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1

RESILIENCE
TO DISASTERS IN ASIA AND THE PACIFIC

CHAPTER 1 RESILIENCE TO DISASTERS IN ASIA AND THE PACIFIC

"Nepal was on right track to achieve MDGs and other internationally agreed development goals. The devastating earthquake of April 25 and its subsequent powerful aftershocks have severely undermined our development endeavors and reversed the development gains achieved over the years."

Sushil Koirala, Prime Minister of Nepal
at the International Conference on Nepal's Reconstruction,
on 25th June 2015 in Kathmandu

Asia and the Pacific is the world's most disaster-prone region – exposed to earthquakes, floods, droughts and typhoons, and many other powerfully destructive natural phenomena. Over recent decades the countries of the region have been striving to become more resilient to disasters, and protect their most vulnerable communities. But there is a lot more to do. The region's rapid economic growth is exacerbating many existing risks and creating new ones.

This is a pivotal year for disaster risk reduction in Asia and the Pacific: 2015 marks the end of the 'Hyogo Framework for Action' (HFA), a ten-year disaster management framework created in the aftermath of the 2004 Indian Ocean tsunami. But it also marks the beginning of a new 15-year plan – the 'Sendai Framework for Disaster Risk Reduction 2015-2030'.

In addition, in 2015 the world is transitioning from the Millennium Development Goals to the Sustainable Development Goals – whose achievement will depend critically on building much greater resilience to disasters. Indeed, Sustainable Development Goal 1 on ending poverty has as a core target: 'By 2030, build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.'[1]

Moreover, in December 2015, at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, the world will attempt to align efforts at climate change adaptation with those for building resilience and reducing disaster risk.

In this report resilience to disasters is defined as 'the capacity of countries to withstand, adapt to, and recover from natural disasters'.[2] This chapter will consider the extent to which countries in Asia and the Pacific have achieved this – tracking all the relevant goals and indicators and also identifying the challenges that remain. It builds on the findings of the *Asia-Pacific Disaster Report 2012* and *the ESCAP theme study 2013, Building Resilience to Natural Disasters and Major Economic Crises.*

THE DISASTER EPICENTRE

Asia and the Pacific is the world's most disaster-prone region. Over the period 2005-2014 that coincides with the HFA, the region had 1,625 reported disaster events – over 40 per cent of the global total. Approximately 500,000 people lost their lives, and around 1.4 billion people were affected. This meant that of the world totals, the region accounted for 60 per cent of deaths and 80 per cent of those affected. At the same time there was vast economic damage – $523 billion worth – accounting for 45 per cent of global damage.[3, 4]

Over the past decade, a person living in Asia and the Pacific was twice as likely to be affected by a natural disaster as a person living in Africa, almost six times as likely as someone living in Latin America and the Caribbean, and 30 times more likely than someone living in North America or Europe.[5] All this in a region that is home to more than half of the world's poorest people.[6]

In Asia and the Pacific the most frequent disasters are floods and storms, but over the period 2005-2014 the greatest loss of life, 200,000, was the result of earthquakes and tsunamis (Table I-1 and Figure I-1). There were also large numbers of deaths from extreme temperatures – though this was primarily the result of one event in 2010 – a severe heat wave in North and Central Asia that killed 56,000 people. It should be emphasized, however, that all these regional aggregate numbers are probably underestimations. As yet, there is no standardized methodology for gathering disaster statistics, and many small disasters go unreported (Box I-1).

Over the period 2005-2014 the most disaster-prone subregion was South-East Asia, with 512 events and 177,000 deaths – three per 100,000 people (Figure I-2 and Figure I-3). Many countries in this subregion are located along the Pacific 'Ring of Fire' and also on major typhoon tracks, as well as being vulnerable to erratic monsoons. South and South-West Asia also have high seismic and flood risks. The subregion with the largest number of people affected over this period, however, was East and North-East Asia which, because of its high concentration of economic assets, also suffered the greatest economic damage. The countries of the Pacific subregion had fewer people affected, though this still represented a substantial proportion of their island populations.

TABLE I-1

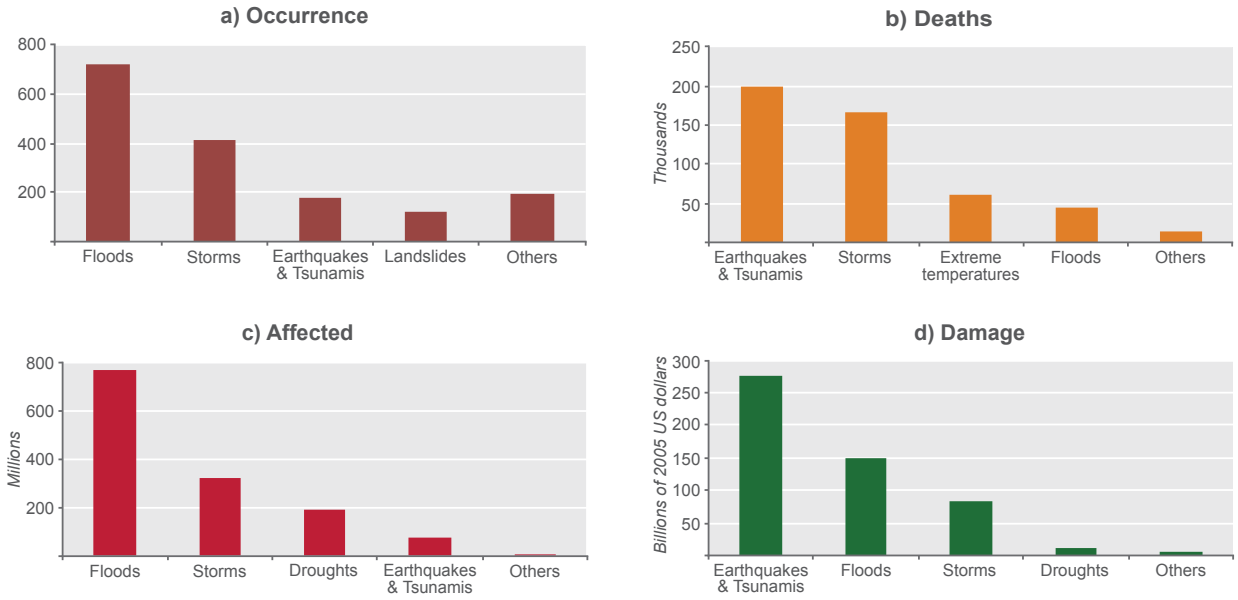
Human impact of disasters in Asia and the Pacific, total 2005-2014

	Lives lost	People affected (millions)
Earthquakes and tsunamis	199,418	74
Storms	166,762	321
Floods	43,800	771
Others	73,772	199
Total	483,752	1,366

Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

FIGURE I-1

Disaster occurrence and impacts in Asia and the Pacific, total 2005-2014



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

BOX I-1

Disaster statistics in Asia and the Pacific

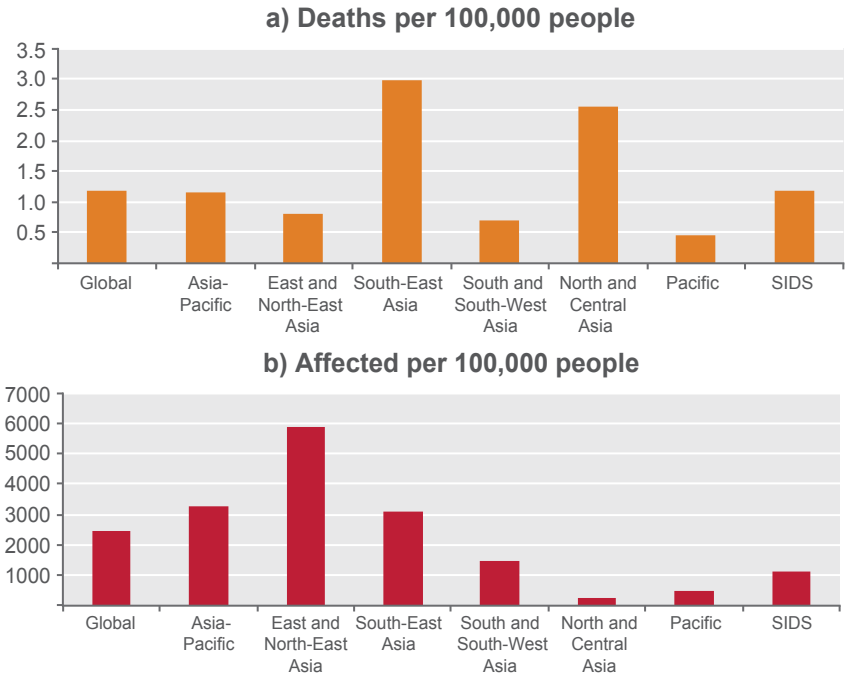
Access to reliable disaster data has been difficult. This is partly due to a lack of agreed classifications and definitions for even the most basic indicators – such as the number of events, the number of deaths and affected people, and the direct economic impacts. In the absence of standardized statistics, efforts to aggregate, analyse and interpret the data often rely on various secondary sources.

Improving disaster statistics is a regional priority. In 2014 Asia-Pacific countries requested ESCAP to establish an expert group to develop a regionally agreed basic range of disaster statistics. This work was given a renewed impetus from the adoption of the Sendai Framework for Disaster Risk Reduction, and has been further stimulated by the ongoing formulation of SDG targets and indicators, which has increased the demand for specific disaster-related statistics. The intergovernmental expert group has already begun its work, and a proposal for a basic range of disaster-related statistics is expected to be presented in 2016 during the 72nd ESCAP Commission.

Another important initiative is the Global Centre for Disaster Statistics. This has been launched by the United Nations Development Programme and the International Research Institute of Disaster Science at Tohoku University. The centre aims to deliver high quality and accessible disaster data, and plans to set up disaster databases in countries that do not have them, while also building the capacity of countries to understand and use disaster databases.[7]

FIGURE I-2

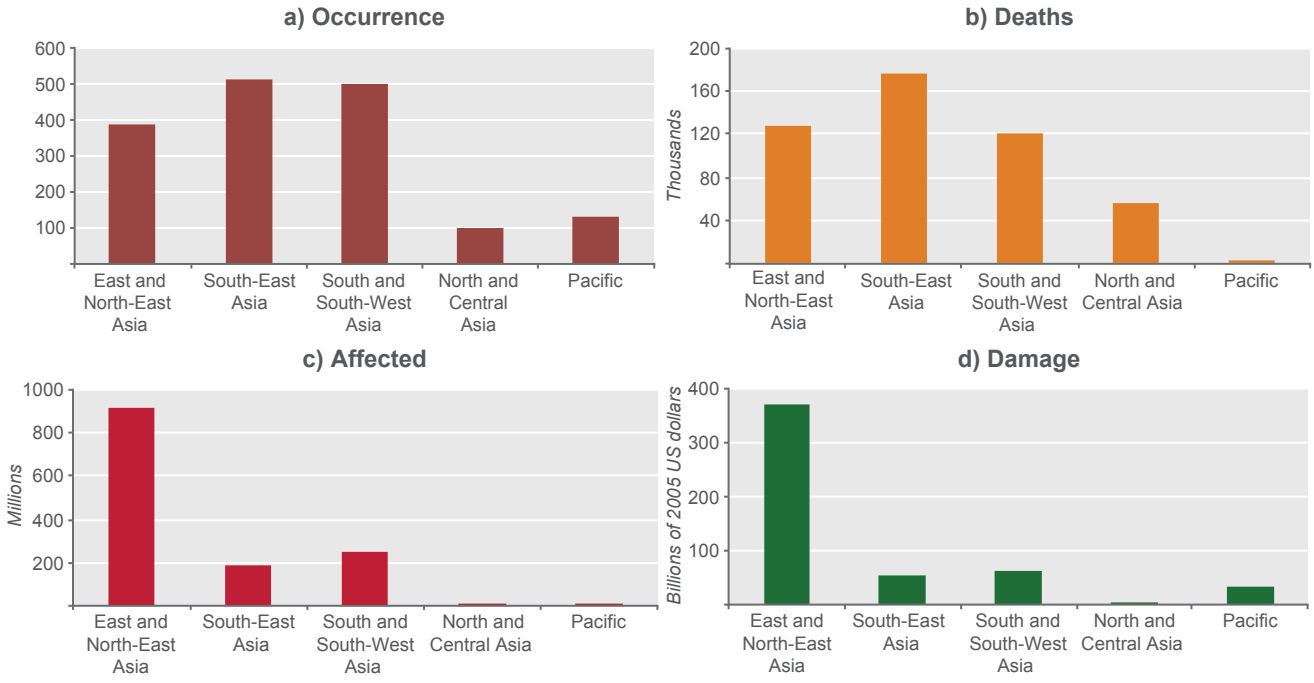
Mortality and numbers of people affected, 2005-2014



Source: ESCAP based on population data from ESCAP statistical database. Available from http://www.unescap.org/stat/data/ (Accessed April 2015), and mortality and the number of affected data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

FIGURE I-3

Occurrence and impacts by subregion, total 2005-2014



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

DISASTERS LARGE AND SMALL

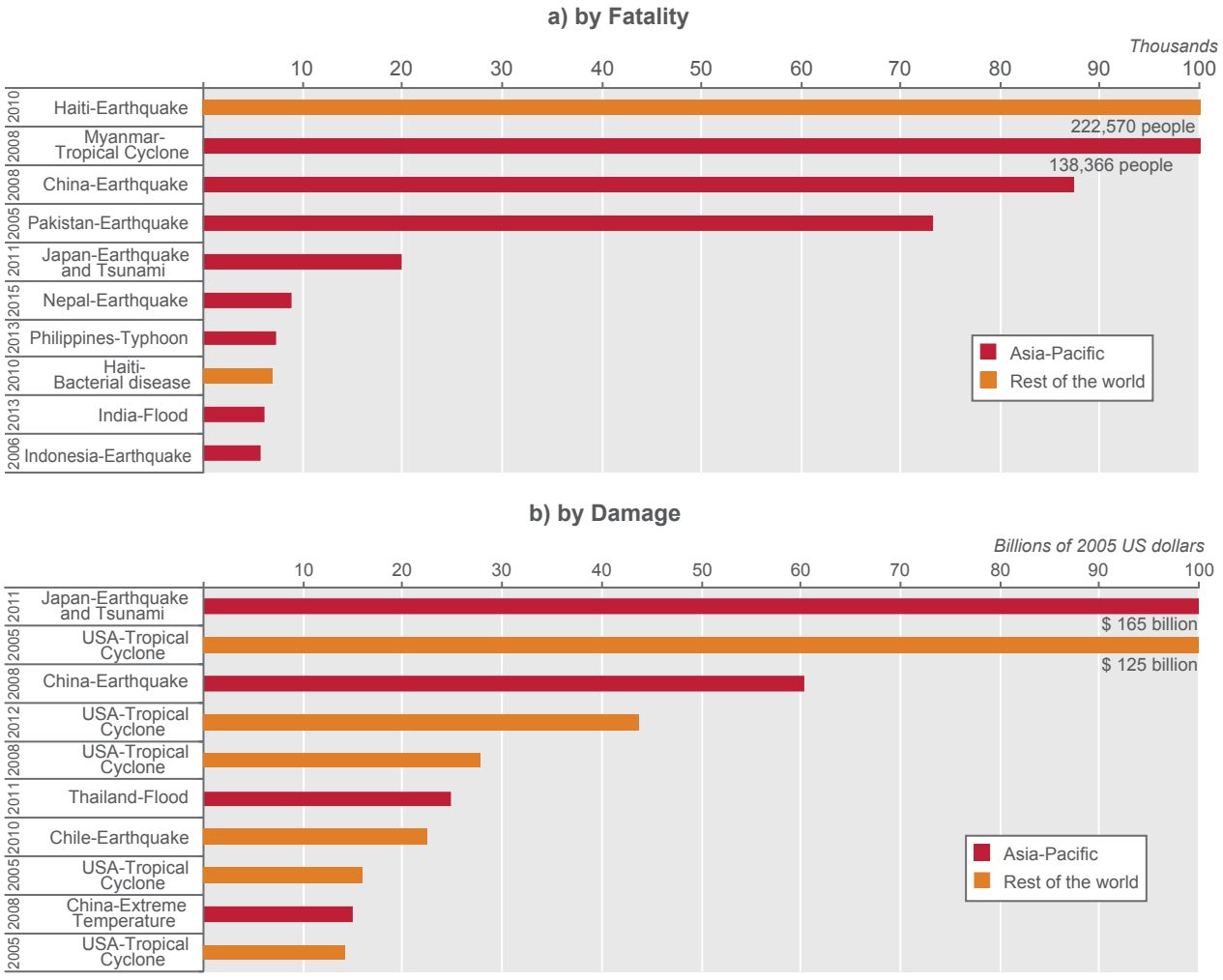
Asia and the Pacific is hit by most of the world's major disasters. Over the last ten years, the region has had eight of the ten largest disasters in terms of fatalities, and four of the ten largest in terms of economic damage (Figure I-4).

