsidy distribution, and training and deploying personnel, as well as the provision of a design catalogue for earthquake-resistant building prototypes.

The Nepal case study illustrates the common governance challenges of financing and implementing post-disaster operations. According to official statistics published on 2 May 2018, Nepal had achieved mixed progress on reconstruction and recovery: Of 379 public buildings to be rebuilt, 220 had been rebuilt and another 147 were under construction. Of 7,553 educational facilities to be rebuilt, 3,613 had been completed and another 1,719 were under construction, while the rest were still in planning stages.

Meanwhile, of 753 cultural heritage structures to be rebuilt, 100 had been completed and another 329 were under construction. Similarly, many health institutions and drinking water systems still had to be rebuilt, with 581 completed and 795 still under construction (NRA 2018). This illustrates how the victims' full recovery of livelihoods remains elusive for many, especially those living in remote areas or still in temporary shelters.

In addition to the different levels of government, community members providing mutual support, and families receiving remittances, voluntary organizations funded by contributions from private individuals and philanthropic organizations occupy their corner of the reconstruction and recovery ecosystem, as do international NGOs. Coordinating these diverse entities presents considerable challenges to governments and their partners. An important role for the entity in charge of reconstruction, typically an office of the national government, is therefore to work together with funders, local government, the private sector, and civil society. Part of the job is naturally to define the aims of post-disaster recovery and coordinate the assemblage and distribution of resources during the design and implementation phases of the recovery process.

Planning and training as key elements of recovery

Contingency planning for recovery, backed by pre-financing arrangements, can be a useful vehicle to clarify expectations before a disaster hits, and to facilitate setting recovery on a BBB track after it does. Defining governance arrangements and codifying them through legislative action before a disaster strikes is particularly important. While the details will always be specific to particular disasters, the main framework for governing the recovery process should be decided ahead of time.

After a disaster, the assessment of needs has conventionally been implemented as a technical exercise using information on economic damage and the country's access to domestic and external resources. Yet more can be achieved toward facilitating the implementation of post-disaster BBB if, in the needs-assessment phase, a plan for BBB is already incorporated into the decision-making process.

Governments and domestic stakeholders should ensure that roles and responsibilities are clearly defined in all phases of post-disaster operations. In particular, though, they should plan in advance for the recovery and reconstruction phases of the disaster cycle. Emphasis should be placed on setting clear mandates within the ministries of national governments regarding the coordination of financing, operations, and monitoring of disaster response, recovery, and reconstruction. Pre-disaster training and simulations should clarify roles and responsibilities across government departments, as well as units' relationships with international and domestic partners in the private sector and civil society.

Often missing in contingency planning are procedures for a transition from emergency response to recovery and reconstruction over the medium and long term. Setting up explicit rules and systems is only part of what is required, but a part that often plagues post-disaster reconstruction. Local staff and partners should have sufficient training and knowledge before the disaster to effectively follow plans and procedures when pressed for time in the post-disaster phase. Capacity-building programs should therefore target international, national, and local actors alike, including the government, private firms, and civil society, and should elaborate the details of operational processes and any requirements related to external disaster risk financing and ways of preparing domestic financial, accounting, and accountability systems to scale up their operations as necessary after a disaster strikes.

To summarize, the United Nations International Strategy for Disaster Reduction notes that national governments would benefit greatly by creating a functional and productive environment where stakeholders appreciate the importance of a build-back-better mindset after disasters (UNISDR 2017).

This should ideally be supported by national laws and equitably enforced, with all necessary resources—human, financial, and otherwise—made readily available. Able leadership and good governance are essential to provide the support mechanisms needed for such a strategy.

External benefits of post-disaster reconstruction and recovery

Supporting evidence for “creative destruction” dynamics that arise organically in post-disaster reconstruction appears to be limited to several cases, such as the 2008 Wenchuan earthquake in the PRC (Box 2.4.3). Nevertheless these few cases point to what a government can do to improve outcomes. One is to offer generous funding to build resilience. After the 2008 earthquake, the Government of the PRC spent a very large amount of money to build more seismically robust infrastructure.

Another way that recovery can engender favorable BBB outcomes, even if not deliberately, is for reconstruction to create positive externalities that enable development to speed up, bringing benefits that would have come only later, if at all, without reconstruction as a trigger. One vintage example can be found in an analysis of the Great Boston Fire of 1872 (Hornbeck and Keniston 2017). The study found that the reconstruction of individual properties rendered benefits to nearby properties that facilitated their development as well. The fire and the resulting need to reconstruct destroyed buildings, it seems, accelerated urban renewal that otherwise would have taken much longer.

