



**LEAVE
NO ONE
BEHIND**

Disaster Resilience for Sustainable Development

Asia-Pacific Disaster Report 2017



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Disaster Resilience for Sustainable Development

Asia-Pacific Disaster Report 2017

Leave No One Behind: Disaster Resilience for Sustainable Development

Asia-Pacific Disaster Report 2017

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About the cover

The mosaic represents diverse communities and countries working together to create a resilient and cooperative system of disaster risk reduction that protects the most vulnerable and leaves no one behind.

FOREWORD



In August 2017, devastating floods swept across South Asia and typhoons wreaked havoc in East Asia. These were stark reminders of nature's destructive potential. In Bangladesh, India and Nepal flooding and landslides killed hundreds of people. They destroyed homes, schools, businesses and crops, and exposed millions to hunger and disease. Such events are shocking, but not surprising. As clearly set out in the *Asia-Pacific Disaster Report 2017*, risk is outpacing resilience. Recent events are the latest in a series of catastrophes in Asia and the Pacific, the most vulnerable region in the world to natural disasters.

Natural disasters can destroy the outcomes of years of work and investment by communities, governments and development organizations. That is why the principle of the disaster resilience is central to the 2030 Agenda's Sustainable Development Goals. If these Goals are to be achieved, then all new infrastructure should be capable of withstanding extreme natural disasters to enable people to escape and survive. Yet the Sustainable Development Goals have another critical stipulation. They are to be achieved not just for most people, but for everyone. The objective is to 'leave no one behind'. This is particularly relevant in the context of disaster risk reduction. Planning for resilience should be both robust and comprehensive. Early warning systems should reach everyone likely to be affected. Food, water or shelter should be swiftly available, even in the most remote areas.

This edition of the *Asia-Pacific Disaster Report* considers what this means in practice. It looks at the relationship between the impact of disasters, poverty and inequality. Where inequality is concerned, the report highlights that each disaster in the region leads to a 0.13-point increase in the Gini coefficient. It explores how the impacts of disasters intersect with violent conflict. It argues that measures for disaster risk reduction should take account of the shifting risks associated with climate change, especially in risk hotspots where a greater likelihood of change coincides with a higher concentration of poor, vulnerable or marginalized people. Although interventions to reduce disaster risk cannot alone prevent conflict, they should be part of an integrated approach to conflict prevention and peace-building.

The report shows that future natural disasters may have greater destructive potential. The region could account for 40 per cent of global economic losses resulting from disasters in the years to come, with small island developing States and least developed countries experiencing annual GDP losses equivalent to 4 per cent and 2.5 per cent, respectively. It also highlights the scientific and technical advances in forecasting that can identify new risks and vulnerabilities, and help anticipate extreme events. I hope this report will help policy makers, in both public and private sectors, understand disaster risk and resilience better, so that decisive action can be taken across Asia and the Pacific.

A handwritten signature in black ink, reading "Shamshad Akhtar". The signature is written in a cursive style with a large initial 'S' and a horizontal line at the end.

Shamshad Akhtar
Under-Secretary-General of the United Nations and
Executive Secretary, United Nations Economic and
Social Commission for Asia and the Pacific

EXECUTIVE SUMMARY

Leave no one behind

Asia and the Pacific is the region most affected by natural disasters. These disasters hit the poorest countries and communities hardest. The 2030 Agenda for Sustainable Development aims to reach everyone – to leave no one behind. If governments are to protect their most vulnerable people, they must ensure that national development strategies are firmly grounded in disaster resilience.

By historical standards, there were fewer disasters in 2016, but they still took a heavy toll – killing 4,987 people, affecting 35 million people and causing estimated damage of about \$77 billion. The greatest loss of life was through flooding, which caused 3,250 deaths. But droughts also affected 13 million people.

Since 1970, the number of people killed has fluctuated considerably from year to year but has averaged 43,000 annually, principally from earthquakes, storms, and floods. Beyond the fatalities, many more people have been affected; since 1970 a person living in the Asia-Pacific region has been five times more likely to be affected by natural disasters than a person living outside the region.

Disasters also cause large-scale damage. Between 1970 and 2016, Asia and the Pacific lost \$1.3 trillion in assets. Almost all of this was the result of floods, storms, droughts and earthquakes including tsunamis. Such damage has steadily been rising. This is partly because as GDP increases there are more physical assets at risk.

FUTURE DISASTER RISKS

One study on future impacts for the period 2020 to 2030 suggests, however, that at current rates of progress most Asia-Pacific countries at higher risk will make limited progress – in terms of reducing either fatalities or the number of people affected.

Beyond measuring the human costs, there have also been efforts to predict future economic costs. These indicate that 40 per cent of global economic losses from disasters will be in Asia and the Pacific, with the greatest losses in the largest economies – Japan and China, followed by the Republic of Korea and India. However, when considered as a proportion of GDP the burden is likely to be greatest in Countries with Special Needs, and in particular in the small island developing states, which are expected to have average annual losses close to 4 per cent of their GDPs. The least developed countries as a whole are expected to have annual losses of around 2.5 per cent of GDP.

Such estimates only consider losses in assets; not in people's socio-economic well-being – in their health, education and livelihoods. Well-being losses from disasters tend to be greater in the least developed countries because poorer people, with fewer assets and living close to subsistence cannot use savings to cope with the impacts and may need more time to recover and reconstruct.

As well as being exposed to natural hazards, countries are also at risk from man-made disasters through wars and violent conflicts. These broader risks have been incorporated into the INFORM index which includes the risks from both natural and man-made disasters. On this basis, the greatest risks are in South and South-West Asia and South-East Asia, largely because of natural hazards, for which the rating is higher than for man-made disasters. However, countries such as Afghanistan, have a higher rating for conflicts.