These included:

- *Cyclone Nargis* – In 2008, this category-3 cyclone struck the coast of Myanmar including Yangon, the largest city. More than 138,000 people were killed or reported missing, 2.4 million people were severely affected and around 800,000 people were displaced.[8]

FIGURE I-4

World's worst natural disasters occur in Asia and the Pacific, 2005-2015



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015), and Nepal (2015) for Nepal Earthquake 2015.

- *Japan earthquake and tsunami* – In 2011, a magnitude 9.0 earthquake caused a tsunami that hit the Japanese east coast, sweeping away buildings, roads and vehicles and killing around 20,000 people. It also damaged the nuclear power plant at Fukushima. This was the world's costliest-ever natural disaster, causing $165 billion in damage, representing 3.8 per cent of Japan's GDP.
- *China earthquake* – In 2008, a magnitude 7.9 earthquake struck Sichuan province killing 87,000 people and causing $60 billion worth of damage – much of this in Chengdu, one of China's largest cities which was close to the epicentre.

Although high-impact disasters with high fatalities grab the headlines, the region is also affected by multiple but recurring events with fewer fatalities. Indeed since the 1970s, 85 per cent of disasters have had fewer than 100 fatalities but cumulatively these have affected 2.24 billion people and caused over $400 billion worth of damage (Figure I-5). This too is likely to be an underestimate. Many smaller disasters are under-reported or excluded from disaster databases. And some major events like extreme temperatures and droughts are often overlooked because they develop quite slowly. Since 1970, extreme temperatures have killed almost 78,000 people and affected almost 10 million, while droughts have affected more than 1.6 billion people.[9]

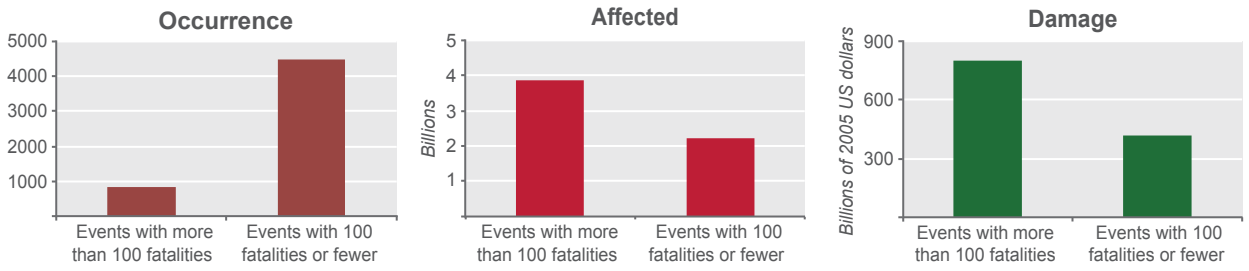
Cascading consequences

While disasters can be itemized separately they are often interlinked. One major disaster can have multiple, cascading consequences. The tsunami in Japan, for example, led to a major nuclear accident at the Fukushima Daiichi Nuclear Power Station. And the 2015 earthquake in Nepal triggered six critical landslides – five in Nepal and one in the Tibet autonomous region of China – that blocked rivers, increasing the risk from flooding.[10] Tropical cyclones too often lead to landslides and floods.

In 2012, the category-4 cyclone Evan hit the islands of Samoa and Fiji. In Samoa, the initial cyclone and the subsequent floods and landslides caused total damage and losses of around $204 million.[11] In Fiji, total damage and losses were $108 million, some of which were the result of subsequent floods which disrupted agriculture.[12] Many people who lived near riverbanks had to be resettled.

FIGURE I-5

Cumulative impacts of smaller, recurrent disasters, 1970-2014



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

EXPOSURE TO DISASTERS

Asia and the Pacific is also in the forefront from the perspective of disaster risk. As defined by the *World Risk Report 2014*, risk is the combination of exposure, susceptibility, and coping and adaptive capacities. On this basis, nine of the 15 countries in the world with the highest exposure and risk are in Asia and the Pacific – with Vanuatu as the most threatened (Table I-2).

Countries with special needs

The most vulnerable countries are those with special needs, including small island developing States (SIDS), least developed countries (LDCs) and landlocked developing countries (LLDCs). Five of the countries in Table I-2 are SIDS. Although their fatalities and losses are small in absolute numbers, each disaster typically affects a high proportion of their populations and their economic activity. Since 2005, SIDS in Asia and the Pacific have recorded damage of around $500 million, and seen 830,000 people affected – by cyclones, floods and tsunamis.[13] Natural disasters have also laid tremendous economic burdens on SIDS – eroding hard-earned development gains. LDCs have lost, on average, almost 1 per cent per year since 1970 while LLDCs have lost over 0.5 per cent of GDP (Figure I-6).[14]

Several low-income developing countries and SIDS recorded damage that even surpassed their GDPs. This was the case in the Democratic People's Republic of Korea in 1995, in Samoa

TABLE I-2

Asia-Pacific countries with high exposure to, and risk from, natural disasters

Rank	Exposure	Risk
1	Vanuatu	Vanuatu
2	Tonga	Philippines
3	Philippines	Tonga
4	Japan	Guatemala
5	Costa Rica	Bangladesh
6	Brunei Darussalam	Solomon Islands
7	Mauritius	Costa Rica
8	Guatemala	El Salvador
9	El Salvador	Cambodia
10	Bangladesh	Papua New Guinea
11	Chile	Timor-Leste
12	Netherlands	Brunei Darussalam
13	Solomon Islands	Nicaragua
14	Fiji	Mauritius
15	Cambodia	Guinea-Bissau

Source: Alliance Development Networks and UNU-EHS, 2014.

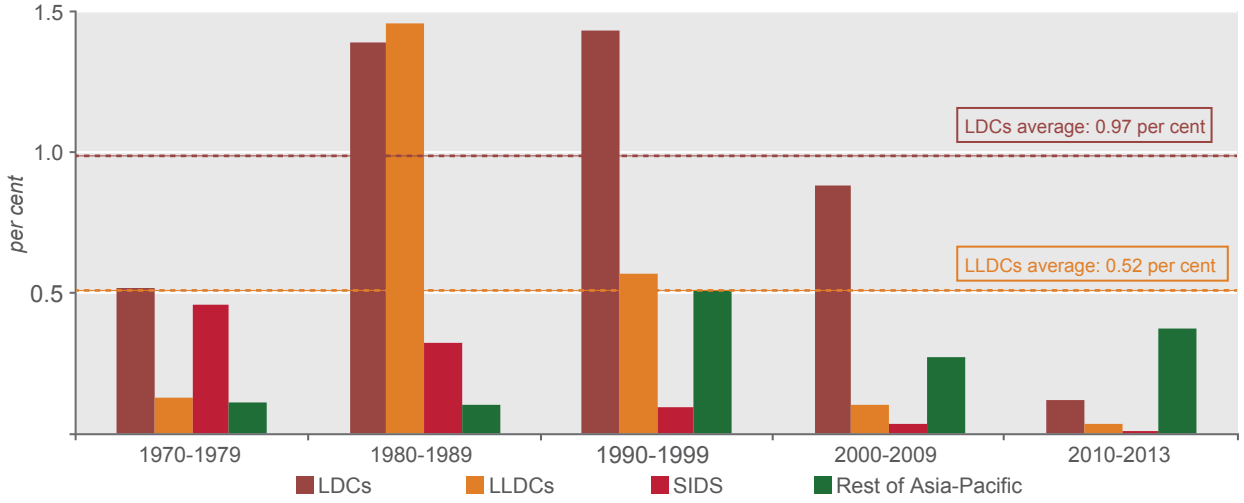
in the early 1990s, in Vanuatu in 1985, and in Mongolia in 1996 (Figure I-7). In 2015 in Nepal the earthquakes caused a combined damage and losses equivalent to one-third of GDP, and in Vanuatu cyclone Pam caused damage and losses equivalent to 64 per cent of GDP (Box 1-2).[15]

CROSS-BORDER THREATS

Many of the disasters in Asia and the Pacific are transboundary. Managing and reducing risk is thus a task that frequently goes beyond the remit of each individual country and requires regional cooperation – issues that are addressed in the following chapters.

FIGURE I-6

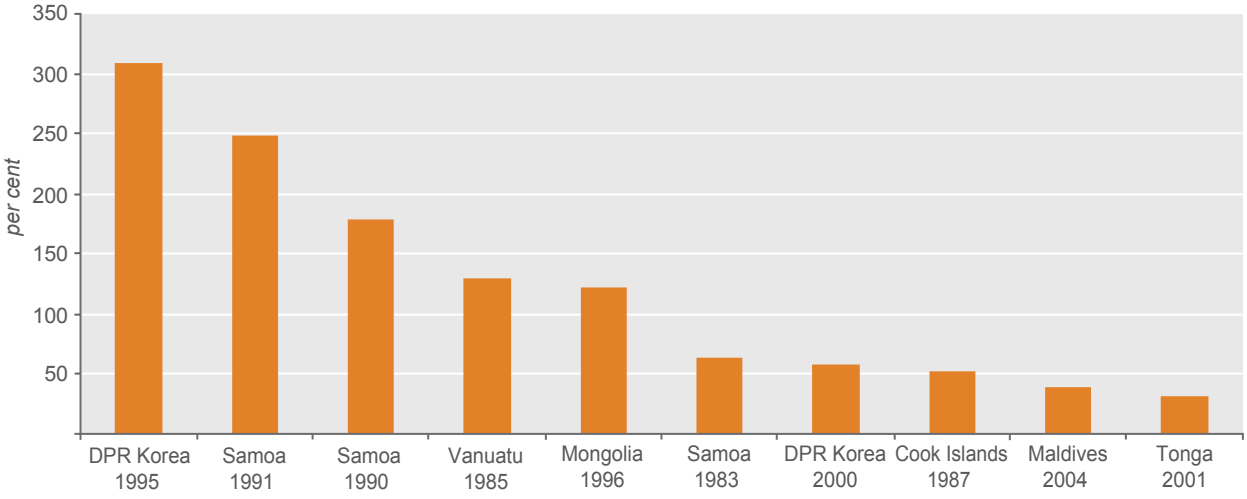
Countries with special needs, damage as a per cent of GDP



Source: ESCAP, 2015f.

FIGURE I-7

Damage from natural disasters as a per cent of GDP



Source: ESCAP based on GDP data from ESCAP statistical database (Accessed 22 May 2015), and damage data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

BOX I-2

Cyclone Pam in Vanuatu

Vanuatu, with a population of 264,000 is one of the region's poorest countries. It is also the country at greatest risk from disasters, being exposed to multiple hazards such as earthquakes, volcanic eruptions, tsunamis, droughts, floods, landslides, tropical cyclones and sea level rise.

On 13 March 2015, a category 5 tropical cyclone, Pam, struck the capital Port Vila and caused catastrophic damage and losses in Vanuatu's 22 inhabited islands.[16] Although the death toll from the cyclone was not high - 11 casualties – around 166,000 people, 60 per cent of the total population, were affected.[17] The cyclone also destroyed up to 17,000 buildings and more than 95 per cent of the agriculture sector, leaving people with no alternative food stocks.[18] Moreover, about 60 per cent of the population in Shefa and Tafea provinces had no access to safe drinking water.[19] Many pieces of critical infrastructure such as buildings, schools and health facilities reported extensive damage.

Each year, Vanuatu also has thousands of visitors – attracted to its picturesque black sand beaches, secluded jungle waterfalls and spectacular volcanoes. Tourism was also badly affected.[20] According to Vanuatu's President Baldwin Lonsdale, cyclone Pam 'set back the country's development by years.'

ESCAP PHOTO

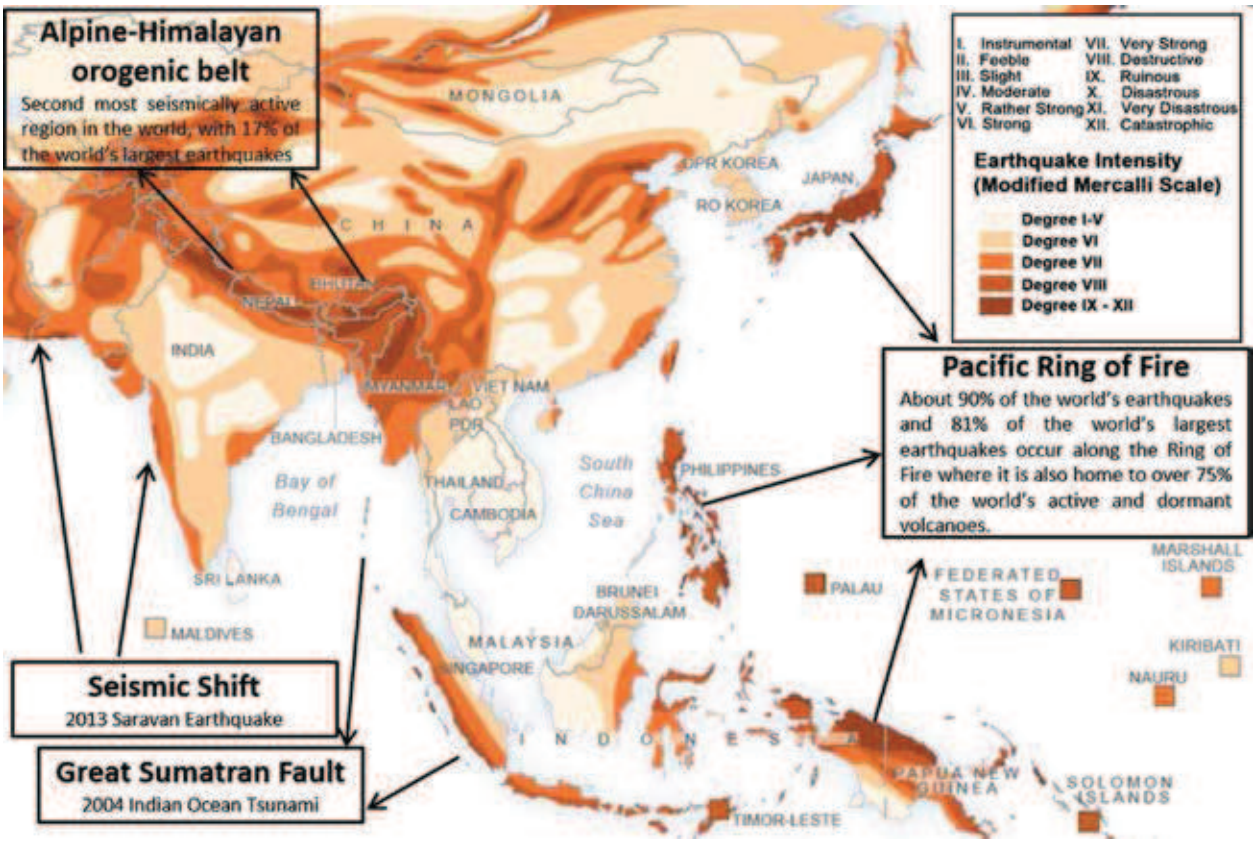
Earthquakes and tsunamis

A major form of transboundary disaster is earthquakes. The Asia-Pacific region has the world's two most seismically active fault lines – which stretch for thousands of kilometres and cross many national borders (Figure I-8). The highest risk is in the Pacific 'Ring of Fire', where tectonic plate movements create around 90 per cent of the world's earthquakes, with the potential for associated tsunamis. These fault lines threaten many countries, of which the most populous are Japan, the Philippines and Indonesia.[21] The region's second most seismically active zone is the Alpine-Himalayan orogenic belt. In April and May 2015 this gave rise to the series of earthquakes that devastated Nepal and affected its neighbours, including Bangladesh, China, India and Myanmar (Box I-3).