Progress through technological leap-frogging is another possibility, though infrequently realized. Hornbeck and Naidu (2014) found that the Great Mississippi Flood of 1927 accelerated the modernization of agriculture in the area through mechanization that was forced in part by labor shortages occasioned by the outward migration of sharecroppers. According to the study, it was this shortage of labor created by the flood that drove farmers to adopt new technologies.

However, evidence exists that, even in a strong post-disaster recovery enjoying generous financing from domestic and international sources, such as insurance and development assistance, the outcome can be a worsening of structural social inequality. This may happen because households with more income are better able to withstand disasters and to benefit from long-term changes in the post-disaster environment (De Alwis and Noy, forthcoming). This is clearly one aspect of the BBB strategy that must be appropriately addressed.

2.4.3 The 2008 Wenchuan earthquake

On 12 May 2008, a massive earthquake measuring 8.0 on the Richter scale struck Wenchuan County, 92 kilometers northwest of Chengdu, the capital of Sichuan Province in the PRC. Damage was widespread across 116,000 square kilometers of heavily affected areas in Sichuan and the neighboring provinces of Gansu and Shaanxi, but most of the damage by far was in Sichuan (box table).

Damage and loss

Province	Sichuan	Gansu	Shaanxi
Number of affected counties	139	40	40
Deaths	68,708	370	125
Missing persons	17,923		
Injured persons	360,796	10,165	2,970
Damaged housing units (CNY million)	418,830	34,498	11,947
Damaged infrastructure (CNY million)	168,794	11,765	7,577
Agriculture, industry, and services (CNY million)	139,466	2,563	2,309
Land, minerals, cultural heritage, etc. (CNY million)	44,680	1,709	998
Total (CNY million)	771,770	50,535	22,830

Source: ADB 2008.

The most severely affected areas in Sichuan were mountainous, with most of the area at 3,000 meters above sea level. The disaster-affected region included economically less-developed national minority regions and wealthier urban regions, notably the cities of Chengdu, Deyang, and Mianyang. The earthquake destroyed houses, other property, and infrastructure for rail transport, electric power supply, water supply and sanitation, as well as such critical infrastructure as hospitals, roads, and communications systems. The earthquake and aftershocks incurred secondary disasters, notably by creating many large barrier lakes that posed a significant threat of flashfloods to millions of people downstream. The cost of reconstruction was estimated at CNY1 trillion, which was nearly equal to the gross provincial product of Sichuan, or 3.9% of the PRC gross domestic product in 2007. The vast majority of households and businesses had no insurance coverage.

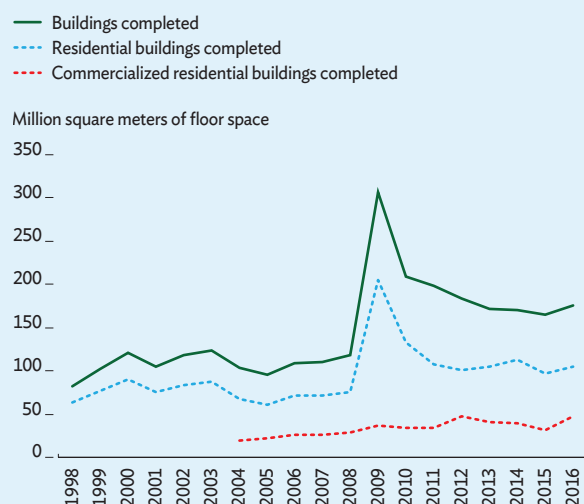
In 2009, in response to a global economic crisis, the government passed a massive CNY4 trillion stimulus package, of which 25% went to earthquake

reconstruction. In addition, richer coastal provinces were paired with disaster-affected counties and required to put aside 1% of provincial government revenue—a very large amount of money for the affected counties—to assist reconstruction in partner counties. Shanghai, for example, was matched with Dujiangyan, a city of 600,000, and provided CNY8.3 billion for 117 projects.

The purpose of pairing provinces with affected counties was to overcome the logistical hurdles of managing post-disaster assistance, as it allowed not only the provision of funding but also the mobilization of personnel and knowledge from the coastal provinces. It engendered competition in which provinces were judged by how effectively they assisted reconstruction in affected counties. This matchmaking generated an additional CNY91 billion in assistance for the affected region and more than 4,000 reconstruction projects. By the end of September 2009, the PRC had mobilized CNY79.7 billion in social contributions from individuals and NGOs—an unprecedented amount to that time—from both inside and outside of the PRC.