POVERTY AND INEQUALITY

Human and asset losses tend to be greater in the poorest communities living in places and conditions that expose them to natural hazards so are least able to withstand disaster impacts. At the same time, disasters destroy many of their already meagre assets, trapping them in poverty that can be transmitted from one generation to the next.

Typically, the greatest impacts are in countries which have the least capacity to prepare for disasters, or respond to them. These include the least developed countries, the landlocked developing countries and the small island developing States. Between 2000 and 2015, in Asia and the Pacific the low- and lower middle-income countries experienced by far the most disaster deaths, and lost more people per disaster event: on average, more than 8,000 people died per disaster – almost 15 times the average toll in the region's high-income countries. In fact, the actual death toll in the poorest countries is probably even higher than these data suggest, since many of these countries lack the means to record the number of deaths.

In all these countries, disasters can have complex and deeply disruptive effects on livelihoods – further disadvantaging those who are already in a vulnerable situation. In rural areas, people are likely to be dependent on agriculture and fragile ecosystems; and have less ability to cope and recover. In cities, they typically occupy low-value land that may be exposed to floods, landslides and other hazards. A high proportion of the victims are women and girls – who often have limited access to information, financial services, land and property rights, health and education – structural disadvantages that reduce their resilience. In addition to hitting the poorest, disasters can also cause the near poor – those living on between \$1.90 and \$3.10 per day – to fall into poverty.

Intensive and Extensive Disasters

The most attention usually goes to 'intensive' disasters like earthquakes and cyclones, but the cumulative damage, particularly for the poor, is often greater for 'extensive' disasters such as droughts, persistent flooding, and small or medium-sized storms that deliver low-intensity but recurrent shocks. Severe storm damage to a poor household's roof can, for example, ruin

harvested grains but government support is often not forthcoming because the storm was not considered a disaster.

As well as losing assets and income from disasters, poor households are also weakened in other ways. In absolute terms, the rich may lose more because they have more to lose. What matters more, however, is the proportion of income or assets lost. The same absolute loss will matter more to a poor household than a rich one and widen socio-economic disparities.

Disasters will thus exacerbate inequalities. A common measure of inequality is the Gini index which ranges from 0 to 1, where 1 represents complete inequality. An analysis for 86 countries globally from 1965 to 2004 found that a natural disaster increased the Gini coefficient by 0.01 in the next year. An analysis by ESCAP among 19 countries in Asia and the Pacific suggests worsening existing inequalities with the increase in Gini coefficient by 0.13.

Poverty, like wealth, is often transmitted from one generation to the next. This process will be sustained by disasters that deplete or destroy the assets and resources of the poor. Extensive disasters are particularly insidious. Droughts, for example, can last for years, even a decade, and lead to chronic, persistent malnutrition.

Cities at risk

Many cities are located in the areas where multi-hazard risks are growing rapidly. In the Asia-Pacific region by 2015-2030 it is estimated that the population in the 'extreme-risk' areas, is expected to grow more than 50 per cent in 26 cities, and by 35 to 50 per cent in 72 cities. As a result, the number of city dwellers exposed to extreme and high risks is likely to increase significantly.

The trend of increasing disparities is particularly notable in the region's cities. Rural-urban migration is crowding people into slums with substandard housing that lack access to services and social protection. Urban growth is taking shape on vulnerable lands, along river banks, drainage channels and steep slopes that are exposed to hazards. If a disaster strikes these cities, the poor will be hit hardest and urban inequalities will widen.

However, there are also serious risks for other urban dwellers. Outside city limits, there are also risks in peri-urban areas. These are attractive for residents because they have low land and rental rates, but they also lack municipal building and development regulations and as a result often have unsafe buildings and inadequate infrastructure.

Even the not-so-poor are living and working in buildings of suspect quality: many modern high-rise buildings may not be very robust. Construction workers often fail to understand or execute building drawings; contractors and designers may have a poor understanding of building codes and regulations; and city governments often lack the capacity to enforce them. Earthquakes in India, Nepal, Indonesia, and Taiwan, Province of China have clearly exposed such vulnerabilities. Compared with those in developed countries, disasters in urban areas of developing countries tend to be more destructive and much harder to recover from. The lack of resources and political

will add further layers of complexity. Disaster risk reduction is hampered by the complexities in land tenure, high densities and high-rise structures, as well as the need to support floating populations that arise from frequent migration.

Asia-Pacific cities have millions of people at risk, but they are also emerging as leaders for community-based disaster risk reduction, as well as for climate change mitigation and adaptation. In recent years, city-to-city partnerships have been sharing experiences and gaining access and knowledge to policy tools for risk sensitive and pro-poor urban development.

RESILIENCE IN AGRICULTURE

In many countries in Asia and the Pacific the largest share of the poorest people are to be found in rural areas working in agriculture. Over the past two decades, rapid economic growth and increased agricultural productivity have helped reduce hunger. Nevertheless, agriculture is under strain. Between 1992 and 2014, the amount of arable land in Asia and the Pacific fell from 0.28 to 0.21 hectares per person. Another concern is the availability of water. Because of growing populations and economic development, nearly all countries in the region are putting pressure on water resources and reducing the quantity available per person.

In Asia and the Pacific over recent years, on average, agriculture absorbed 17 per cent of the total economic impact caused by natural hazards. But the agriculture sector is also linked with industry and services through both demand and production. Reduced agricultural output also therefore slows overall economic growth, leading to a deterioration of country's balance of payments and increased borrowing. Disaster damage to agricultural assets and infrastructure causes substantial disruptions in production cycles, trade flows, as well as in livelihoods and employment opportunities.