Another highly active zone is the Great Sumatran Fault. In 2004 this generated a 9.3 magnitude earthquake and the Indian Ocean tsunami, the largest tsunami in recorded history. Another fault line, the Seismic Shift, threatens the Islamic Republic of Iran, Pakistan and Afghanistan – and led to the 2013 and 2014 earthquakes in Islamic Republic of Iran.

FIGURE I-8

Seismic risk in Asia and the Pacific



Source: Based on Asia-Pacific: Earthquake Risk – Modified Mercalli Scale, OCHA, 2014. Available from http://reliefweb.int/sites/reliefweb.int/files/resources/map_613.pdf.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations; Dotted line (in gray) represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

BOX I-3

Nepal earthquakes, 2015

On 25 April 2015, a 7.6 magnitude earthquake struck Nepal with its epicentre in the district of Dolakha, east of Kathmandu. This was followed by more than 300 aftershocks with magnitudes greater than 4.0, including one 17 days later of magnitude 6.8.

The effects were also felt in neighbouring countries including China, India and Bangladesh. In India, towns bordering Nepal saw more than 70 deaths and 260 injuries. In the Tibet autonomous region in China 27 people died. In Bangladesh, 18 districts were affected, with four deaths and more than 200 injured.[22]

But by far the most devastating impacts were in central and western regions of Nepal. There were 8,790 casualties and 22,300 injuries, with more than eight million people, one-third of the population, affected. Over half a million houses were destroyed and more than 250,000 were partially damaged. In some areas, entire settlements were swept away by landslides and avalanches, and these ruptured, destabilized landscapes also increased the risk of flooding.

The disaster had severe economic impacts. Damage and losses were equivalent to around one-third of the GDP for 2013-2014 – and equivalent to more than 100 per cent of gross fixed capital formation. Productive sectors including tourism, agriculture and commerce saw damage and losses of more than $1.78 billion, the majority of which were for private enterprises.[23] GDP growth for 2015, previously forecast at 4.6 per cent will probably drop to 3 per cent. The earthquakes may end up pushing an additional 2.5 to 3.5 per cent of Nepalese, around 700,000 people, into poverty in 2015.

There was also heavy damage to public infrastructure: more than 1,200 health facilities, and 7,000 schools were completely destroyed or partially damaged. Just before the earthquakes, Nepal met all the criteria for graduation from LDC status, possibly by 2022, but this is now less likely.[24]

Tropical cyclones

On average globally there are 86 tropical cyclones each year. Of these, 50 to 60 arise in three Asia-Pacific ocean basins whose coastlines are shared by multiple countries (Figure I-9).[25] A single cyclone can travel across many countries, causing heavy rainfall and flooding, until it finally makes landfall. Typhoon Kalmaeki of 2014, for example, affected Viet Nam, the Philippines and China.

Transboundary floods

Across Asia and the Pacific each year there are large numbers of small-scale floods, often seasonal, and in many respects beneficial. But there is also the risk of catastrophic flooding. In the last decade there have been major floods in China, India, Pakistan and Thailand. In 2014, there were 52 recorded floods that claimed 3,559 lives.[26]

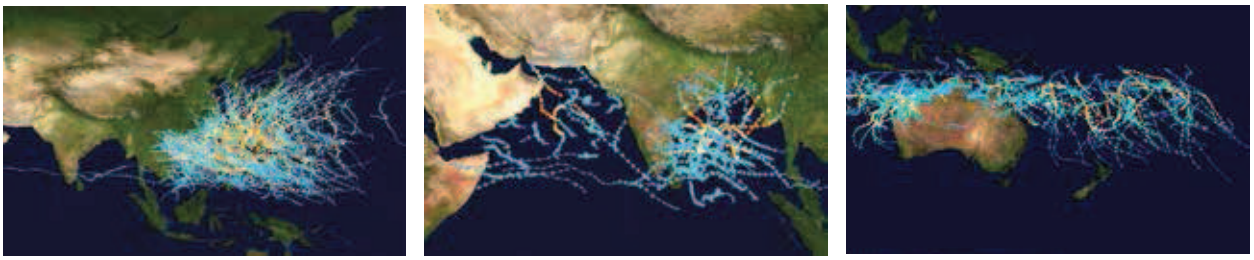
FIGURE I-9

Asia-Pacific ocean basins, and the tracks of tropical cyclones 2005-2014

a) Western North Pacific Ocean & South China Sea

b) Bay of Bengal and the Arabian Sea

c) South-West Pacific Ocean



* a) surrounding countries/states: Cambodia, China, Hong Kong, China, DPR Korea, Guam, Japan, Lao PDR, Malaysia, Palau, Philippines, Republic of Korea, Singapore, Taiwan, China, Thailand and Viet Nam
* b) surrounding countries/states: Arabian Peninsula, Bangladesh, India, Myanmar, Pakistan, Somalia, Sri Lanka and Thailand
* c) surrounding countries/states: Australia, Fiji, New Caledonia, New Zealand, Papua New Guinea, Solomon Islands and Vanuatu

Source: ESCAP based on data from the Joint Typhoon Warning Center (US). Available from http://www.usno.navy.mil/JTWC/. (Accessed August 2015).

Some of these large-scale floods are transboundary – flowing across countries that share basins of rivers such as the Amu Darya, Amur, Brahmaputra, Ganges, Indus, Mekong, Salween, and Yenisey (Figure 1-10). The Mekong basin, for example, receives water from many rivers, including the Nam Ngum, Nam Theun, Nam Hinboun, Se Bang Fai, Se Bang Hieng, Se Done, Mun-Chi, Se Kong, Se San, and Sre Pok. Flooding in this basin can affect up to six countries – Cambodia, China, Lao People's Democratic Republic, Myanmar, Thailand and Viet Nam. There are similar risks in South Asia: in 2014, transboundary floods in the Chenab, Indus, Jhelum, and Ravi basins contributed to $18 billion worth of damage in India and Pakistan.[27]

Another major source of transboundary floods is snowmelt in high mountains. In 2000, for example, a landslide dammed the outlet of the Yigong Lake in Nyingchi, China. Snow and ice melt continued to flow into the lake causing the dam to burst two months later, leading to significant damage not only in China but also in India where it killed 30 people and made 50,000 homeless.[28]

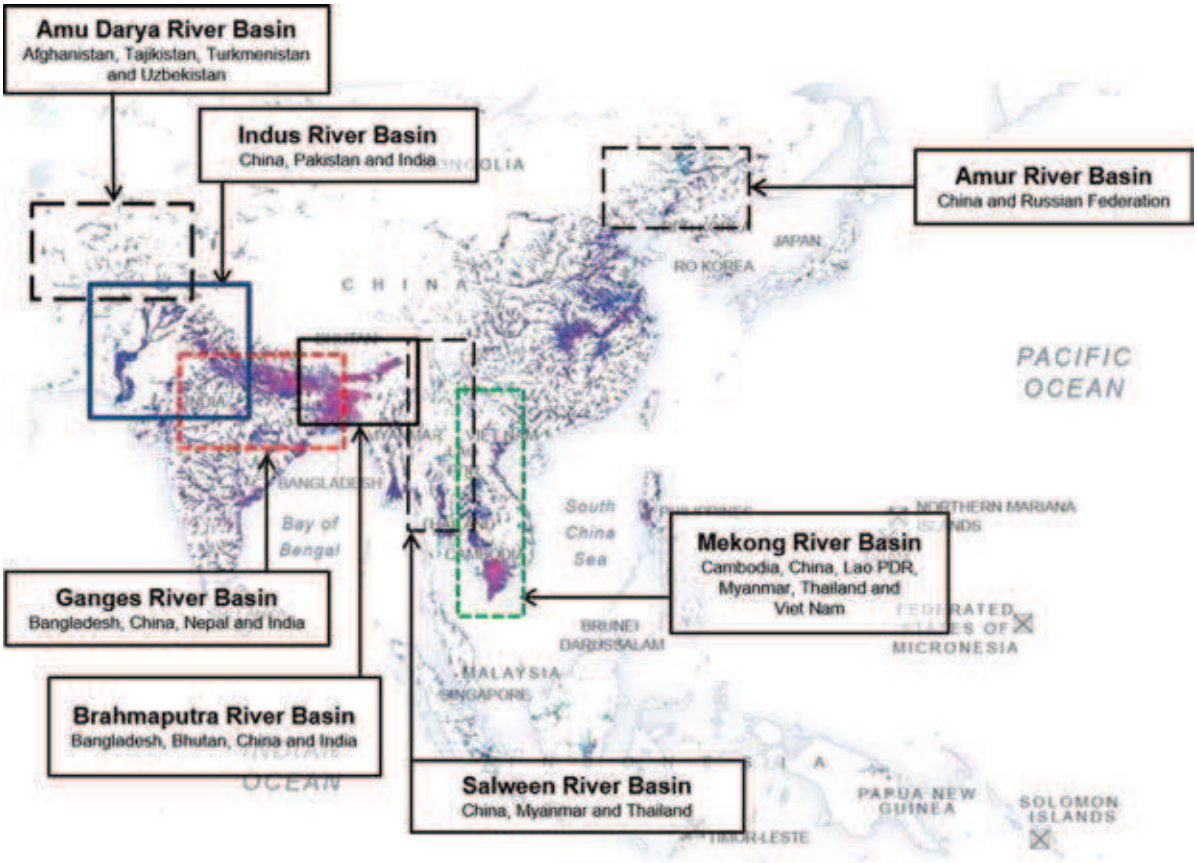
Mountainous regions can also give rise to glacial lake outburst floods (GLOFs). The Hindu-Kush Himalayas region, for example, covers Afghanistan, Bhutan, India, Nepal and Pakistan. Here, as the glaciers recede they create large meltwater lakes which are often unstable and can suddenly release vast quantities of water. Nepal alone has identified 24 GLOF events given available information.[29] GLOFs have also been observed recently in Pakistan and Tajikistan. And in Kazakhstan a heat wave in 2015 gave rise to a GLOF in Almaty along the Kargalinka River which damaged 127 homes and led to the evacuation of around 1,000 people.[30]

Volcanic eruptions

Since 1950, each year there have been on average 31 volcanic eruptions around the world.[31] People in 86 countries live within 100 kilometres of an active volcano but the largest numbers of people exposed are in Asia and the Pacific – notably in Indonesia, the Philippines and Japan.[32]

FIGURE I-10

Transboundary flood risk in Asia and the Pacific



Source: Based on Asia-Pacific: Flood Risk, OCHA, 2014. Available from http://reliefweb.int/sites/reliefweb.int/files/resources/map_616.pdf, with river basin data from ICIMOD.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations; Dotted line (in black) represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Volcanoes can result in pyroclastic flows, ash and tephra, debris avalanches, landslides, and emissions of volcanic gases and sulphuric acid aerosols. These can cause serious health problems, soil and water contamination, and crop failure and may also disrupt aviation. Many of these impacts are transboundary, particularly atmospheric pollution.

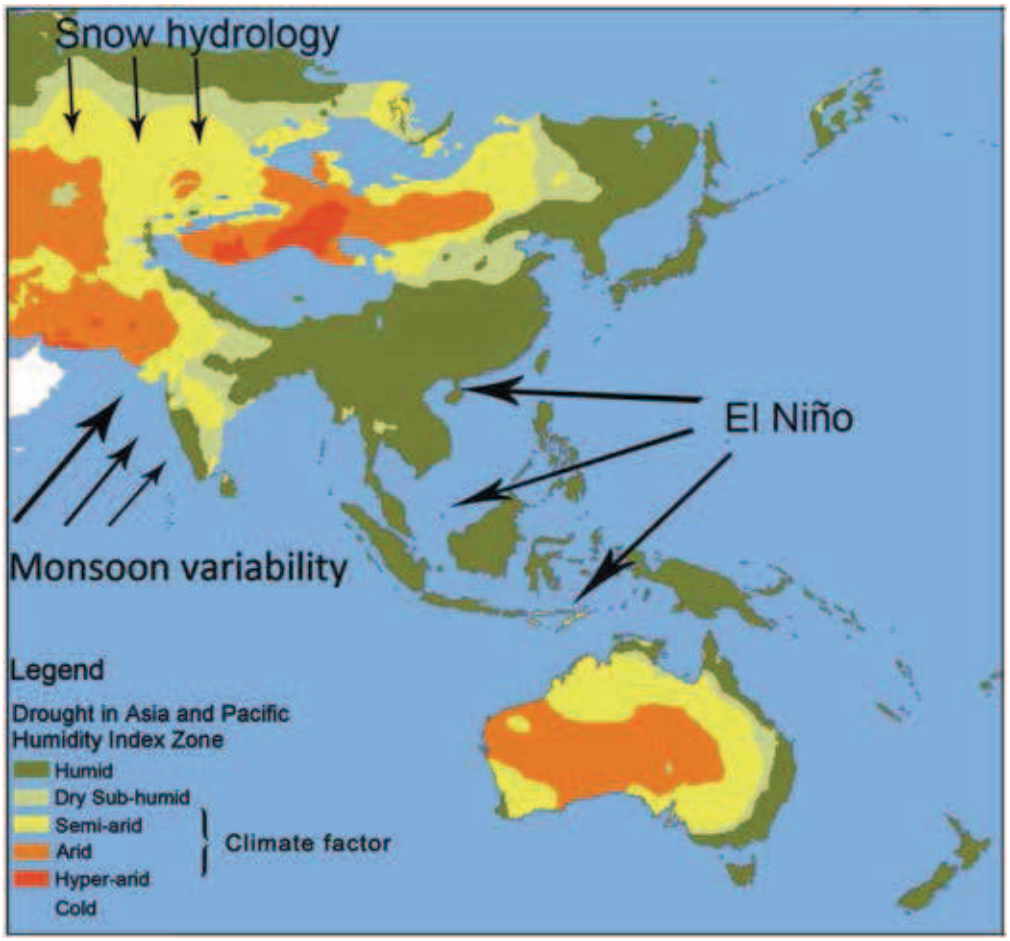
In 1991 the eruption of Mount Pinatubo in the Philippines killed 680 people and caused damage to crops, infrastructure and personal property of around $374 million.[33] Nevertheless, many lives were saved as a result of effective monitoring and forecasting and timely evacuation organized by the disaster management authorities. In 2015, the eruption of Mount Sinabung in North Sumatra, Indonesia was also forecast in a timely manner, allowing many villagers to be evacuated. Similarly in Japan in May 2015, more than 100 people were evacuated after a volcano erupted on the tiny southern island of Kuchinoerabu.[34] Such measures have, over the last century, saved an estimated 50,000 lives across the world. However there are still many unmonitored 'high-exposure' volcanoes.[35]

Droughts

Droughts are produced by climatic conditions that are frequently cross-border (Figure I-11). Water resources used by one or more countries can originate upstream in another country. Many neighbouring countries also feel the impact of prolonged dry periods due to seasonal variations. These can be due, for example, to El Niño events, which affect countries in South-East Asia and the Pacific in every few years: between 1997 and 1998, during a severe El Niño event, 11 countries in Asia and the Pacific were affected by drought, impacting around 7.5 million people.[36] Another source of cross-border drought is monsoon variability which often affects countries in South and South-West Asia as well as South-East Asia. In North and Central Asia drought conditions are affected by snow hydrology and extent of snowmelt. The Asia-Pacific region also has many semi-arid, arid or hyper-arid areas, exposed to high drought risk – as in South and South-West Asia, North and Central Asia, China and Australia. This issue is considered in greater detail in Chapter 2 of this report.

FIGURE I-11

Transboundary drought risk in Asia and the Pacific



Source: GRID-NAIROBI and University Of East Anglia's Climate Research Unit.