Sichuan's regional economic indicators showed rapid recovery in aggregate from the earthquake. The massive spending on reconstruction stimulated the region's economy for a few years before the effect began to wane. The largest increase in manufacturing value added was in construction, which grew quickly until 2010, before eventually subsiding (box figure 1).

1 Building construction in Sichuan



Source: ADB 2008.

2.4.3 Continued

Park and Wang (2017) used data from a survey conducted more than 10 months after the earthquake of 3,000 rural households living in 100 poor villages in 10 counties in the disaster-affected areas. The study found that asset and income losses for surveyed households were substantial, especially in the most severely damaged areas. It described “an overwhelming government response to the disaster,” with subsidies provided to households in 2008 that were so large that median income per capita was 17.5% higher in 2008 than in 2007 and the poverty rate declined from 34% to 19%. The extent of government support for victims of the Wenchuan earthquake was unprecedented.

Perhaps reflecting this massive infusion of funding to the affected region, the trajectory of the provincial population seems to have shifted for the better after recovery investment started to bear fruit (box figure 2). The earthquake in Wenchuan is a clear example of a build-back-better recovery, premised on a massive investment in recovery through funding received from both the Government of the PRC and the governments of several provinces.

2 Resident population in Sichuan at year-end



Source: ADB 2008.

Migration after a disaster

Outmigration is sometimes perceived as a failure of BBB, but it can be a boon to those who choose to migrate and for their families. An example from Viet Nam is instructive. Rural households in Viet Nam cope with disasters mainly by sending family members into urban areas (Gröger and Zylberberg 2016). As is common in lower-income countries, only selected members of households are able migrate away from disaster-affected areas. Often, those displaced by a storm opt not to return. While the migrants' households benefit from remittances, the affected region ends up with a lower population and therefore less economic activity.

Conversely, disasters can motivate migration *into* the affected region. They may be attracted by spending on reconstruction, by the structural changes brought about by the recovery spending, or even by risk reduction achieved after the disaster. Such dynamics were evident in population increases seen in areas in the Netherlands affected by the North Sea Flood in 1953, for instance, as these places benefited from a large public works program aiming to strengthen flood protection in flood-prone areas (Husby et al. 2014). In-migration can also reflect a surge in job opportunities, particularly in the building industry, that may be only temporary.

Voluntary migration into and out of affected areas can therefore, under certain circumstances, enhance resilience and improve well-being. Governments sometimes try to convince inhabitants of affected areas to relocate away from the most hazard-prone area by, for example, banning home construction within a certain distance of the shoreline.

Much better data is required on the length of post-disaster migration in and out of affected areas to really grasp its drivers and implications. Only then will it be possible to develop appropriate policies and measures to manage migration well and encourage optimal flows of people.

Policy aims of building back better

“Build back safer” may be a better tagline than build back better because “better” can mean many things, some of which may actually worsen risk by, for example, increasing population density. “Safer” provides a clearer goal to focus on during recovery, especially with respect to reconstructing residential and commercial buildings. The thinking behind this emphasis is that safety should trump all other aspirations for post-disaster recovery (Kennedy et al. 2008).

In many cases, however, there are other aims that residents and policy makers hope to achieve with recovery and reconstruction. These aims can impose trade-offs that need to be carefully balanced to avoid jeopardizing the goal of maintaining or strengthening safety. Important questions need to be asked when following BBB principles after a disaster (Kennedy et al. 2008): Will recovery ensure safety and security? What will be the impact on the affected community? Is it fair and equitable, and does it tackle the root causes of vulnerability?

Following this logic, the World Bank has suggested three separate components to building back better: stronger, faster, and more inclusive (Hallegatte, Rentschler, and Walsh 2018). In line with this approach, it has been argued that building back stronger may have a different connotation than, say, building back safer. This would be the case if, for example, safety standards called for construction methods and standards that could reasonably ensure that lives would not be lost as a consequence of a disaster but not necessarily that the buildings would be stronger and continue to be habitable after the disaster. However, even these goals can impose trade-offs that ought to be carefully considered during reconstruction and recovery, especially considering that, ultimately and most fundamentally, the process should end with resilience enhanced enough for the community to survive future disasters and more generally thrive in future circumstances. The number of BBB components can thus be extended to four: safety, speed, fairness and inclusivity, and future social and economic potential.