Disasters also undermine all aspects of food security, by reducing food supplies, and cutting the incomes of poor communities. The events can take several years to recover from trapping poor communities in a cycle of hunger and poverty.

In addition, there are longer-term impacts on agriculture. Prolonged drought contributes substantially to land degradation. Water and land scarcity, coupled with a succession of disasters, erodes traditional coping mechanisms, particularly for the poorest people who live on the most degraded land. Desertification, land degradation and drought, when compounded by poverty and inequality, can also affect political insecurity and conflict. Some of the world's most conflict-prone regions are drylands. Drought and degradation drive people off their land, creating economic migrants and environmental refugees.

Building disaster resilience of agriculture thus assumes greater significance beyond the economic impacts, it is also critical for improving livelihoods and reducing poverty. Disaster risk reduction and resilience must be systematically embedded into agricultural development plans and investments – particularly in countries facing recurrent disasters and where agriculture is a critical source of livelihoods, food security and nutrition if no one is to be left behind.

Making agriculture more resilient will mean preserving the productive base of natural resources and ecosystem services while increasing the capacity to withstand risks, shocks and climate variability. Strategies for achieving resilient agriculture include: boosting agricultural productivity with stress-tolerant varieties; adjusting planting dates, expanding water harvesting, storage, and conservation; and insurance and social protection schemes for farmers.

Coping with disasters in rural areas also opens up new opportunities. Many of the same measures that will make communities and households more resilient to disasters can also act as stepping stones out of poverty.

DISASTERS AND CLIMATE CHANGE

Climate change magnifies the risk of disasters and increases their costs. As the climate system has warmed, the number of weather-related hazards globally has tripled, and the number of people living in flood-prone areas and cyclone-exposed coastlines has doubled – and this trend is expected to increase.

Over the past century, most of the Asia-Pacific region has seen warming trends and greater temperature extremes. The impact of climate change will be felt particularly through periodic weather events that can be considered as climate risk fault-lines – monsoon rainfall and El Niño/La Niña events – as well as through heatwaves, sand and dust storms, floods cyclones and droughts.

Monsoons – For East Asia, most models show an increase in mean precipitation in the summer monsoons and an increase in heavy precipitation events. For India, all models and scenarios project an increase in both mean and extreme precipitation in the summer monsoon.

El Niño/La Niña – It is not clear whether rising global and ocean temperatures will intensify El Niño events – though they could affect their frequency.

Heat waves – Climate change can increase the number of heat waves that cause substantial mortality.

Dust storms – Higher temperatures reduce soil moisture which, combined with higher wind speeds, trigger large-scale sand and dust storms – especially in South-West Asia, and North and East Asia.

Floods – Risk projections indicate substantial increase in losses, particularly in East, South, South-West and South-East Asia with the problems becoming worse by 2030. China, India, Bangladesh and Pakistan would experience losses two to three times greater than in the reference year of 2010.

Cyclones – Climate change is predicted to increase the frequency of high-intensity storms in ocean basins. Future climate scenarios also suggest that tropical cyclones will have shorter return periods and be increasingly destructive.

Drought – By 2030, drought risk will have increased substantially. There will also be a shift in the geography of drought: in South Asia towards the west; in South-East Asia towards the east.

Climate risks are widespread across the region, but there are also hotspots where greater likelihood of change coincides with high concentrations of vulnerable, poor or marginalized people. Generally, these cut across national boundaries.

River deltas – The Mekong and the Ganges–Brahmaputra–Meghna deltas will be affected by sea-level rise due to subsidence, decreases in sediment supply, increase in groundwater salinity, and deteriorating water quality. They will also suffer loss and erosion because of floods, storm surges, and extreme cyclonic events, exacerbated by the loss of protection from mangrove forests and sand dunes.

Semi-arid regions – These areas are likely to experience more frequent and intense droughts – and as a result will become more extensive.

Glacier- and snowpack-dependent river basins – More than 1.5 billion people living in the floodplains of the Ganges, Indus, and Brahmaputra depend on the Himalayan water system. Based on a projected glacier area in 2050, declining water availability could eventually threaten some 60 million people with food insecurity.

Coherence between climate change adaptation and disaster risk reduction

For disaster risk reduction to be successful, it must take account of the shifting risks associated with climate change and ensure that measures do not increase vulnerability to climate change in the medium to long term. Traditionally hazard analysis has been based on historical data, but this is no longer sufficient, because hazard characteristics are changing as a result of climate change. For instance, a 100-year flood or drought may become a 30-year flood or drought. Climate scenarios inevitably have ranges of uncertainty which increase as they project further into the future. Many buildings and critical infrastructure will have to cope in 2100 with conditions that, according to most climate models, will be radically different from current ones. Managing risks from long-term climate change should be viewed as part of a broader strategy for managing climate risks for all timescales. The aim should be to build climate resilience while adapting to climate change – and treat these as complementary processes.

Many adaptations can be implemented at low cost. It has been estimated that transitioning to a low-carbon pathway would cost the region 1.4 to 1.8 per cent of GDP by 2050. This is lower than the costs of inaction; without action, the region could see GDP decrease over this period by 3.3 per cent due to climate change impacts. This has important implications for achieving the goal of eradicating poverty, in all its forms, by 2030.