ECONOMIES AT RISK

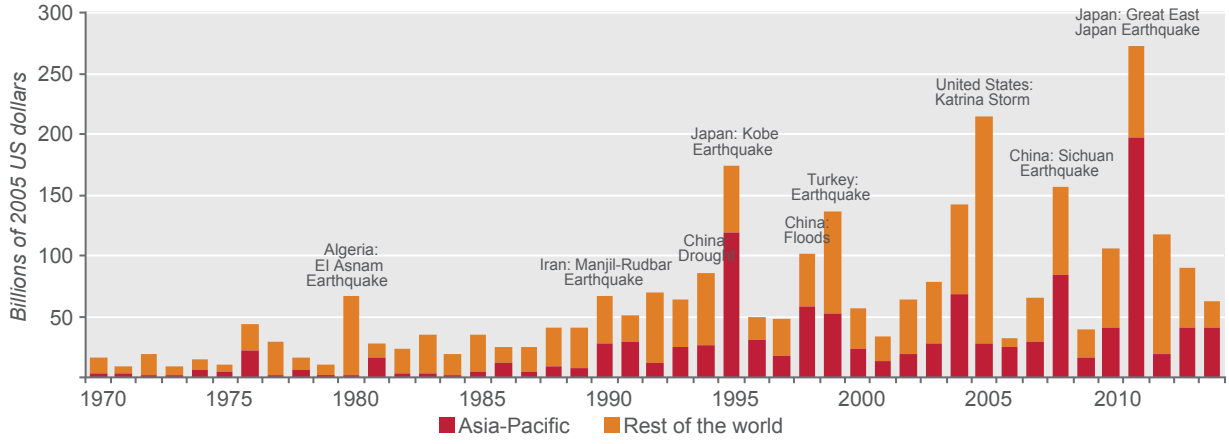
Though the immediate concern from disasters must be from the threats to human life and health, countries across Asia and the Pacific are also concerned about the economic cost – which appears to be increasing. Between the 1970s and the decade 2005-2014 damage to property, crops and livestock increased from $52 billion to over $523 billion (Figure I-12).[37] The damage has also been increasing as a proportion of GDP, from 0.16 per cent in the 1970s to 0.34 per cent in the decade of 2005-2014.[38] If "losses" in terms of lost income and increased cost of production due to above damage to assets are counted, then the total economic costs would be much higher.

Most of the economic impact is the result of damage and losses to the housing, transport and agriculture sectors. As indicated in Figure I-13, for some recent disasters more than half the economic impacts were felt in these sectors – and in some cases 80 per cent. Agriculture is particularly vulnerable. In Lao People's Democratic Republic in 2009, for example, typhoon Ketsana led to the inundation of 28,500 hectares of crop planted areas. This further threatened food security since the five affected provinces were responsible for about half of domestic rice production. Many farmers lost their livelihoods.[39] Similarly in Pakistan following 2011 floods, damage and losses in agriculture sector amounted to $1.84 billion, and a total of about 881,000 hectare or 53 per cent of the planted land was affected.[40]

While all subregions have suffered, more than half the economic damage has been in East and North-East Asia (Figure I-14). Moreover, these data are likely to be serious underestimates since they may not fully allow for the subsequent disruption of livelihoods and economic activities – which can account for close to half of the total cost. The recent Nepal earthquake recorded such losses, amounting to 40 per cent of the total.[41]

FIGURE I-12

Damage from natural disasters rising, 1970-2014



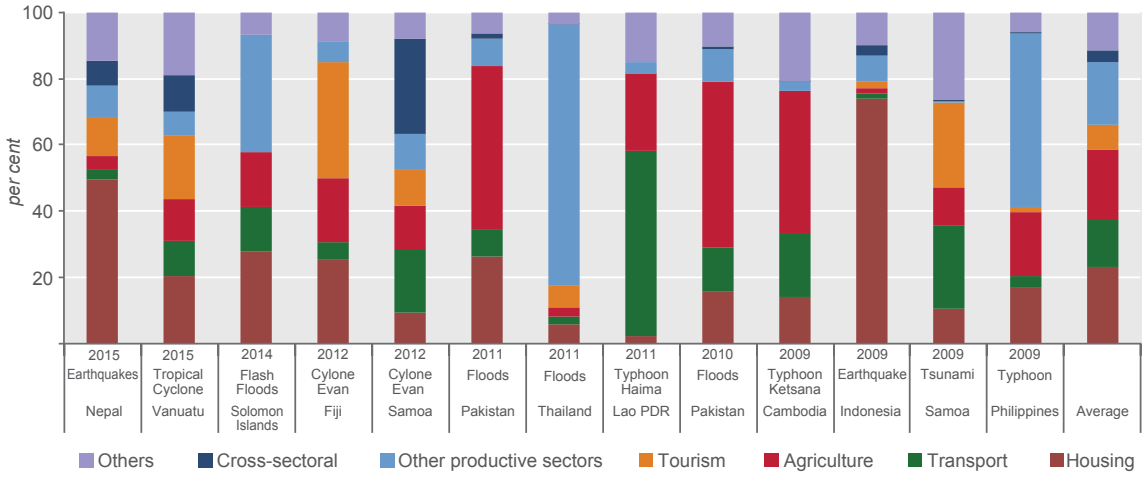
Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

Notes: Labels in the figure show major disasters that contributed to high damage and loss in selected years.

Damage and loss assessments fail to take into account the long-term costs – particularly for small economies that do not have well diversified economic structures, and those that face macroeconomic instability. A recent study of 6,700 cyclones found detrimental impacts even decades later.[42] The largest event in the sample saw a reduction in long-term GDP of almost

FIGURE I-13

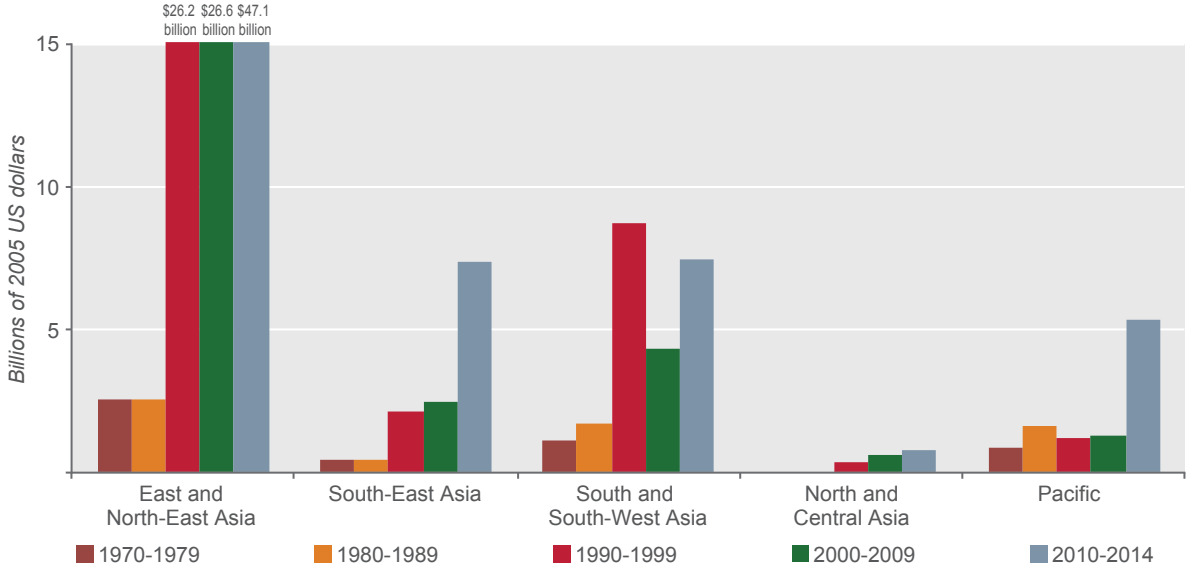
Sectoral damage and losses in disaster-hit countries, per cent of total



Source: ESCAP based on Post Disaster Needs Assessment Reports for each event.

FIGURE I-14

Annual average damage from natural disasters by subregion, 1970-2014



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

30 per cent. Others, depending on the scale and frequency of the disaster, were in the range of 7 to 15 per cent. In the Pacific SIDS, after major cyclones the GDP per capita was likely to lag behind the 'no disaster' counterfactual for many years. The damage may be reflected in depressed GDP for a long period, when a country is hit by a series of disasters. Pakistan, for example, was hit by a major earthquake in 2005, followed in 2007 by cyclone Yemin and subsequent flooding, and was unable to return to its long-term GDP trend.[43]

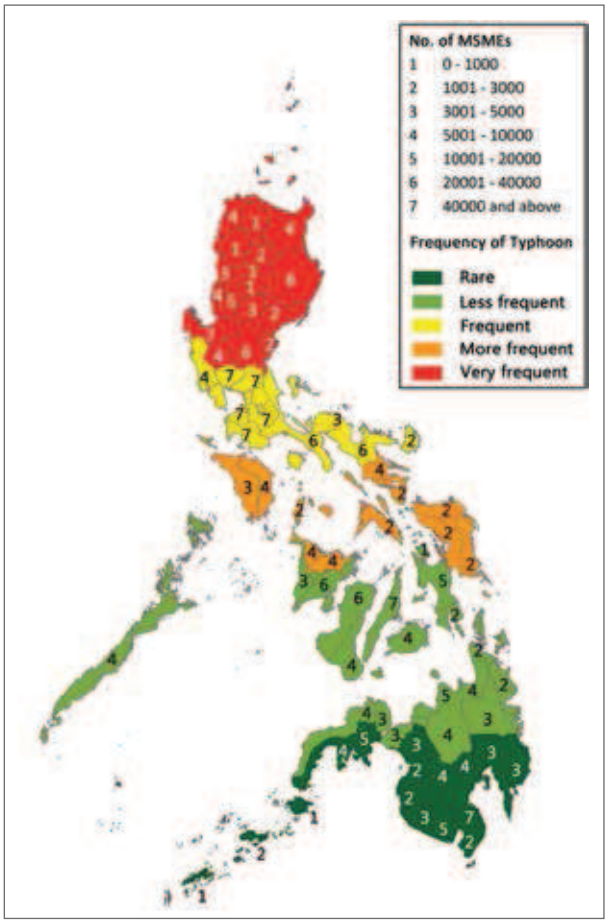
Small and medium enterprises

In most Asia-Pacific economies small and medium-sized enterprises (SMEs) employ over half the labour force and contribute to 20 to 50 per cent of GDP.[44] These enterprises are often vulnerable, particularly those in the informal sector. Typically, the latter are located in more hazardous and exposed areas, such as urban slums, cannot afford adequate risk assessments, and have limited access to insurance.[45]

In the Philippines, for example, 90 per cent of firms are microenterprises of which most are informal. More than 60 per cent are concentrated in high-risk disaster areas: the National Capital Region, Calabarzon, Central Luzon, Central Visayas and Western Visayas (Figure I-15).[46] When typhoon Ondoy struck in 2009, SMEs were hit the hardest.[47] Small firms and home-based enterprises had to close down due to flood damage. Similar experiences were recorded in 2012 when typhoon Pablo hit the provinces of Davao Oriental and Compostela Valley. Owners of beach resorts, small stores, lodging houses, machine and equipment rental companies, as well as tour guides together suffered a total loss of around $700,000.[48]

FIGURE I-15

SMEs in the Philippines located in areas of high typhoon frequency



Source: Ballesteros and Domingo, 2015.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Global repercussions

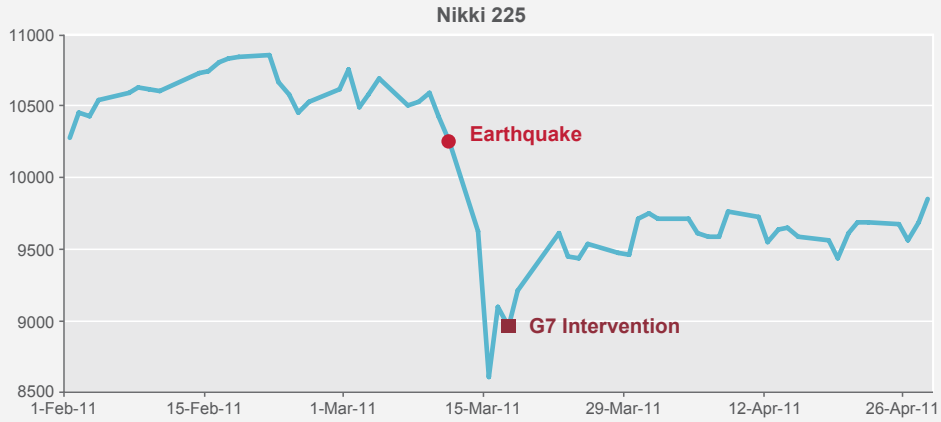
Given the significance of Asia and the Pacific in the global economy, the impact of major disasters in this region can soon reverberate around the world. The Japan earthquake of 2011, for example, affected global commodity prices (Box I-4). In New Zealand a major drought in 2013 led to an increase in the world price of milk powder (Figure I-16).[49]

BOX I-4

Impact of 2011 Japan earthquake on global markets and prices

The earthquake in Japan in March 2011 closed the Fukushima Daiichi nuclear power plant. This in turn affected Japanese production activities, especially the automobile and semiconductor industries. Over the next three days the Nikkei Index fell by 17.5 per cent, or by close to $460 billion (in 2011 US dollars).

Volatility of Japanese Nikkei 225 Index, February to March 2011

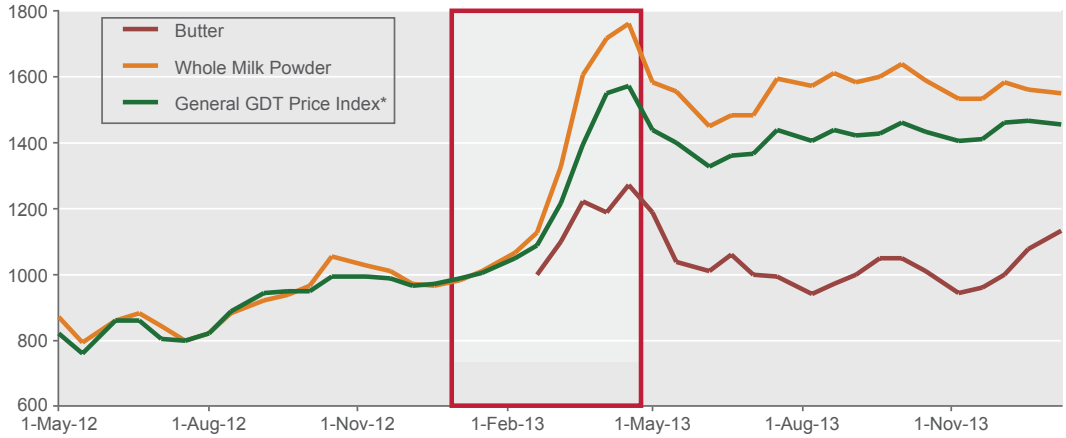


Source: Historical data obtained from various sources: Capital IQ, Thomson Financial Network, Morningstar Inc, SIX Financial Information, and Interactive Data Real-Time Services.

The disaster also caused fluctuations in global equity markets. On the day of the disaster there were big drops in the major Asia-Pacific stock markets. In anticipation of the Government repatriating yen to fund recovery projects, investors rushed to buy the yen, Global oil prices dropped because markets anticipated Japanese industries to lower demand for oil. Energy prices, on the other hand rose because of the Fukushima incident. In the UK, for example, local electricity prices rose by 2 per cent.[50]

FIGURE I-16

A drought in New Zealand in 2013 led to higher world prices for milk powder



* GDT = Global Dairy Trade

Source: ESCAP based on data from Global Dairy Trade. Available from https://www.globaldairytrade.info/. (Accessed May 2015).