Building back a safer environment

Reducing the risk of mortality and morbidity in future events is an uncontroversial goal of recovery and reconstruction in the aftermath of any adverse event. One important observation is that, unlike a lot of the other impacts of disasters, mortality and morbidity are irreversible. As such, it is clear why preventing them should be the overriding goal of reconstruction and recovery policies. All things considered, preventing mortality and morbidity is always likely to be the most important goal guiding government policy after a disaster. It seems indisputable that safety should be prioritized because the consequences of unsafe—or less safe—reconstruction would affect harmed individuals and their families for a very long time.

Hallegatte, Rentschler, and Walsh (2018) used the term “stronger” instead of “safer.” This implied reconstructing houses, public buildings, and transportation and other infrastructure in ways that make them more able to resist the onslaught of an extreme disaster. If the hazard is an earthquake, for example, this suggests rebuilding with more robust construction methods so that buildings will not collapse when shaken. Safety can also be achieved, however, through softer defenses—the classic example of which is mangrove forests to counter risks from storm surges—or by retreating from dangerous locations altogether (Hino et al. 2017). Improved safety post-disaster can be achieved by other policies as well, ones that do not entail strong, hard, or soft engineering solutions.

Even further from bricks-and-mortar concerns but maybe no less important is the strengthening of social ties within communities. This was found to be important in preventing mortality in the 2011 tsunami in Japan (Aldrich and Sawada 2015). Safety under tsunami risk depends on timely warnings and the ability to evacuate. Social ties allow the timely evacuation of people, such as the elderly, who would find it difficult to evacuate independently. Therefore, one can build back a safer community by establishing mechanisms that strengthen social ties. This can be achieved in many ways, for example through the spatial planning of residential neighborhoods.

Building back faster for well-being

Rebuilding at a faster pace is also a fairly obvious and uncontroversial goal of public policy. All things being equal, a faster recovery is always better than a slower one. Speed is often motivated as well by political and electoral pressures. Surprisingly, though, governments sometimes do not realize that speeding up recovery is achievable and should be seen as an explicit policy goal. For example, many post-disaster situations give rise to complicated legal questions that need to be resolved in court, such as on property rights, insurance liability, and the role of the various branches of government versus

the private sector. Governments should make every effort to speed this up and purposely remove any bottleneck that delays reconstruction and recovery.

In Sichuan, the government made a conscious and concerted effort to speed up recovery even as it benefited greatly from the abundant resources made available to finance reconstruction. In many cases, lack of funding is a stubborn bottleneck impeding reconstruction. Indeed, recovery in Sichuan was much faster than in other disaster-affected areas—in Myanmar, for example, in the aftermath of Tropical Cyclone Nargis in 2008, or even in high-income Japan during reconstruction following the 2011 earthquake and tsunami. There are other barriers and hurdles to the process, however, so funding cannot be considered a guarantee of rapid reconstruction.

The more difficult problem is when the desire to speed up recovery conflicts with other explicit aims of the BBB framework. There may even be a trade-off between speed and safety. If, for example, the disaster uncovered vulnerability or exposure that was not recognized before—perhaps with the discovery of a previously unknown seismic fault line—it may take some time to investigate and determine the best corrective action, which may be an appropriate engineering solution. In such cases, building back safer may require a more deliberative process.

The desire for speed clearly conflicts with the desire to consult with the affected local community and seek its participation, and it typically conflicts as well with the desire to carefully consider all plausible development, planning, and reconstruction paths. Many of these alternative paths entail significant planning effort and require reallocating property rights for certain assets, the most difficult of which is almost always land. Alternative paths are challenging to implement in the best of times, and this is clearly one reason why speed does not seem to be a priority in many reconstruction projects. The existence of a trade-off between speed and a carefully considered reconstruction path is undeniable, but, all things being equal, speed should be prioritized. A slow recovery makes achieving a build-back-better recovery more difficult.

Building back inclusively for a fairer community

Recovery should aim to be fair and inclusive in both process and outcome. If recovery does not include consultations with communities and other stakeholders that were affected by the event and will be affected by reconstruction, it is not inclusive in process. While there may be a lot of advantages to having recovery guided by an authority tied to the central government and funded by it, the need to continuously consult with those that are directly affected is not diminished and may even be strengthened.