The costs of adaptation are modest partly because of a steep drop in the cost of green technologies, but also because of the potential for large efficiency savings and significant co-benefits. There are four priority areas to promote climate change adaptation and improve resilience: implement effective carbon pricing; phase out fossil fuel subsidies; encourage renewable energy and energy

efficiency; and expand climate finance. All these efforts can take advantage of new tools that are becoming available.

PATHWAYS TO CONFLICT PREVENTION

There is often a close relationship between armed conflict and disasters. Conflicts undermine the capacity and commitment of states to prevent and respond to natural disasters and humanitarian crises. At the same time, disasters themselves can create unstable economic conditions, exacerbate social fault lines and heighten social exclusion – creating fertile ground for conflict.

In recent years, most conflicts in Asia and the Pacific have been within states – though the region also has around 15 potential areas of inter-state conflict. Compared with natural disasters, which are one-off and sometimes rapid events, conflicts tend to last longer. Nevertheless, conflicts and disasters both compound risks to create complex and converging crises, so they can be considered together.

This is common where there is competition for natural resources, along with environmental stress, degradation and mismanagement. Drought and desertification, for example, can exacerbate disputes where poor people are competing for limited land and water. A severe drought threatens local food security, aggravates humanitarian conditions, and often triggers large-scale human displacement. It may also provide the breeding ground for sustained conflict. Environmental shock and violent conflict thus create vicious circles.

Building disaster resilience to reduce conflict

Communities in conflict-affected areas tend to have lower resilience to disasters. Similarly, community members affected by disasters can be more vulnerable to engaging in conflict. In these circumstances, in addition to more conventional peacebuilding approaches, climate adaptation and disaster risk reduction offer further entry points for preventing conflict.

In situations where conflict is based on competition for scarce resources, better management of natural resources, combined with climate change adaptation, can channel competing interests into non-violent resolutions. In a volatile situation where conflict is either brewing or in full swing, these interventions can offset or soften the impact of a disaster.

The most dramatic windows of opportunity can be opened by large-scale, generally rapid onset disasters. In Indonesia, for example, the post-tsunami recovery in 2005 was seen as an historic opportunity to ‘build back better’ – addressing both tsunami recovery and post-conflict reconstruction in a more unified way. In 2005, after 29 years of war, the separatist movement signed a peace agreement with the Indonesian Government.

Aid is not always so supportive, and in some cases, post-disaster responses can exacerbate conflict. If infusions of aid appear to favour some sections of society over others they may increase social tensions. Disaster management should therefore be conflict sensitive to guard

against unintended harm, while peace-building should be hazard proof.

Environmental management, conflict prevention, disaster risk reduction and peace-building thus should not be seen as separate activities but as linked to each other, as well as to programmes for poverty reduction and improving livelihoods. Interventions to reduce disaster risk cannot prevent conflict, but they can be part of a larger, more integrated approach to conflict prevention and peace building.

LEAVE NO ONE BEHIND – POLICIES, ACTIONS AND TOOLS

The international community has placed disaster risk reduction at the heart of sustainable development. Over the period 2015–2016, governments established a comprehensive global framework. This comprised six separate but interrelated agreements:

- Sendai Framework for Disaster Risk Reduction 2015–2030
- 2030 Agenda for Sustainable Development
- Paris Agreement under the United Nations Framework Convention on Climate Change
- Agenda for Humanity
- New Urban Agenda
- Addis Ababa Action Agenda under the Third International Conference on Financing for Development

Governments aiming to build resilience in line with this global framework need to continually re-learn and retool disaster risk reduction to meet new challenges, such as climate change, as well as new mandates, such as the SDG requirement to ‘leave no one behind’.

For this purpose, there is an abundance of tools and approaches. Some are already proven; others are emerging. Many are driven by technological advances in risk assessment, communication, and financing. But these science-based approaches need to be customized to national and local needs and should be sensitive to the differing circumstances of poor communities. The overall strategy should be to:

Make SDG implementation plans risk informed – Governments will need to assess the current risks, and the gaps in disaster risk reduction, with data disaggregated by gender, age, and income as well as by other social groups – capturing the complexities of the dynamic process of risk generation and accumulation over time. Another essential requirement is the establishment of multi-stakeholder platforms to gather and synthesize risk information and to translate it into risk reduction measures. A useful model has been demonstrated by national monsoon outlook forums.

Address the risks faced by different poor populations – Leave no one behind means identifying the specific vulnerabilities of poor countries and communities. Several countries in the region are moving towards ‘impact-based’ forecasting – which combines hazard forecasts with data on risk to highlight how people in hazard exposed and marginal areas could be affected. The potential impacts to affected populations then need to be communicated. In rural areas, this

can be part of agriculture extension systems – delivering weather and information along with a bundle of other advisory, financial, market, and rural extension services.

Strengthen risk governance at all levels – National strategic plans of action for disaster risk management need to be revised and aligned with the Sendai and other global frameworks and extended to the local level. Resilience is a cross-cutting issue and needs stronger political commitment and bureaucratic drive if it is to be extended across multiple disciplines and sectors.

Invest in disaster risk reduction – Policy makers often fail to appreciate the economic value of disaster risk reduction. Globally, disaster risk reduction interventions have an estimated rate of return of between four and seven times. On this basis, to reduce the average annual loss for Asia and the Pacific of \$160 billion by 10 per cent by 2030 the average annual investment required would be between \$2.3 billion and \$4.0 billion. In the case of reducing risks from seismic hazards in urban areas, for example, it may not be feasible to engaged in demolition and reconstruction, but there are affordable forms of retrofitting. Just as important, all new projects should be disaster resistant not only in their structural components, but also in their impacts on society, livelihoods and the environment.