Disasters in Asia and the Pacific can also hit the global economy by disrupting production networks. Many enterprises in the region are key links in regional and global supply chains. In Japan, for example, following the 2011 earthquake, most of the 337 private firms that had to close down were outside the tsunami-affected areas – and of these 90 per cent went bankrupt within six months.[51] Japanese automobile production was almost halved and electrical component production fell by 8.25 per cent.[52] The knock-on effect was also felt in neighbouring countries. Three months after the disaster, due to shortages in components automobile production dropped by 20 per cent in Thailand and by 24 per cent in the Philippines, and in Indonesia by 6 per cent.[53]

There was a similar outcome as a result of the floods in Thailand in 2011. Firms in Thailand tend to cluster in a small number of industrial locations many of which were severely inundated – leading to chain disruptions not only in Thailand but across the region. Nissan and Toyota, whose own automobile plants were not physically damaged, had to suspend production because essential parts were not arriving in time.[54] These indirect effects spread globally, as Toyota's production lines in Malaysia, Viet Nam, Pakistan, the Philippines, United States and Canada had to make up for output loss in Thailand. In addition, computer manufacturers outside Thailand experienced serious supply shortage and rising prices of computer hard drives, as major manufactures of its components were clustered in the affected areas.[55]

ESCAP PHOTO

Infrastructure exposed

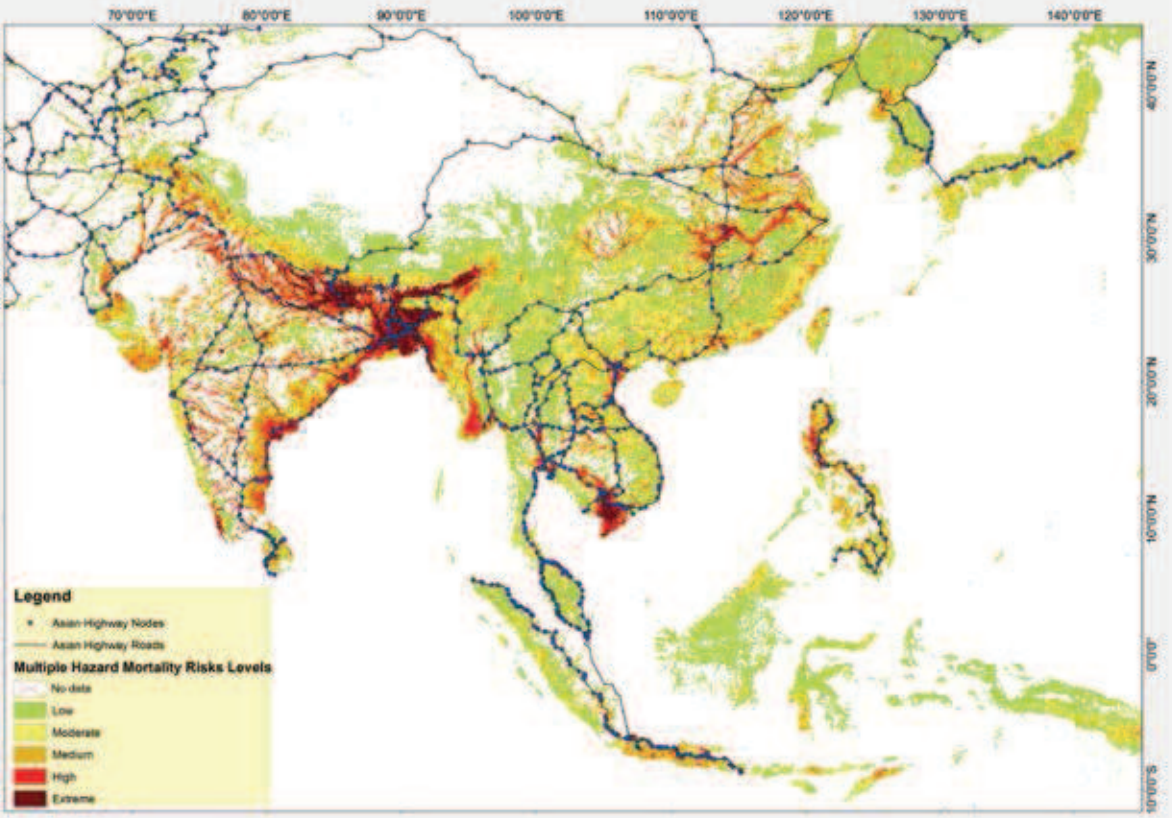
Disasters in Asia and the Pacific can have a severe impact on the region's infrastructure, much of which has multi-hazard disaster risk (Box I-5). Much of this infrastructure, however, has been built without careful consideration of the potential for disaster – putting at risk not just economic activities but also the provision of critical services.

BOX I-5

Risks to transboundary transport networks

The Asia-Pacific region is linked by a system of cross-boundary highways and railways, many of them integrated into the Asian Highway or the Trans-Asian Railway. Parts of these systems are in high disaster risk areas (box figure). Moreover many of the roads are of low quality and less resilient. Over 60 per cent of routes in Nepal, Kyrgyzstan, Myanmar, Cambodia and Pakistan are reported to be class III or below.

In 2014, heavy rainfalls in Nepal, for example, caused severe landslides in Sindhupalchowk district, completely blocking the Arniko highway, the main transport route between Nepal and China. Importers taking alternative routes faced significantly higher costs, and consumer prices rose. Cross-border transactions of goods and services were also disrupted in 2015 by the Nepal earthquakes.[56]



Source: ESCAP based on the map from UNEP, GRID and ESCAP, Asian Highway Database.

- *Transport* – Many transport networks have not been built with disaster-resilience in mind. In 2011 in the Lao People's Democratic Republic, for example, continuous rain in hilly regions as a result of typhoon Haima caused landslides that blocked national, provincial and tertiary road networks.[57] This resulted in much higher vehicle operating costs and made it difficult to get to markets. Emergency repairs also hindered traffic flow in existing roads, where the increased traffic burden led to longer travel times and reduced economic efficiency. Transport impacts, can also be transboundary as when they affect part of the Asian Highway or the Trans-Asian Railway networks.
- *Energy* – The Nepal earthquake in 2015, for example, damaged hydropower facilities as well as power distribution lines and transformers, and caused a drop in power production. It also halted progress on the construction of new facilities.[58]
- *Telecommunications* – In Fiji, in 2012 cyclone Evan led to electricity faults and blackouts and cuts in landline telephone services. Damage to two critical sites resulted in service failures in rural regions.[59]
- *Water and sanitation* – The floods in Solomon Islands in 2014 damaged around 1,000 shallow, unprotected wells and inundated them with trash. Flood-induced landslides also damaged dams, pipelines and water tanks as well as gravity-fed and rainwater catchment systems. Losses to water and sanitation systems amounted to $2.2 million in subsequent losses in economic productivity – almost three times the initial infrastructure damage.[60]

Some countries have made significant progress in building resilient infrastructure. Japan, for example, prior to the 2011 earthquake and tsunami had reinforced shoreline breakwater structures and these mitigated tsunami damage along the coast. Trains in Japan are designed to decelerate automatically when they sense earthquakes.[61]

In Sri Lanka after the 2004 Indian Ocean tsunami, the Government set up the Reconstruction and Development Agency to coordinate efforts to rebuild with more resilient infrastructure, including a new telecommunications network with an early warning system, a data collection mechanism, and an emergency response centre.[62] Other countries have also been making their infrastructure more resilient (Table I-3).

TABLE I-3

Recent investments in disaster-resilient infrastructure

Country	Intervention
Fiji	Flood warning system for the town of Navua
Indonesia	Strengthening the flood resilience of housing; integrated flood impact protection scheme for the city of Semarang
Philippines	Building hanging footbridges over rivers to provide access to schools and vital infrastructure during floods
Samoa	Improving flood forecasting systems for river catchments; strengthening the flood resilience of houses in risky areas
Thailand	Typhoon forecasts five to seven days in advance to facilitate early harvesting of crops

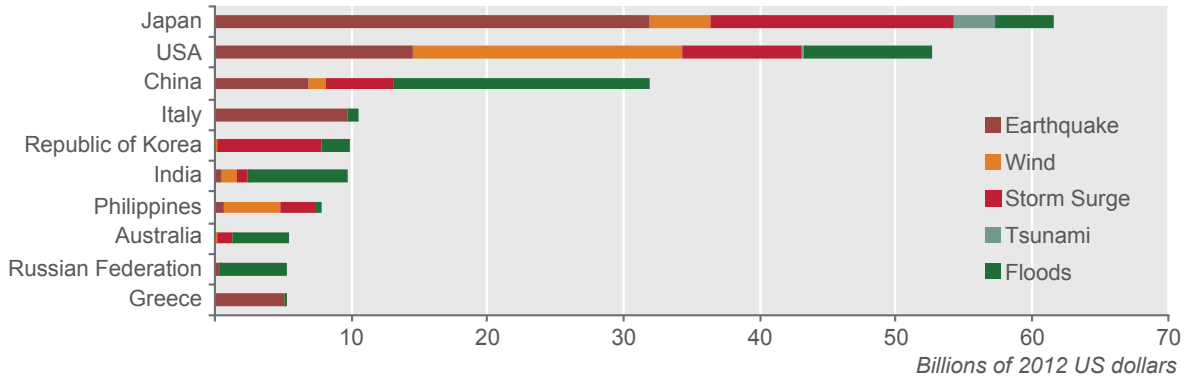
Source: ESCAP based on ADB, 2013.

Estimating future losses

Policymakers contemplating the costs and benefits of investing in disaster risk reduction should also be considering potential future losses. These can be estimated in terms of the annual average loss (AAL).[63] By the year 2030, AAL globally is predicted to be $415 billion. Of this, 40 per cent is expected to be in the Asia-Pacific region which has seven of the ten countries with the highest losses (Figure I-17). The largest such losses in the region are expected from floods and earthquakes (Figure I-18).

FIGURE I-17

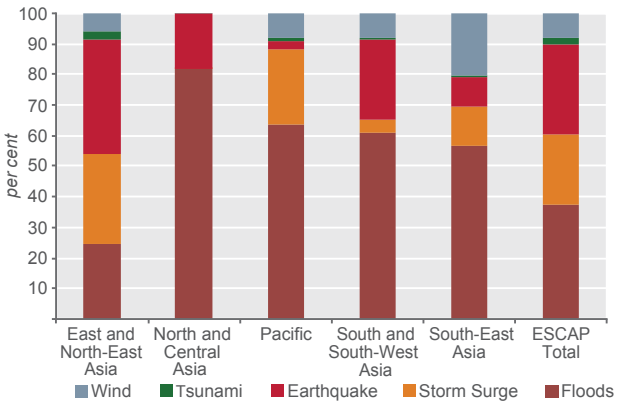
10 countries with the highest predicted annual average losses from disasters

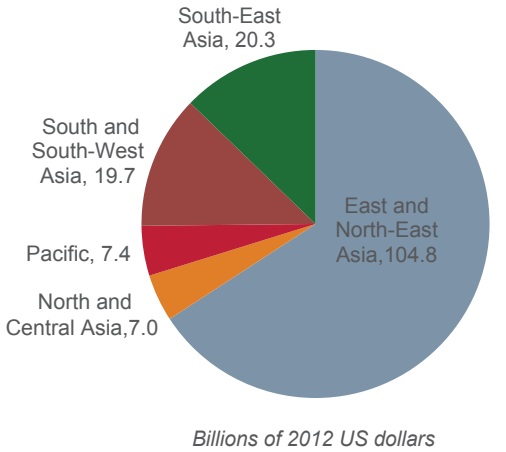


Source: ESCAP based on data from UNISDR, 2015b.

FIGURE I-18

Breakdown of predicted annual average losses by type of hazard and subregion





Source: ESCAP based on data from UNISDR, 2015b.

CITIES AT RISK

Asia-Pacific has one of the world's most rapid rates of urbanization. Between 1950 and 2010 the proportion of the population living in urban areas increased from 20 to 45 per cent, and by 2050 it is expected to reach 64 per cent. More than two billion people currently live in cities[64] and a further one billion are likely to join the urban population by 2050.[65]

While fast-growing cities create opportunities they also present problems for disaster risk management. Many cities are outgrowing the capacity of basic services such as roads, water supplies, and sewage disposal systems, and are thus exposing their people, particularly those in slum areas, to many dangers.[66] Much of this is a consequence of poor management which has led to unplanned and chaotic growth with unsafe buildings and poor drainage systems.[67]

For example, the city of Mumbai in India is vulnerable to monsoon rains, yet has done little to mitigate flood risk. In 2005, the city was hit by a large monsoon that causes more than 400 casualties, as well as heavy damage to buildings and critical infrastructure.

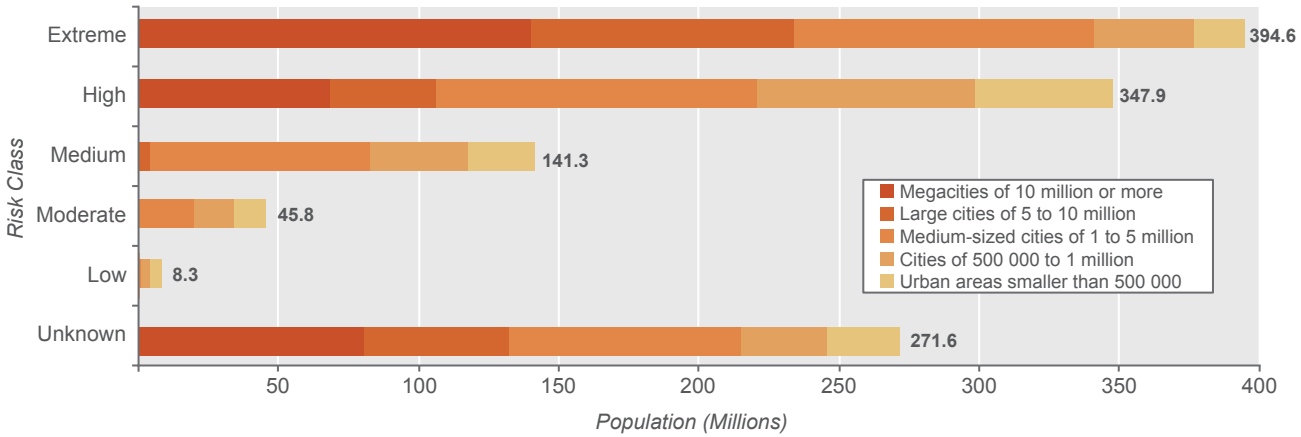
Around 60 per cent of Asia-Pacific city dwellers, 742 million people, are now at 'extreme' to 'high' disaster risk (Figure 1-19).[68] For 'extreme' hazard risk, the largest number of people are in megacities. By 2030, the number at 'high' or 'extreme' multi-hazard risk could reach 980 million.[69]

Many of the rapidly expanding cities are located in major multi-hazard 'hotspots' – areas with significant risk from cyclones, earthquakes, floods and landslides – notably in South and South-West Asia, South-East Asia and East and North-East Asia (Table I-4, Figure I-20).

ESCAP PHOTO

FIGURE I-19

Asia-Pacific city dwellers exposed to multiple hazards, 2014



Source: ESCAP based on population data from UN-DESA, 2014, and estimated risk index for multiple hazard from UNEP and UNISDR, 2013.

Notes: Categories of risk are based on cumulated risk of cyclones, earthquakes, floods and landslides and expected annual losses per unit area]. The estimated risk index ranges from 1 (low) to 5 (extreme).