Without adequate consultation, there will be no buy-in from the local community and no assurance that the right decisions will be made and supported. It is not unusual for recovery to be derailed or delayed when disagreements or tensions arise between affected communities and the authority guiding recovery. The aim of bringing all community stakeholders into the decision-making process is to ensure both that the recovery trajectory is in the right direction and will achieve its stated build-back-better aims, and that community participation will smooth and speed up the process by preventing misunderstandings and miscommunication.

It is well known that affected communities are themselves the first responders in disasters, often with little or no immediate external support. Often overlooked is that local communities are also the key to ensuring sustained recovery and reconstruction. New evidence from flood resilience surveys across 88 communities in Asia shows that community investments can build resilience while delivering broader development benefits, such as better education, transportation, and food supply. Without close community participation, these shared benefits will not be recognized (Box 2.3.6). Recent experience from major earthquakes and tropical cyclones in Asia emphasizes also the importance of local communities and actors as custodians of local knowledge and experience that can be pivotal to the effective delivery of humanitarian response and recovery efforts.

Toward maintaining a fair and inclusive process, it must be monitored carefully to see who might be excluded from it. The benefits of the build-back-better process must be received by all segments of society, especially the most disadvantaged. Noteworthy in this context are the many research projects that have observed recoveries frequently excluding the poorest and most vulnerable (Karim and Noy 2016, Hallegatte et al. 2016b, and Patankar, forthcoming). Given the overwhelming evidence of how recovery often fails to reach the disadvantaged, it is apparent that planning for building back better needs to incorporate ways to ensure that the weakest segments of society are included and are empowered during post-disaster reconstruction.

Building back social and economic potential

Post-disaster recovery should aim to generate potential for improved social well-being and expanded economic opportunity. Without improvement, the quality of life will eventually deteriorate (Sen 2000, Friedman 2006). A fair, fast, and safe recovery does not necessarily mean that the reconstructed city or community will have more social and economic potential or opportunities than it did before. Yet without that social and economic potential, the build-back strategy will fail.

Policy should therefore focus not only on the goals of safety, speed, and fairness but also strive to create conditions that will ensure gainful employment and stronger social ties toward improving community well-being. A cautionary tale might be Kobe, Japan, where reconstruction after an earthquake in 1995 was fast, safe, and most likely fair, but nevertheless brought a reduction in economic opportunity (duPont et al. 2015).

Policy makers at all levels should strive for a reconstruction framework that not only preserves previously available social amenities and economic activity, but aims to move the community toward livelihoods that are sustainable over the long term and toward social relationships that can support the community for many years to come. In many cases, preserving the economic opportunities and social ties that were there before the disaster might not even be feasible any more. In these cases, it is even more important for the authorities to be proactive in identifying and generating conditions that will foster long-term social strength and economic prosperity. Ultimately, without renewed social and economic potential, a sustainable build-back-better recovery is not possible.

Much accomplished, much more to do

The risks posed by the heightened impact of disasters in Asia, especially in the lower-income countries of the region, are manifestly real. Damage and losses can propagate across time and space, causing widespread and prolonged adverse impacts on society and the economy. However, citizens, firms, civil society, governments, and multilateral institutions can do a great deal to mitigate the dangers posed by disasters, avert their consequences, and manage the aftermath. The growing seriousness of problem indicates commensurate room for improvement on all fronts.

Low-hanging fruit is ready to be picked: better early warning systems for disasters; greater investment in protection by, for example, building cyclone or tsunami shelters; contingency funds made automatically available after their triggering events; and more policy attention to planning recovery in advance, rather than having to scramble in the emergency phase.

Plenty more can and should be done to initiate change in the ability of societies to pursue the aims of the Sendai Framework Agreement, which focuses on four priorities for action:

- Priority 1. Understanding disaster risk.
- Priority 2. Strengthening disaster risk governance to manage disaster risk.
- Priority 3. Investing in disaster risk reduction for resilience.
- Priority 4. Enhancing disaster preparedness for effective response and to build back better during recovery, rehabilitation, and reconstruction.

Increasing attention has been paid to priorities 1 and 2: understanding disaster risk in developing Asia and dealing with the governance issues that abound in disaster risk management. While this is certainly a welcome development in the region, and though more needs to be done, other aspects of disaster resilience also need to be addressed. As this chapter argues, more attention must now be paid to all four priorities, including 3 and 4: strengthening countries' disaster resilience, improving disaster preparedness, and promoting a more comprehensive strategy for reconstruction. Only then can countries ensure a safer, faster, and more inclusive post-disaster recovery—a recovery that can realize economic and social potential.

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