Manage the fiscal burden of disasters – Asia-Pacific developing economies typically struggle to finance reconstruction and relief and the already limited insurance penetration has not kept pace with economic growth. This can be offset to a certain extent by international aid. One option is forecast-based aid financing. When a disaster has been forecast beyond an agreed threshold of probability, funds are released for disaster preparedness and response as well as for building resilience. Governments and other actors have also considered ways of sharing risks – both within and between countries. Key risk-transfer instruments include: financial insurance, micro-insurance, and micro-financing, investment in social capital, government disaster reserve funds, and intergovernmental risk sharing. For individual farmers, for example, a useful option is parametric, weather-index insurance.

Monitor progress in resilience-building – Traditional statistics for disaster risk reduction can be complemented with earth observation data and geospatial information. However, taking advantage of these new data sources needs investments in staff training and in systems for integrating geospatial, and earth observation data and ensuring interoperability. Advances in technology or technical human capabilities will only deliver their potential as part of integrated systems that align the flow of information with the shifting needs and demands of users.

ACTION FOR REGIONAL COOPERATION

Resilience can be facilitated and strengthened through international and regional cooperation. ESCAP member countries can ensure that populations and countries with low capacity can make use of technologies through partnerships and regional cooperation. There can also be measures at the regional level. Countries can reduce variability in food availability through food reserves and trade schemes. Asia and the Pacific can take advantage of its strength as a hub for knowledge and technologies. There have been initiatives, for example, to provide timely information for slow-onset disasters – such as forest fires, haze, droughts, floods, and cyclones.

Actions include:

Regional early warning systems – Joint action is needed to improve warning systems for shared hazards that cut across national borders. ESCAP and WMO have established the Typhoon Committee and the Panel on Tropical Cyclones. There are also options for other hazards such as transboundary river-basin floods, flash floods and landslides. The costs of warning systems vary greatly among countries, each of which will need affordable and practical solutions. A major concern is sustaining the necessary funding, so it is important to emphasize the benefits of investing in a regional ‘public good’. On average, over the next century the Indian Ocean Tsunami Warning System will save at least 1,000 lives per year. Countries can also work together to exchange experience and technical assistance – improving inundation maps and warning chains, for example, and developing evacuation plans.

Sharing data and knowledge – If countries are to take advantage of space applications they will need better access to information and knowledge. To achieve this, ESCAP’s Regional Space Applications Programme for Sustainable Development in Asia and the Pacific (RESAP) supports low-capacity, high-risk countries. One of the flagship programmes is the Regional Drought Mechanism. Another regional programme for enhancing access to space-based data is SERVIR which provides satellite-based earth observation data through the International Centre for Integrated Mountain Development and the Asian Disaster Preparedness Center.

Building regional capacity – It is now possible to provide climate forecasts for three to six months in advance and integrate these into early warning systems. For this purpose, ESCAP Trust Fund on Tsunami, Disaster and Climate Preparedness has been an effective vehicle for supporting regional cooperation and sharing of data, tools and expertise to support disaster resilience in high-risk, low capacity countries of Asia-Pacific. ESCAP has also recently established the Asian and Pacific Centre for the Development of Disaster Information Management to provide member countries with advisory services and technical cooperation on transboundary disasters such as earthquakes, droughts and sand and dust storms.

REINFORCING THE FUTURE

Disasters may not be completely predictable, but they can be anticipated. Governments across Asia and the Pacific now have a greater understanding of how natural disasters unfold – exposing weaknesses in physical and social infrastructure and striking hardest at the poorest.

In response, governments have established the necessary policy frameworks. And scientific advances have enhanced tools for more effective action. But building resilience is not a job for the public sector alone, it must involve multiple stakeholders, from the private sector and civil society, to regional and international organizations. This requires ‘whole-of-government’ and ‘all-of-society’ engagements – to build more resilient structures and societies for current and future generations. This will be an essential basis for achieving the Sustainable Development Goals – for extending the benefits of human progress to everyone, with a resolute determination to leave no one behind.

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EXPLANATORY NOTES

Analyses in the *Asia-Pacific Disaster Report 2017* are based on data and information available up to the end of July 2017.

The Asia-Pacific region, unless otherwise specified, refers to the group of ESCAP members and associate members that are within the Asia and the Pacific geographic region. Groupings of countries and territories/areas referred to in the present edition of the Report are defined as follows:

- **ESCAP region:** Afghanistan; American Samoa; Armenia; Australia; Azerbaijan; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; Cook Islands; Democratic People's Republic of Korea; Fiji; French Polynesia; Georgia; Guam; Hong Kong, China; India; Indonesia; Iran (Islamic Republic of); Japan; Kazakhstan; Kiribati; Kyrgyzstan; Lao People's Democratic Republic; Macao, China; Malaysia; Maldives; Marshall Islands; Micronesia (Federated States of); Mongolia; Myanmar; Nauru; Nepal; New Caledonia; New Zealand; Niue; Northern Mariana Islands; Pakistan; Palau; Papua New Guinea; Philippines; Republic of Korea; Russian Federation; Samoa; Singapore; Solomon Islands; Sri Lanka; Tajikistan; Thailand; Timor-Leste; Tonga; Turkey; Turkmenistan; Tuvalu; Uzbekistan; Vanuatu; and Viet Nam
- **East and North-East Asia:** China; Democratic People's Republic of Korea; Hong Kong, China; Japan; Macao, China; Mongolia and Republic of Korea
- **North and Central Asia:** Armenia; Azerbaijan; Georgia; Kazakhstan; Kyrgyzstan; Russian Federation; Tajikistan; Turkmenistan and Uzbekistan
- **Pacific:** American Samoa; Australia; Cook Islands; Fiji; French Polynesia; Guam; Kiribati; Marshall Islands; Micronesia (Federated States of); Nauru; New Caledonia; New Zealand; Niue; Northern Marina Islands; Palau; Papua New Guinea; Samoa; Solomon Islands; Tonga; Tuvalu and Vanuatu
- **South and South-West Asia:** Afghanistan; Bangladesh; Bhutan; India; Iran (Islamic Republic of); Maldives; Nepal; Pakistan; Sri Lanka and Turkey
- **South-East Asia:** Brunei Darussalam; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Timor-Leste and Viet Nam