TABLE I-4

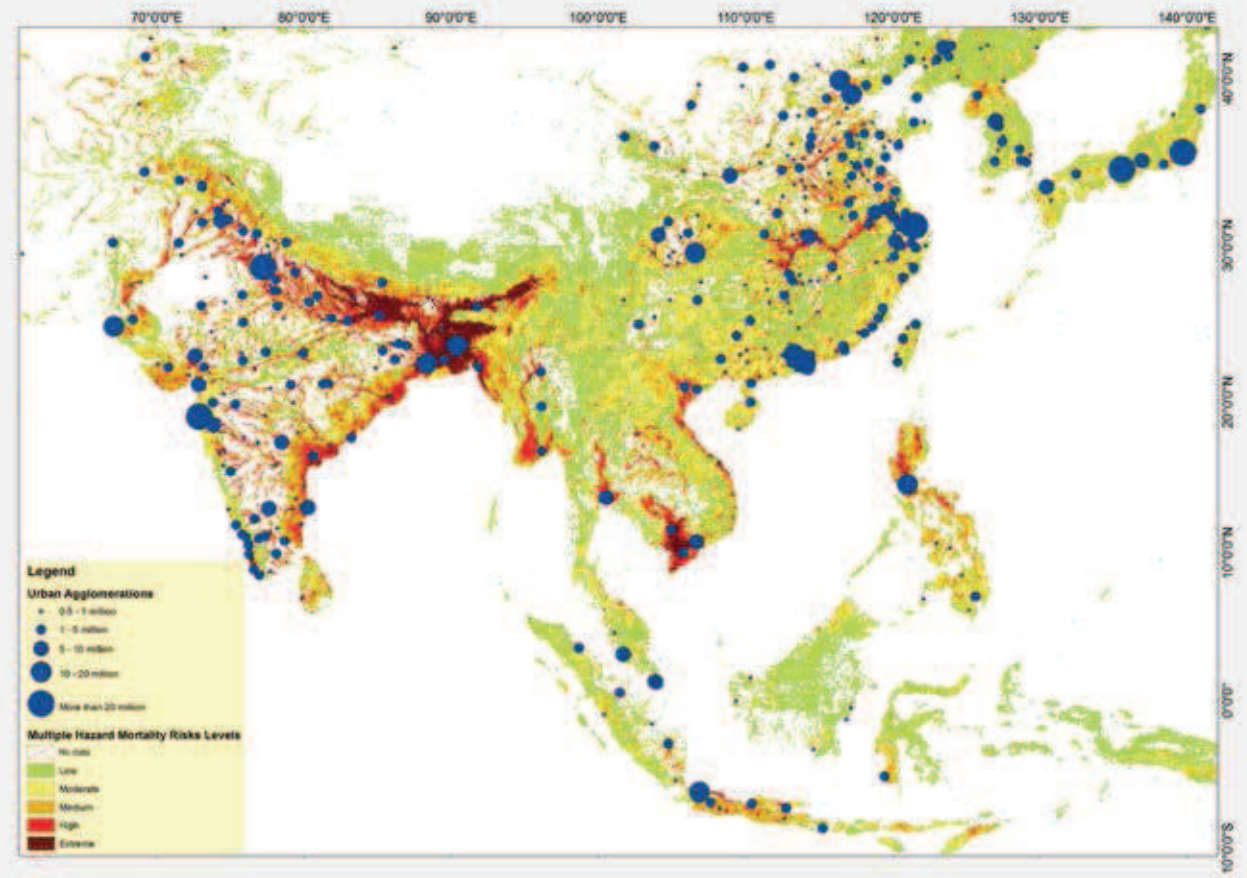
Multi-hazard hotspots

Hotspot areas	Location	Number of cities with people at extreme risk	People at extreme risk, millions (estimates)	
			2014	2030
South and South-West Asia	From the eastern coast of India in the Bay of Bengal into the Ganges-Brahmaputra Delta in Bangladesh and northwards into the Himalayan belt.	85	166	244
South-East Asia	The Irrawady Delta in Myanmar, Chao Phraya Delta in Thailand, Mekong Delta in Cambodia and Viet Nam, the eastern coastline of Viet Nam up to the Red River Delta, Manila and other pockets across the Philippines and Indonesia.	17	46	66
East and North-East Asia	Largely concentrated around the major river deltas of China including the Yellow River, Yangtze and Pearl. The southern and eastern Japanese seaboard also contains hotspots, as well as the flat plains of west-central Democratic People's Republic of Korea.	64	166	219

Source: ESCAP estimates based on population data from UN-DESA, 2014, and estimated risk index for multiple hazards from UNEP and UNISDR, 2013.

FIGURE I-20

Asia-Pacific cities exposed to multiple hazards



Source: ESCAP based on population data from UN-DESA, 2014, and estimated risk index for multiple hazards from UNEP and UNISDR, 2013.

This is not surprising, since many of the same attributes that expose these locations to disasters also make them attractive for settlements. Coastal areas, for example, which are exposed to hydro-meteorological hazards and tsunamis, also offer critical inputs for industry, including water and space for shipping and ports. Lowlands that are prone to flooding also offer good access for road, rail and water transport. And river valleys and surrounding plains are prone to flooding, but these same floods deposit sediments and nutrients that make for rich farming land. Over hundreds of years, such advantages led to the creation of strategic global business and financial centres such as Beijing, Shanghai, Hong Kong, China and Tokyo. These and other, newer, magnets will continue to attract people, particularly those looking for better job opportunities as well as greater access to services such as education and health.

Most of the attention for disaster hotspots has been on the megacities.[70] Little comprehensive work has been undertaken in smaller cities, those with fewer than five million people – though these account for 60 per cent of the Asia-Pacific urban population. In fact these smaller cities have greater difficulty in absorbing new entrants because they have fewer links to markets, weaker infrastructure and local governments, and fewer financial resources.[71] As a consequence they can be especially vulnerable to disaster events (Box I-6).[72]

BOX I-6

Vulnerability of small cities: the case of Tacloban, Philippines

Tacloban is the largest city in Leyte island in the Philippines. Between 1990 and 2010, Leyte experienced a wave of rapid urbanization and Tacloban's population grew from 136,000 to 221,000. This was partly achieved by the uncontrolled expansion of the city onto the most hazardous land next to the ocean. Building standards were poor – about one-third of Tacloban's homes had wooden exterior walls and one in seven had grass roofs. Historically, located at the tip of a funnel-shaped bay, Tacloban had been a dangerous place to live and was hit by severe typhoons in 1897 and 1912. Nevertheless, many of the new people in the city knew little of the risk, or how to prepare or respond.

On 7 November 2013, Tacloban was directly hit by super typhoon Haiyan (known locally as Yolanda) and the associated storm surge, leading to death and destruction on a vast scale. Witnesses spoke of corpses littering the wrecked city and of dazed survivors wandering streets strewn with debris, begging for help. "From the shore and moving a kilometre inland, there are no structures standing. It was like a tsunami," said the Interior Secretary, Manuel Roxas.

Around 60 per cent of buildings were destroyed and 30 per cent severely damaged with around one million damaged homes. The telecommunications system was wiped out and it took three days to clear the damage caused to the airport. Nearly 6,300 bodies were recovered while approximately 1,000 were listed as missing.[73] The capacity of the Tacloban authority itself was decimated as key staff were among the casualties. Thousands of families were forced to take shelter in tents strewn along the coastline. Business activity dropped to less than half the pre-disaster level, with serious implications for Leyte as a whole, as Tacloban is the island's main economic hub.

PEOPLE AT RISK

Across Asia and the Pacific there are 772 million people living on less than $1.25 a day,[74] and they are particularly vulnerable to disasters. One reason is that they tend to live in low-value hazard-prone areas, such as slums, steep slopes, seismic zones, floodplains and river banks or remote areas. They may also be out of range of early warning systems. In 17 countries from the Asia-Pacific region where recent data is available, over 500 million poor people are living at medium or higher disaster risk.[75] The poorest lack the resources to invest in preventive measures or insurance, nor will they have adequate savings or assets to draw upon should disaster strike.[76]

As a result they often resort to 'erosive' coping strategies such as taking high-interest loans, reducing their food consumption or selling off income-generating assets. In extreme cases, the poor can pull their children out of school or cut their consumption of essential nutrients to reduce their financial burden.[77] A study conducted in Nepal and Viet Nam revealed that small-scale and recurrent disasters reduced primary enrolment rates.[78]

Disasters are thus likely to further impoverish people – or push the 'near-poor' into poverty. In rural Andhra Pradesh, India, the single most important factor contributing to impoverishment is drought.[79] But people can also be pushed into poverty by more sudden disasters. This was

one consequence of the Sichuan Earthquake in 2008. Before the earthquake, 4 per cent of the province's population were covered under the 'basic provision protection', which provides subsidies to households with incomes below a certain threshold. Following the earthquake, however, the proportion rose to 6 per cent, where it stayed five years after the disaster.[80]

Among the poor, the most vulnerable to natural disasters are women, children, older persons, persons with disabilities and migrants. Following the Indian Ocean tsunami, for example, 70 per cent of those who died were women.[81] After the 2015 earthquakes in Nepal, older people were the most at risk because they were not sufficiently mobile to gain access to essential items.[82] Those with disabilities are also at risk since inaccessible physical infrastructure and information prevent them from effectively evacuating to emergency shelters – and as a result their mortality rates during disasters may be two to four times higher than the average (Box I-7). Indigenous people too are likely to be exposed since they rely heavily on natural resources, so are likely to be displaced by natural disasters.[83] Moreover, after a disaster children and older people are more susceptible to post traumatic stress disorder.[84]

BOX I-7

Towards disability-inclusive disaster risk reduction

One in every six people in Asia and the Pacific has some form of disability – 650 million women, men and children – numbers that are set to increase due to multiple factors including population ageing.[85] Disasters themselves are a common cause of physical, sensory, and psychosocial impairment. In addition, persons with existing disabilities face a wide range of barriers to survive, with many current disaster risk reduction measures inaccessible for them. As a result, their mortality rates during disasters are two to four times higher than that of those without disabilities.[86]

For example, deaf persons may not receive early warning signals, as they are often transmitted only through audible means. Similarly, wheelchair users struggle to access evacuation routes, emergency shelters, temporary housing units, and bathrooms, during times of disaster. Persons with intellectual disabilities and psychosocial disabilities may be left isolated without sufficient communication support. In addition, there can be discrimination in the distribution of emergency aid and assistance on the basis of disability.[87]

The Sendai Framework for Disaster Risk Reduction promotes the involvement of persons with disabilities, and points to the importance of inclusive, risk-informed decision-making. This can be achieved by disseminating knowledge and information in accessible formats and easy-to-understand language. The framework also calls for disability-disaggregated disaster statistics.

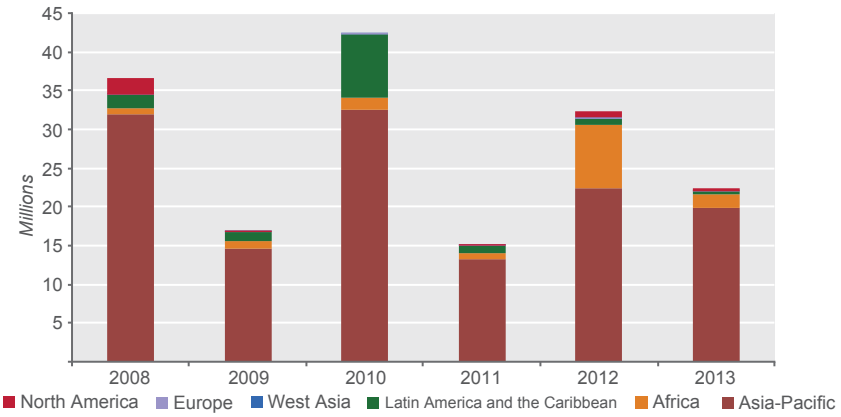
In Asia and the Pacific, the Incheon Strategy to "Make the Right Real" for Persons with Disabilities in Asia and the Pacific, the guiding document for the Asian and Pacific Decade of Persons with Disabilities, 2013-2022, promotes disability-inclusive disaster risk reduction in its seventh goal.

Displaced by disasters

With large numbers of vulnerable people exposed to multiple hazards, countries in the Asia-Pacific region face the highest risk of disaster-induced displacement.[88] Between 2008 and 2013, globally around 165 million people were displaced by disasters (Figure I-21). Of these 134 million were in Asia and the Pacific of whom 57 million were in East and North-East Asia, 47 million were in South and South-West Asia and 30 million were in South-East Asia (Figure I-22). Some have been displaced for days or weeks, others for several years. In 2013, in the Philippines, for example, typhoon Haiyan ('Yolanda') displaced 4.1 million people and even six months later half of these were still not in permanent housing (Box I-8).[89]

FIGURE I-21

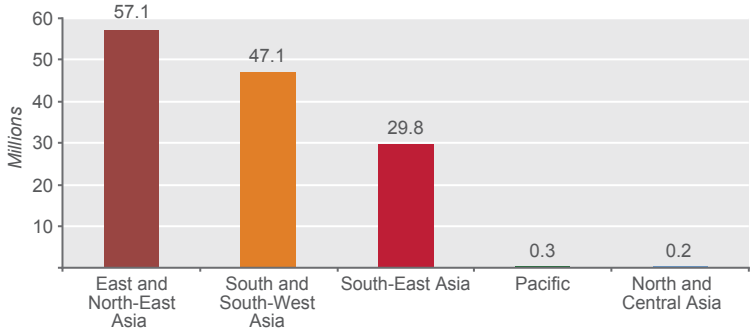
Displacement by natural disasters by region, 2008-2013



Source: ESCAP based on data from IDMC, 2014.

FIGURE I-22

Displacement in Asia and the Pacific by subregion, 2008-2013



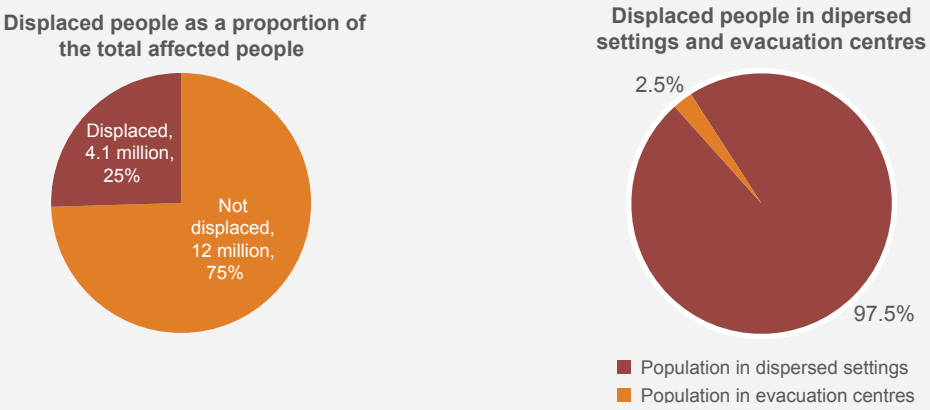
Source: ESCAP based on data from IDMC, 2014.

BOX I-8

Typhoon Haiyan (Yolanda)

Typhoon Haiyan, which hit the Philippines on 8 November 2013, was one of the strongest typhoons ever recorded in the region. It caused tremendous economic damage and losses affecting close to 14.1 million people and also displaced 4.1 million. Of these only 2.5 per cent took shelter in the evacuation centres, most sought refuge with friends and relatives, others created informal settlement and tent cities and went later to transitional bunkhouses.[90]

Typhoon Haiyan displacement, Philippines 2013



Source: ESCAP based on Philippines, NDRRMC, 2014.

Most people returned to their homes, or close to their homes, within hours, days or weeks of the storm passing. But those who returned early generally lived in precarious conditions, in damaged homes or in makeshift shelters or temporary sites in the devastated areas. Six months later over two million people were still in inadequate shelters.[91] Over 26,000 people were estimated to be living in temporary or transitional collective displacement sites, and another 200,000 people were awaiting government clearance to enter disaster-affected areas.[92] As of October 2014, one year after the disaster, 95,000 households, representing 475,000 people, were still living in unsafe shelters. More than 300 people were still in evacuation centres, 4,760 in tents, and close to 20,000 in transitional sites or bunkhouses.[93]

Displacement further impoverishes people and reduces their access to education and health services – and potentially exposes them to human rights abuses. It also dislocates family and community structures.[94] In the aftermath of typhoon Haiyan, for example, many families split up to seek work in other places.

Social protection

One source of defence for the most vulnerable against disasters would be stronger systems of social protection.[95] At present across Asia and the Pacific these are limited – 60 per cent of the population are not covered by social

protection.[96] Nor do most social programmes take into account the risks of natural disasters. A study of 124 social protection programmes in South Asia, for example, indicated that only 28 addressed disaster resilience. Typically they are small and fragmented safety nets financed by ad-hoc external resources that focus mainly on short-term emergency relief.[97]

However, in the last decade some good practices are emerging.[98] Bangladesh's Chars Livelihood programme, for example, has successfully addressed the vulnerability of the poorest of the poor by integrating social protection with disasters. The programme aims to improve the livelihoods of over one million people by providing asset grants to extremely poor households living on river island 'chars' that suffer from recurrent floods and erosion. Other financial measures and instruments such as microfinance and micro-insurance schemes, could also address some of the gaps of formal social protection measures.

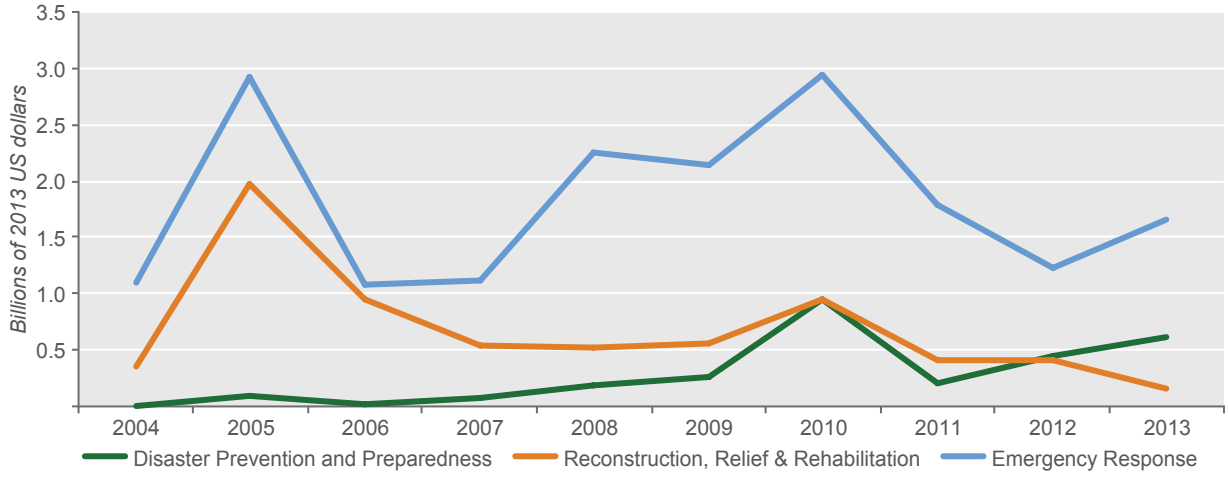
International assistance

Most international assistance for disasters is for emergency response and rehabilitation rather than prevention. Over the period 2004-2013, total official development assistance (ODA) from the international community to Asia and the Pacific was $438 billion – of which $27.8 billion was for disasters. Of this, $18.2 billion was for emergency response, and $6.8 billion was for reconstruction, relief and rehabilitation. Only $2.9 billion was allocated for disaster prevention and preparedness. However, the share for prevention and preparedness has been rising (Figure I-23).

Even for response, however, funding allocations may have the wrong priorities – and as a consequence may reinforce existing inequalities.[99] Following a major earthquake in Pakistan, for example, it was reported that the reconstruction funds were mainly directed towards landowners,

FIGURE I-23

Allocation of international aid for disasters in Asia and the Pacific, 2004-2013



Source: ESCAP based on OECD, creditor reporting system. Available from https://stats.oecd.org/Index.aspx?DataSetCode=CRS1. (Accessed June 2015).

Notes: International aid for disasters refers to 'humanitarian aid' category of ODA, and includes aid for both natural disasters and conflicts.

large infrastructure projects, industry, or developers.[100] Similarly, after the 2015 earthquake in Nepal, it was reported that many vulnerable groups including women, disadvantaged communities, indigenous people, and people with disabilities, had greater difficulty getting urgently needed relief.[101] When donor pledges do not materialize into actual disbursement, it adds another layer of hardship in disaster management.

ENVIRONMENT AT RISK

One of the best sources of resilience to natural disasters is a healthy natural environment with robust ecosystems. Unfortunately, much of this protection has been weakened by human-induced environmental degradation. Disasters can then further damage the environment, raising the prospect of a downward spiral.

Many ecosystem goods and services provide critical protection from natural hazards (Table I-5). In mountainous areas, for example, vegetation cover and root structures bind the soil together – protecting against erosion and making slopes more stable, thus helping to prevent landslides. In coastal areas and inland river basins, healthy peatlands, wet grasslands and other wetlands reduce water run-off after heavy rainfall or snowmelt, and help control floods. Also in coastal environments, tidal flats, deltas and estuaries absorb water from upland areas and serve as buffers against storm surges and tidal waves. In addition, coral reefs, sea grasses, sand dunes and coastal vegetation such as mangroves can effectively reduce wave heights and limit erosion from storms and high tides.[102] In India in 1999, for example, coastal mangrove ecosystems reduced the impact of cyclone in Odisha (formerly Orissa) (Box I-9).[103]

BOX I-9

Mangrove ecosystems reduce loss of life and damage from cyclones

India's second-largest mainland mangrove forest is the Bhitarkanika Conservation Area in the eastern state of Odisha (formerly Orissa), which harbours the highest diversity of Indian mangrove flora and fauna. In October 1999 a cyclone hit the coast of Odisha affecting around 20 million people and causing 15,000 deaths.[104] This was a category 5 cyclone, with a wind speed of more than 300 kilometres per hour and a storm surge of up to 10 metres.[105]

A study was undertaken to determine the storm protection function performed by the Bhitarkanika mangrove ecosystem.[106] This looked at the impact on three villages located the same distance from the coast. One was protected by mangroves, one had an embankment on its seaward side, while the other had no protection at all. The village protected by mangrove suffered losses of $33 per household, while in the village with no protection the losses were $44. The greatest loss, $154 per household, was in the village surrounded by the embankment which was breached and slowed the draining of flood water, increasing the damage to crops. Embankments near the mangrove forest were not breached while those further away were breached in a number of places, implying that mangroves protected these defences. The local people appreciated the functions performed by the mangrove forests and were willing to cooperate with the forest department in mangrove restoration.

This result matched the outcome of a study of 409 villages in Kendrapada district where the presence of wider mangrove belts reduced deaths compared to villages with narrow or no mangroves.[107]

TABLE I-5

Ecosystems help mitigate disaster hazards

Mountain forests, vegetation on hillsides	• Vegetation cover and root structures protect against erosion and increase slope stability by binding the soil, preventing landslides. • Forests protect against rock fall and stabilize snow, reducing the risk of avalanches. • Catchment forests especially primary forests, reduce risk of floods by increasing infiltration of rainfall and delaying saturation. • Forests on watersheds are important for water recharge and purification, drought mitigation and safeguarding drinking water supply.
Wetland, floodplains	• Wetlands and floodplains control floods in coastal areas, inland river basins and mountain areas subject to glacial melt. • Peatlands, wet grasslands and other wetlands store water and release it slowly, reducing the speed and volume of run-off after heavy rainfall or snowmelt in springtime. • Marshes, lakes and floodplains release wet-season flows slowly during drought periods.
Coastal ecosystems (mangroves, saltmarshes, coral reefs, barrier islands, and sand dunes)	• Coastal wetlands, tidal flats, deltas and estuaries reduce the height and speed of storm surges and tidal waves. • Coastal ecosystems protect against hurricanes, storm surges, flooding and other coastal hazards – combined protection by coral reefs, seagrass beds and sand dunes/coastal wetlands/coastal forests is particularly effective. • Coral reefs and coastal wetlands such as mangroves and saltmarshes absorb (low-magnitude) wave energy, reduce wave heights and reduce erosion from storms and high tides. • Coastal wetlands buffer against saltwater intrusion and adapt to (slow) sea level rise by trapping sediment and organic matter. • Non-porous natural barriers such as sand dunes (with associated plant communities) and barrier islands dissipate wave energy and act as barriers against waves, currents, storm surges and tsunamis.
Drylands	• Natural vegetation management and restoration in drylands helps ameliorate the effects of drought and control desertification, as trees, grasses and shrubs conserve soil and retain moisture. • Shelterbelts, greenbelts and other types of living fences act as barriers against wind erosion and sand storms. • Maintaining vegetation cover in dryland areas, and agricultural practices such as use of shadow crops, nutrient-enriching plants and vegetation litter increase resilience to drought. • Prescribed burning and creation of physical firebreaks in dry landscapes reduce fuel loads and the risk of unwanted large-scale fires.

Source: PEDRR, 2010.

These benefits are referred to collectively as ecosystem services. They provide food, fresh water, timber, soil formation, and nutrient cycling, while also regulating the climate, controlling floods and maintaining water quality. Some efforts have been made to estimate the value in financial terms. For example, according to the Economics of Ecosystems and Biodiversity, the flood mitigation services provided by the Muthurajawela wetlands in Sri Lanka are worth around $5 million per year.[108]

Ecosystem degradation

Over the past 50 years, humans have degraded the region's forests, grasslands, deserts, tundra, mountains, agricultural areas, freshwater and coastal and ocean ecosystems – and done so more rapidly and extensively than in any other similar period in human history.[109] This has steadily reduced the capacity of ecosystems to protect against natural hazards. An indication of the extent of the damage is provided by the Food and Agricultural Organization's Global Land Degradation Information System.[110] This includes two indices – the biophysical status index and the biophysical degradation index – which when combined give a picture of the overall status of land degradation (Table I-6). They show that in 32 of 34 Asia-Pacific countries, ecosystems are experiencing 'medium' to 'strong' degradation. In addition, in half of

TABLE I-6

Land degradation classes in Asia and the Pacific, by country

Biophysical degradation index*		Biophysical status index** Low → High: <25	25-50	50-75	>75
Strong	>0.7	-	-	-	-
	0.55-0.7	Iran (Islamic Rep. of) Turkmenistan Uzbekistan	Afghanistan Armenia Azerbaijan Bangladesh China India Kyrgyzstan Lao PDR Mongolia Pakistan Tajikistan Thailand Turkey Viet Nam	Bhutan Brunei Darussalam Cambodia DPR Korea Georgia Indonesia Malaysia Myanmar Nepal New Zealand Papua New Guinea Philippines Republic of Korea Russian Federation Sri Lanka	Japan
	0.5-0.55	-	Australia Kazakhstan	-	-
Weak	<0.5	-	-	-	-

Key:
- Low status,medium to strong degradation
- High status, medium to strong degradation
- Low status, weak degradation
- Low status, improving
- High status, stable to improving

Source: ESCAP based on data from FAO, 2011b.

*This index considers the overall processes of declining or improving ecosystem services.
**This index considers the actual state of the biophysical ecosystem factors (biomass, soil, water and biodiversity) to provide goods and services.

these countries ecosystems have only a low capacity to provide goods and services. These degraded areas are home to around 3.3 billion people – 79 per cent of the region's population.

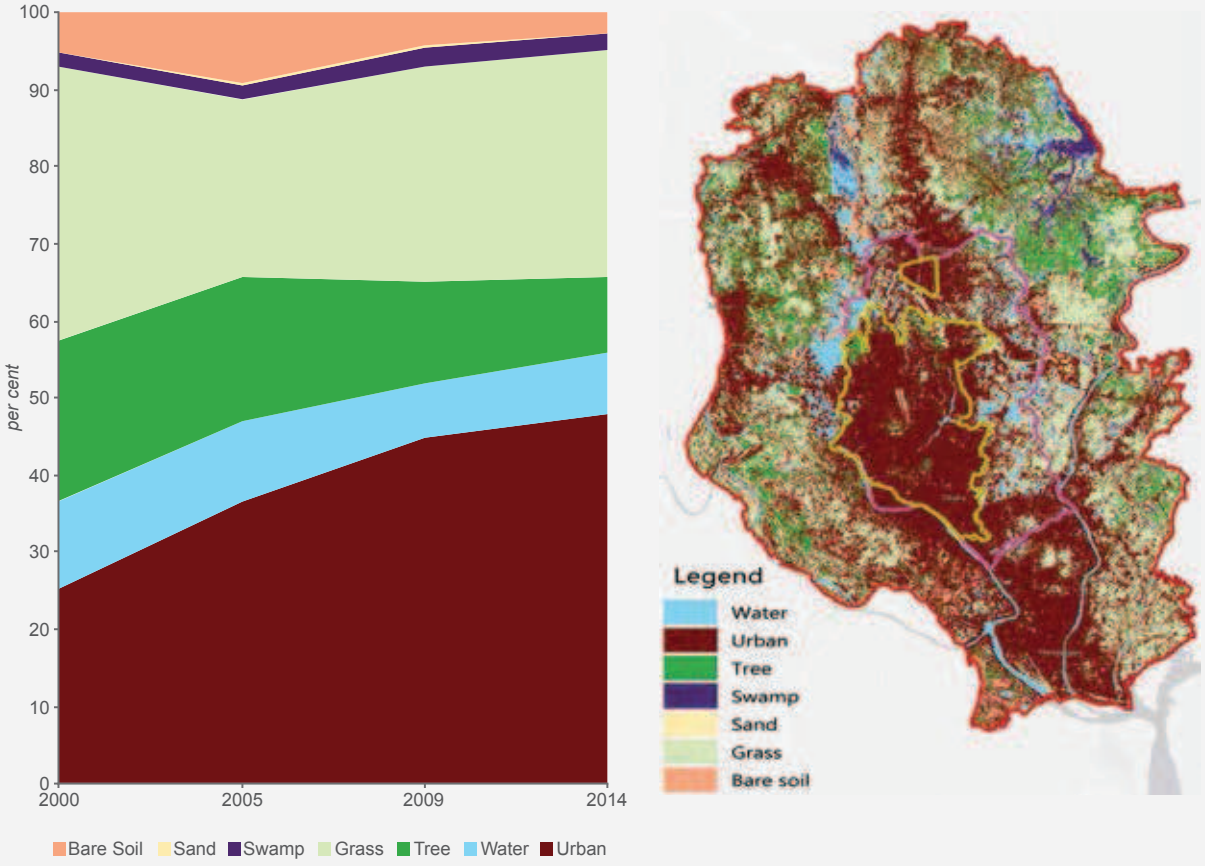
Degraded ecosystems can exacerbate the impact of natural hazards – affecting their magnitude, frequency, and timing. For example, in Pakistan deforestation has increased the susceptibility to floods and landslides during heavy rainfall.[111] Over time, such degradation steadily increases the risk. This is evident, for example, in Dhaka, Bangladesh where it is increasing people's vulnerability and exposure to natural disasters (Box I-10).

BOX I-10

Ecosystem degradation and the accumulation of risk in Dhaka, Bangladesh

Dhaka, the capital of Bangladesh, is one of the region's fastest-growing cities. This has resulted in major changes in land use and cover. Satellite images made between 2000 and 2010 show that over this period vegetation cover has been reduced by more than half while the land occupied by urban areas has increased by 20 per cent. This has depleted environmental barriers that can reduce the impacts of cyclones, floods and droughts, increasing the risks and the danger of exceptionally large impacts in a single disaster event.

Land cover change and risk accumulation in Dhaka between 2000 and 2014



Source: ESCAP based on USGS database.

Disasters and climate change further degrade weakened ecosystems

A resilient ecosystem can withstand shocks and rebuild itself. But if it is already fragile rebuilding may take longer; indeed it may never fully recover. In 2004, for example, wave action from the 2004 Indian Ocean tsunami damaged coral reefs – in Andaman and Nicobar Islands, Indonesia, Thailand, and Sri Lanka – but the damage was greatest in reefs that had previously suffered from destructive fishing practices such as the use of cyanide and dynamite.[112] With more effective management to reduce damage from human activities, most of the coral reefs will recover within five to ten years. But those that suffered the most extensive damage may take 20 or more years to recover, and even then may not be fully restored.

An additional factor influencing the integrity and quality of ecosystems is climate change, though the anticipated impacts differ significantly from subregion to subregion and from country to country – some areas may see more heatwaves, others greater precipitation, others more extensive droughts.[113]

The most significant impacts, however, are likely to be in coastal areas, with possible risks of sea level rise, greater storm intensity, higher wind speeds, greater wave action and higher sea surface temperature. All may exacerbate shoreline erosion.[114] In India, for example, in some places shores and beaches are retreating several metres a year – both through natural processes and human activity. But the erosion becomes even more severe when the coast is hit by a cyclone.[115] People in the low-lying island nations of the Pacific are already having to relocate inland due to coastal erosion and sea level rise – an indication of future disasters waiting to unfold.

At the Third United Nations World Conference on Disaster Risk Reduction in 2015 many countries including Bangladesh, Cambodia, Timor-Leste and the Pacific island States confirmed their commitment to simultaneously address disaster risk reduction and climate change adaptation. But the region as a whole is not well prepared for the complexity of the emerging climate change impacts. These issues will be further discussed at the global climate negotiations in December 2015.