Developing ESCAP region: ESCAP region excluding Australia; Japan and New Zealand

Developed ESCAP region: Australia; Japan and New Zealand

Countries with Special Needs

- Least developed countries: Afghanistan; Bangladesh; Bhutan; Cambodia; Kiribati; Lao People's Democratic Republic; Myanmar; Nepal; Solomon Islands; Timor-Leste; Tuvalu and Vanuatu. Samoa was part of the least developed countries prior to its graduation in 2014
- Landlocked developing countries: Afghanistan; Armenia; Azerbaijan; Bhutan; Kazakhstan;

Kyrgyzstan; Lao People's Democratic Republic; Mongolia; Nepal; Tajikistan; Turkmenistan and Uzbekistan

- Small island developing States: Cook Islands; Fiji; Kiribati; Maldives; Marshall Islands; Micronesia (Federated States of); Nauru; Niue; Palau; Papua New Guinea; Samoa; Solomon Islands; Timor-Leste; Tonga; Tuvalu and Vanuatu

ECONOMIC CLASSIFICATIONS AND GROUPINGS

The classification of countries into income groups is from the World Bank. The World Bank divides countries according to their 2015 gross national income per capita, calculated using the World Bank Atlas method. Group classifications are: low income (\$1,025 or less), lower-middle income (\$1,026– \$4,035), upper-middle income (\$4,036–\$12,475) and high income (\$12,476 or more).

- **Low-income economies:** Afghanistan; Democratic People's Republic of Korea; Nepal.
- **Lower middle-income economies:** Armenia; Bangladesh; Bhutan; Cambodia; India; Indonesia; Kiribati; Kyrgyzstan; Lao People's Democratic Republic; Federated States of Micronesia; Mongolia; Myanmar; Pakistan; Papua New Guinea; Philippines; Samoa; Solomon Islands; Sri Lanka; Tajikistan; Timor-Leste; Tonga, Uzbekistan; Vanuatu; Viet Nam.
- **Upper-middle-income economies:** American Samoa; Azerbaijan; China; Fiji; Georgia; Iran (Islamic Republic of); Kazakhstan; Malaysia; Maldives; Marshall Islands; Palau; Russian Federation; Thailand; Turkey; Turkmenistan; Tuvalu.
- **High-income economies:** Australia; Brunei Darussalam; French Polynesia; Guam; Hong Kong, China; Japan; Macao, China; Nauru; New Caledonia; New Zealand; Northern Mariana Islands; Republic of Korea; Singapore.

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References to dollars (\$) are to United States dollars, unless otherwise stated.

The term "billion" signifies a thousand million. The term "trillion" signifies a million million.

In the tables, two dots (..) indicate that data are not available or are not separately reported; a dash (-) indicates that the amount is nil or negligible; and a blank indicates that the item is not applicable.

In dates, a hyphen (-) is used to signify the full period involved, including the beginning and end years, and a stroke (/) indicates a crop year, fiscal year or plan year.

ABBREVIATIONS

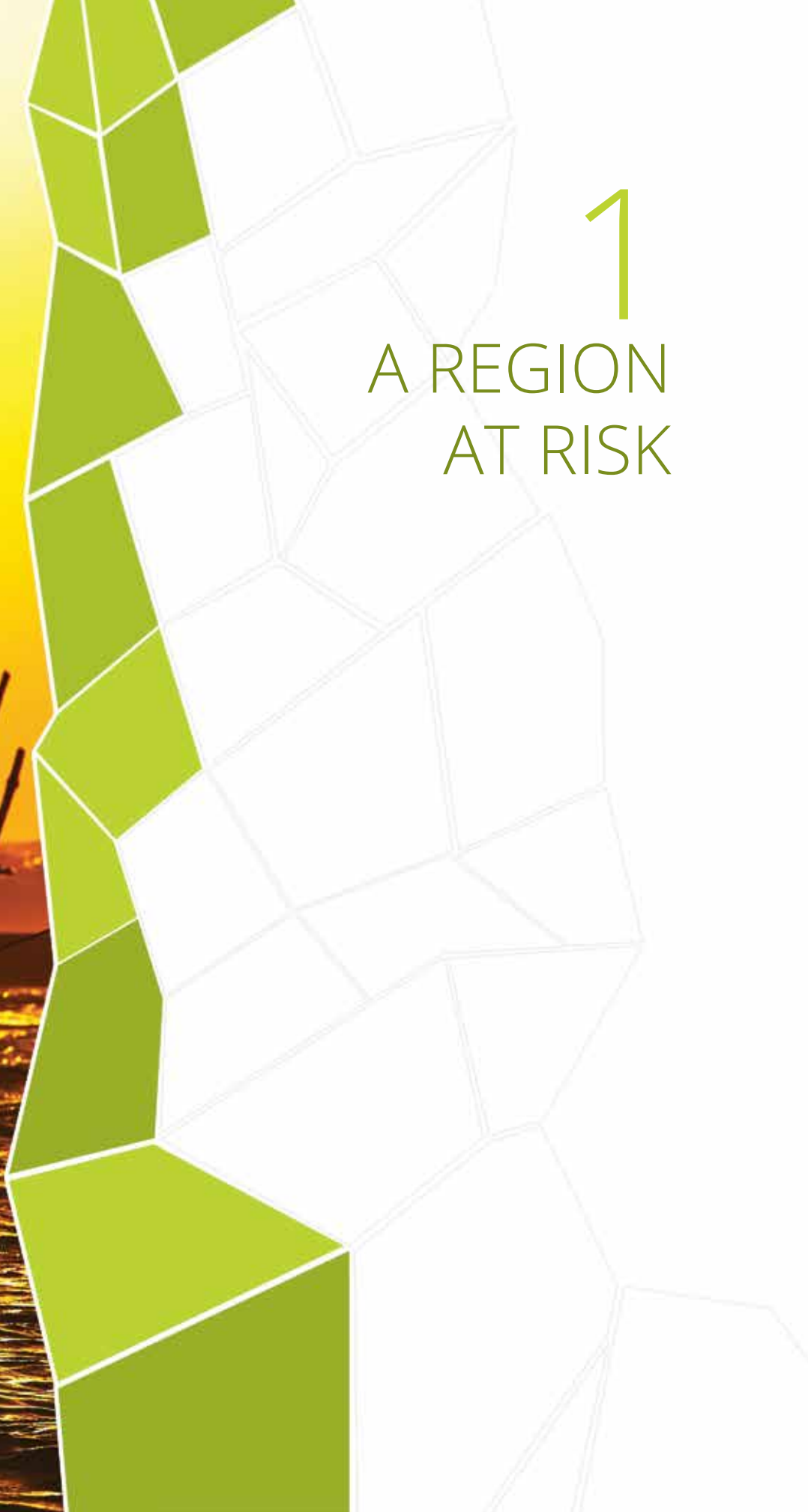
AAAA	Addis Ababa Action Agenda
AAL	Annual Average Loss
ABA	Area Based Approaches
ACCCRN	Asian Cities Climate Change Resilience Network
ADB	Asian Development Bank Institute
ADPC	Asian Disaster Preparedness Center
AOGCMs	Atmosphere-Ocean General Circulation Models
APDIM	Asian and Pacific Centre for the Development of Disaster Information Management
Aqua-MODIS	Aqua - Moderate Resolution Imaging Spectroradiometer
ARISE	ASEAN Regional Integration Support from the EU
ASI	Agriculture Stress Index
AWS	Automatic Weather Stations
AVHRR	Advanced very-high-resolution radiometer
BHRC	Building and Housing Research Center
BWDB	Bangladesh Water Development Board
CCA	Climate Change Adaptation
CDAAS	Climate Data Access and Analysis System
CERF	The United Nations Central Emergency Response Fund
CFAB	Climate Forecast Application in Bangladesh
CLIVAR	Climate and Ocean: Variability, Predictability and Change
CMIP	Coupled Model Inter-Comparison Project
CORDEX	Coordinate Regional Downscaling Experiment
CRED	Centre for Research on the Epidemiology of Disasters
CREWS	Climate Risk and Early Warning System
CRIV	CREF Index for Risk and Vulnerability
CSN	Countries with Special Needs
DDPM	Department of Disaster Prevention and Mitigation (Thailand)
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DWR	Doppler Weather Radar
ECMWF	The European Centre for Medium-Range Weather Forecasts
EM-DAT	Emergency Events Database
ENSO	El Niño-Southern Oscillation

EPS	Ensemble Prediction System
ESA	European Space Agency
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCP	Eastern Solent Coastal Partnership
EU	European Union
EWS	Early Warning System
FAO	Food and Agriculture Organization of the United Nations
FFWC	Flood Forecasting and Warning Center
FRDP	Framework for Resilient Development in the Pacific
FSC	Food Security Cluster
GAR	Global Assessment Report
GCM	General Circulation Models
GDDP	Global Daily Downscaled Projections
GDP	Gross domestic product
GED	General Education Development
GFCs	Global Framework For Climate Services
GFDRR	Global Facility for Disaster Reduction and Recovery
GISTDA	Geo-Informatics and Space Technology Development Agency
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GHG	Greenhouse gas
HDI	Human Development Index
IBFI	Index Based Flood Insurance
ICIMOD	The International Centre for Integrated Mountain Development
ICLEI	International Council for Local Environmental Initiatives
ICRC	International Committee of Red Cross and Red Crescent
ICT	Information and Communication Technology
IDMC	Internal Displacement Monitoring Centre
IDP	Internally Displaced People
IFPRI	International Food Policy Research Institute
INFORM	Index for Risk Management
IOTWMS	Indian Ocean Tsunami Warning and Mitigation System
IPCC	Intergovernmental Panel on Climate Change
IWMI	The International Water Management Institute
JRC	Joint Research Center
LDC	Least Developed Countries
LECZ	Low Elevation Coastal Zones
LiDAR	Light Detection and Ranging
LISS	Linear Imaging Self-Scanning Sensor