The complex chain of events involving human activity, climate change and natural disasters creates a vicious feedback loop. Breaking this cycle will require more effective management of ecosystems – integrated with measures on social protection, disaster risk reduction and climate change adaptation. Thus far, however, there has been little cross-fertilization between these sectors.[116]

BUILDING GREATER RESILIENCE

Investing in disaster risk reduction is cost effective. Globally, disaster risk management strategies can have a four-fold return in terms of mitigating the impacts of disasters. In Asia and the Pacific investments in hydrometeorological early warning systems, for example, can have returns between 4 and 36 times.[117]

Nevertheless, over the last 10 years, countries in Asia and the Pacific have not made sufficient progress in building resilience.[118] This can be due to budget constraints, or lack of information or of political will. But there can also be limitations in human perception of risk – myopic behaviour in gauging unforeseen risks, as well as a tendency to overestimate the probability of unlikely events, and underestimate the

probability of common ones.[119] Moreover when assessing risk and vulnerability there is a lack of standardized data, methodologies and tools. Although more countries now have disaster risk reduction policies and legislation, many have yet to incorporate these into development policies, planning, programmes and projects.[120]

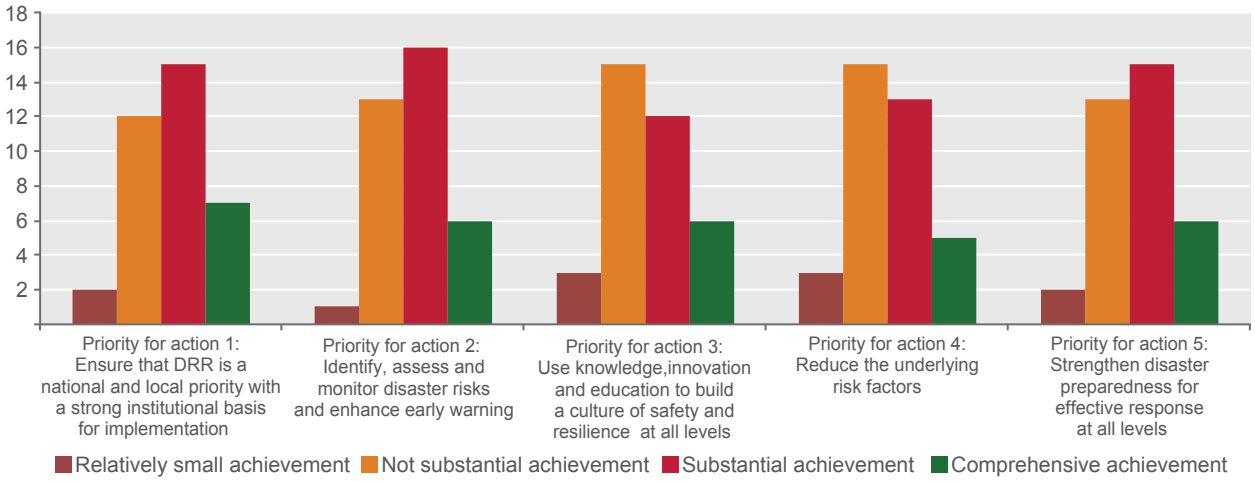
Some countries have increased their budget allocations for disaster risk reduction. Notably, in 2013 Mongolia spent 1 per cent of the government budget on disaster management,[121] and between 2006 and 2012 Indonesia increased investment in disaster risk reduction from about 0.4 per cent of the government budget to 0.7 per cent.[122] Generally, however, investment in disaster management is inadequate and is mostly spent on response and recovery. There has been progress in building institutional capacities for early warning, preparedness and response, but there are still significant gaps.

The scale of the gaps is evident when considering progress in terms of the Hyogo Framework for Action in Asia and the Pacific 2011-2013 (HFA). This set out a series of priorities on such issues as institutional commitment, early warning systems and building a culture of safety and resilience. Based on self-assessments, around half the countries, including high exposure countries like Bangladesh and the Philippines, reported 'comprehensive' or 'substantial' achievement. However, for the other countries progress was 'not substantial' or 'relatively small' (Figure I-24).

Another indication of the state of progress is provided by the 2014 *World Risk Report* and its world risk index. This index has a number of components. One is the degree of exposure; another is the coping capacity of governments and medical services, along with the extent of insurance coverage. As indicated Figure I-25, many countries with high exposure have limited coping capacities. Japan is highly exposed but is also more resilient. However, most other high-exposure countries, including Bangladesh, Cambodia, Fiji, the Philippines, Solomon Islands, and Vanuatu, have less capacity, so are more vulnerable to natural disasters. One example of how to build resilience and to enhance coping capacities is that of Gujarat state in India (Box I-11).

FIGURE I-24

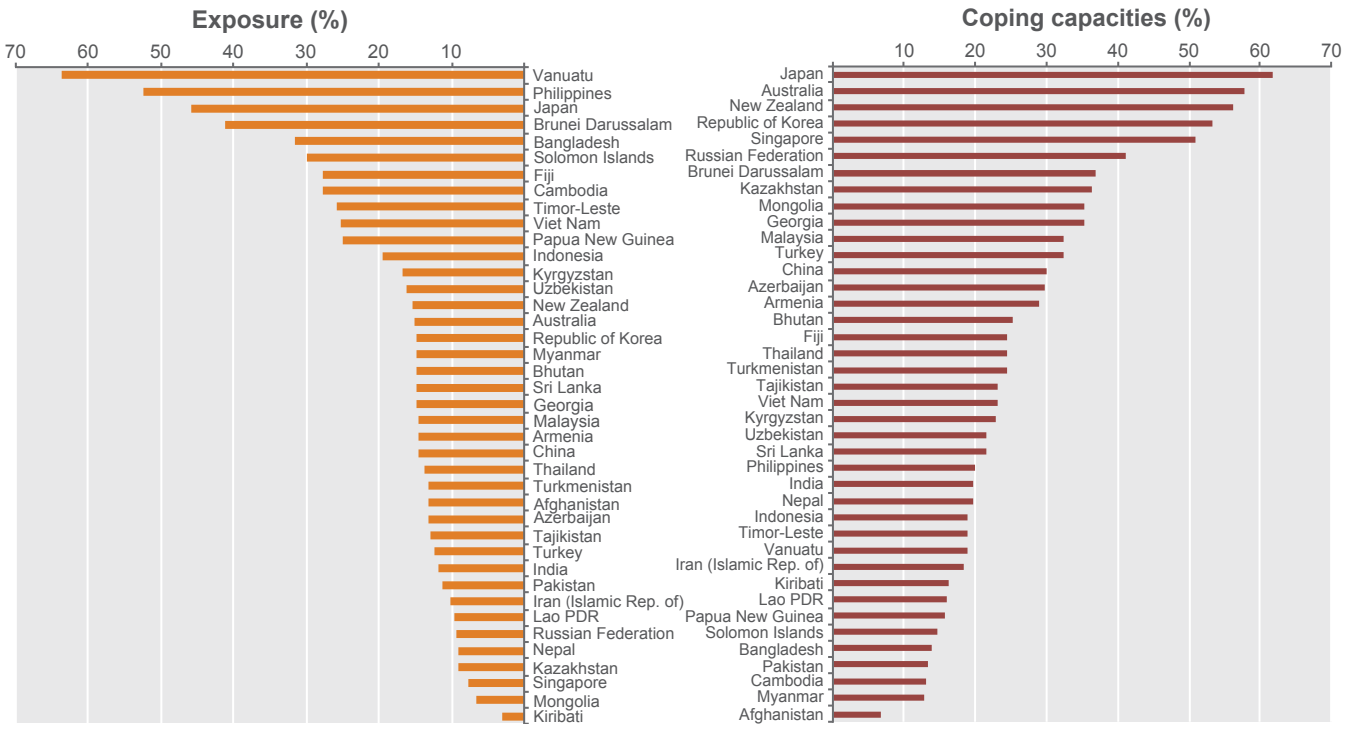
Asia-Pacific performance in the five HFA priorities for action, 2011-2013



Source: ESCAP based on UNISDR, 2013e.

FIGURE I-25

Exposure and coping capacities in Asia and the Pacific



Source: ESCAP based on data from Alliance Development Works and UNU-EHS, 2014.

BOX I-11

Building resilience in Gujarat, India

On 26 January 2001, Gujarat state in India was struck by a magnitude 7.7 earthquake, which devastated a huge area, including Bhuj, the capital of Kutch district. Around 13,800 people were killed and more than 1.2 million houses were damaged.[123]

In response, the theme of the Gujarat Earthquake Rehabilitation and Reconstruction Policy was to 'Build Back Better'. This established the Gujarat State Disaster Management Authority to implement rehabilitation and reconstruction, as well as activities for disaster preparedness and mitigation.

A key result of the programme was disaster-resilient buildings. To achieve this, the government offered economic incentives, including subsidies and tax exemptions. It also offered cash assistance, part of which was disbursed only after the verification of construction quality. Schools, hospitals, community halls, town halls, markets and other public buildings were retrofitted enforcing resilient building codes. Critical physical infrastructure was also redesigned and reconstructed so as to be more resilient. Technical assistance was provided on the statutory requirements and engineers provided guidance to house owners. To underpin the land use plans the government also undertook seismic-microzonation, and implemented awareness raising programmes on hazard resilience technology.

The results have been positive. Recent surveys have suggested that people feel that the houses have been adequately engineered to withstand tremors. There have been no subsequent reports of collapsed or severely damaged houses from natural disasters.

THE UNFINISHED AGENDA

Since the Hyogo Framework of Action the region has made good progress in addressing disaster risks, but there is a lot more to do. Existing risks are being exacerbated, and new risks are created, by the region's rapid economic growth, rising population, burgeoning cities, and the consequent impact these interrelated processes have on environmental buffers. Climate change has added a further layer of risk and uncertainty.

Building resilience to disasters is everyone's business. But in developing countries that do not have well developed markets for risk transfer or risk sharing much of the responsibility rests with the government. Regional cooperation is critical as many of the disasters have cross-border origins and impacts. Subsequent chapters of this report analyse the needs and the opportunities – offering practical recommendations and proven solutions.

Chapter 2 – Drought – the forgotten disaster – This chapter examines a regular phenomenon, which, because it develops more slowly than other disaster events, often goes unrecognized until too late. It suggests ways to reorient the management of drought response so as to reduce both the risks and the impact. Regional cooperation for sharing technology and know-how is highlighted as importance.

Chapter 3 – The value of early warning – This chapter highlights the benefits of multi-hazard early warning systems which not only save lives but are also very cost effective – especially for hazards that occur frequently. It argues that warning systems should be people centred and strengthened so as to reach the 'last mile'. It also points to the value of regional cooperation.

Chapter 4 – Right information, right people, right time – This chapter explores the critical issue of effective information management. Asia and the Pacific can take advantage of many advances in ICT and space applications. This chapter suggests how the vast quantities of data now being produced can be organized and analysed so as to serve the interests of the region's poorest people.

Chapter 5 – At the heart of sustainable development – Disaster risk reduction is a responsibility for every part of government – from education to health to transport to social protection. Just as every sector can be affected by earthquakes or floods or cyclones, so every sector needs to consider how to make its activities disaster resilient. This chapter indicates how disaster risk reduction can be an integral part of all development activities.

ENDNOTES

1 United Nations, Open Working Group proposal for Sustainable Development Goals, A/68/970.

2 ESCAP, 2013a.

3 ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. (Accessed April 2015).

4 Unless noted otherwise, disasters in this report includes drought, earthquake and tsunami, epidemic, extreme temperature, flood, landslide, mass movement (dry), storm, volcanic activity and wildfire. Fatalities (or deaths) in this report refers to persons confirmed as dead and persons missing and presumed dead as defined by EM-DAT. "Damage" in this report refers to damage to property, crops, and livestock; "Losses" refers to negative impacts in business activities, income generation and increased costs of production caused indirectly as a consequence of damage. Unless noted otherwise, damage in this chapter is in 2005 constant US dollars.

5 ESCAP, 2013a.

6 Population living in poverty (2011), $1.25 per day in 2005 PPP, ESCAP Statistical Database. (Accessed 5 March 2015).

7 UNDP, 2015b.

8 Myanmar and others, 2008.

9 ESCAP, 2015f.

10 Mahr and Sharma, 2015.

11 Samoa, 2013. In current US dollars.

12 Fiji, 2013. In current US dollars.

13 These figures do not include the impacts of Cyclone Pam which struck Vanuatu earlier in 2015 which is outside the period of analysis (Box 1-2).

14 ESCAP, 2015f.

15 Nepal, 2015; Vanuatu, 2015a

16 Vanuatu, 2015a.

17 EM-DAT: The OFDA/CRED International Disaster Database. (Accessed April 2015).

18 Vanuatu, 2015a and UNDP, 2015a.

19 OCHA, 2015b.

20 Vanuatu, 2015a.

21 USGS, 2015.

22 Local newspapers from India, China and Bangladesh.

23 Nepal, 2015. In current US dollars.

24 Nepal, 2015.

25 Data source: the Joint Typhoon Warning Center. Available from http://www.usno.navy.mil/JTWC/ (Accessed August 2015).

26 ESCAP, 2015b.

27 ESCAP, 2015b. In current US dollars.

28 ICIMOD, 2010.

29 ICIMOD, 2011.

30 Floodlist, 2015.

31 UNISDR, 2015b.

32 UNISDR, 2015b.

33 De Guzman, Emmanuel M. In current US dollars.

34 The Guardian, 2015b.

35 UNISDR, 2015b.

36 EM-DAT: The OFDA/CRED International Disaster Database. (Accessed April 2015).

37 ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. (Accessed April 2015).

38 EM-DAT (for damage) and ESCAP Statistical database (for GDP).

39 Lao PDR, 2009.

40 ADB and World Bank, 2011. In current US dollars

41 Nepal, 2015.

42 Hsiang and Jina, 2014.

[43] ESCAP, 2013a.

[44] ESCAP et al., 2015.

[45] ESCAP and ADPC, 2014.

[46] Ballesteros and Domingo, 2015.

[47] Philippines and others, (n.d.).

[48] Ballesteros and Domingo, 2015. In current US dollars.

[49] New Zealand, 2013.

[50] The Guardian, 2011.

[51] Ono, 2014.

[52] Ye and Abe, 2012.

[53] Ye and Abe, 2012.

[54] Ye and Abe, 2012.

[55] ESCAP, 2013a.

[56] DPNet, (n.d.)

[57] Lao PDR, 2011.

[58] Nepal, 2015.

[59] Fiji, 2013.

[60] Solomon Islands, 2014. In current US dollars.

[61] PwC, 2013.

[62] Palliyaguru and others, 2007.

[63] Annual average loss (AAL) is the estimated average loss annualised over a long time period considering the full range of loss scenarios relating to different return periods. Note that the AAL used here includes only earthquake, wind, storm surge tsunami and floods. Other disaster categories, such as droughts, are not included.

[64] The term 'city' refers to urban areas with a population of 300,000 or more.

[65] UN-DESA, 2014.

[66] World Bank, 2010a.

[67] World Bank, 2012a.

[68] UNEP, 2013. Global estimated risk index for multiple hazards.

[69] Categories of risk are based on cumulated risk of cyclones, earthquakes, floods and landslides and expected annual losses per pixel. Unit is estimated risk index from 1 (low) to 5 (extreme).

[70] Pelling, 2007.

[71] UNDP, 2013a.

[72] UN-HABITAT, 2007.

[73] Philippines, NDRRMC, 2014.

[74] ESCAP, 2014b.

[75] Data source: Poverty data from UNSD, risk data from Alliance Development Works and UNU-EHS, 2014, and population data from World Bank. $1.25 (PPP) per day is used as the threshold determining poverty, following the MDG indicators

[76] Del Ninno and others, 2001.

[77] World Bank, 2010b; World Bank, 2013b.

[78] UNISDR, 2011a.

[79] ODI, 2013.

[80] ESCAP, based on Sichuan Statistical Yearbook, 2005-2014.

[81] ESCAP, 2015f.

[82] HelpAge International, 2013.

[83] World Bank, 2015b.

[84] Jia and others, 2010; Hoffman, 2009.

[85] ESCAP, 2012.

[86] ESCAP and others, 2014.

[87] UNISDR, 2013f.

[88] Displacement refers to any involuntary or forced movement, relocation or evacuation of individuals or groups of people from their homes or regular place of residence in order to avoid the threat or impact of a disaster.

[89] Philippines, 2014; OCHA, 2014b.

90 Philippines, NDRRMC, 2014.

91 OCHA, 2014b.

92 Philippines and others, 2014.

93 OCHA, 2014a.

94 UNISDR, 2015b.

95 ESCAP, 2013b.

96 ESCAP, 2014b.

97 Davies and others, 2013.

98 World Bank, 2013a.

99 World Bank, 2015b.

100 Refugees International, 2010.

101 Amnesty International, 2015.

102 UNU, 2013.

103 UNEP, 2014.

104 Venkataramakrishnan, 2014.

105 Nayak, 2009.

106 Badola and Hussain, 2005.

107 Das and Vincent, 2009.

108 UNU, 2013.

109 Millennium Ecosystem Assessment, 2005.

110 FAO, 2011b.

111 IUCN, 2006.

112 Global Coral Reef Monitoring Network, 2006.

113 IPCC, 2012.

114 IPCC, 2014.

115 Mimura, 2013.

116 World Bank, 2011b.

117 Hallegatte, 2012.

118 UNISDR, 2015b

119 ESCAP, 2013a.

120 UNISDR, 2013e.

121 Mongolia, 2015.

122 Darwanto, 2012.

123 India, GSDMA, 2002.