LLDC	Landlocked Developing Countries
MMI	Modified Mercalli Intensity
MODIS	The moderate-resolution imaging spectroradiometer
MunichRe	Munich Reinsurance Company
NatCatSERVICE	Natural catastrophe statistics online
NAPA	National Adaptation Plans of Action
NASA-SeaWiFS	National Aeronautics and Space Administration - Sea-viewing Wide Field-of-view Sensor
NCOF	National Climate Outlook Forum
NDGC	National Geophysical Data Center
NDMA	National Disaster Management Authority
NEX	NASA Earth Exchange
NMHSs	National Meteorological and Hydrological Services
NOAA	The National Oceanic and Atmospheric Administration
NREGA	National Rural Employment Guarantee Act
NWP	Numerical Weather Prediction
OECD	Organization for Economic Co-operation and Development
OCHA	The United Nations Office for the Coordination of Humanitarian Affairs
OCM	Ocean Color Monitor
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OFDA	Office of United States Foreign Disaster Assistance
PDMA	Provincial Disaster Management Authority
PDNA	Post Disaster Needs Assessment
PDSI	Palmer Drought Severity Index
PML	Probable Maximum loss
PTC	Panel on Tropical Typhoons
PWD	People with disabilities
RCOFs	Regional Climate Outlook Forums
RCP	Representative Concentration Pathways
RECI	Regional Economic Cooperation and Integration
RESAP	Regional Space Applications Programme for Sustainable Development
RIMES	Regional Integrated Multi Hazard Early Warning System for Africa and Asia
SAR	Synthetic Aperture Radar
SDGs	Sustainable Development Goals
SEZ	Special Economic Zones
SIDS	Small Island Developing States
SPOT	Satellite Pour l'Observation de la Terre (Satellite for Observation of Earth)

SSOP	Synergized Standard Operating Procedures
SST	Sea Surface Temperatures
TC	Typhoon Committee
TOPS	Terrestrial Observation and Prediction System
UCDP	Uppsala Conflict Data Program
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNISDR	United Nations Office for Disaster Risk Reduction
UNU-EHS	United Nations University Institute for Environment and Human Security
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WCRP	World Climate Research Program
WDS	World Data Service
WFP	World Food Program
WHO	World Health Organization
WII	Weather Index Insurance
WMO	World Meteorological Organization
WRI	World Resource Institute





1

A REGION
AT RISK

A REGION AT RISK

Asia and the Pacific is the region most affected by natural disasters. The greatest losses of life and economic impacts are in the most populous countries, but proportionately the economic impacts are greatest in the least developed countries and small island developing States.

For the last several decades, the Asia-Pacific region has experienced the greatest human and economic impacts reported from natural disasters. This partly corresponds to its size – Asia and the Pacific has 60 per cent of the world's people and 40 per cent of the landmass, as well as 36 per cent of global GDP.¹ But even taking the region's size into account, a person living in Asia and the Pacific is much more likely to be affected by natural disasters.²

By historical standards, 2016 witnessed relatively lower disaster impacts, but disasters still took their toll – killing 4,987 people, affecting 34.5 million people and causing estimated damage of about \$77 billion (Table 1-1). The greatest loss of life was through flooding, which caused 3,250 deaths – in Bangladesh, China, Democratic People's Republic of Korea, India, Nepal, Pakistan, and Sri Lanka. But droughts also affected 13.4 million people, primarily in China and Cambodia, including many people who suffered from El Niño-induced droughts in Indonesia, Mongolia, Timor-Leste, Viet Nam, and in Papua New Guinea, other Pacific island countries.

Major disasters in 2016 and 2017 included:

Afghanistan – In February 2017, avalanches, snowfall and rain-related disasters caused significant damage to homes and livelihoods in 22 out of 34 provinces.³

China – In August 2017, typhoon Hato battered Hong Kong, China; Macao, China; and southern China, severely damaging houses and farmland.

Fiji – Tropical cyclone Winston, a category 5 cyclone, struck Fiji in February 2016. Approximately, 540,400 people were impacted – 62 per cent of the population.⁴

Mongolia – In 2016-17, a dzud (summer drought followed by severe winter) affected more than 157,000 people across 17 of 21 provinces.⁵

Philippines – In February 2017, a 6.7 magnitude earthquake affected over 53,000 people.⁶

Sri Lanka – In September–October 2016, around 1.2 million people were affected by drought in 17 of 25 districts.⁷

Viet Nam – The country had the worst drought for 90 years; here, as elsewhere, induced or exacerbated by the recent El Niño phenomena.⁸

South Asia – In June 2017, torrential monsoon rains led to floods and landslides in Bangladesh, India and Nepal, killing over 900 people and affecting almost 41 million people (Box 1-1).⁹

The events in 2016 fit into a broader historical sequence over the past half century. The most

Table 1-1

Disaster impacts in Asia and the Pacific, 2016

	Lives lost	People affected	Estimated damage (million \$, current)
Floods	3,250	13,785,307	35,846
Storms	880	6,345,793	11,409
Droughts	-	13,381,000	3,000
Extreme temperature	336	158,100	1,727
Earthquakes	198	613,022	24,407
Others	323	240,480	835
Total	4,987	34,523,702	77,223

Source: EM-DAT: The OFDA/CRED International Disaster Database. (Accessed on 4 July 2017)

Box 1-1

Floods and landslides in South Asia, June 2017

In South Asia, many of the region’s vulnerable people live in the vast agrarian belts along the Indus, Ganges, Brahmaputra-Meghna basins which are subject to periods of widespread and seasonal flooding. Monsoon variabilities, El Niño and La Niña, and other extreme weather events often result in large-scale flooding, which has significant impacts, especially on the poor and vulnerable populations who depend on subsistence agriculture.

In June 2017, torrential monsoon rains triggered floods and landslides in Bangladesh, India and Nepal. This killed more than 900 people, and affected 41 million people. Many areas became inaccessible due to damage to roads, bridges, railways and airports.

	Bangladesh	India	Nepal
Deaths	114	Over 600	143
People affected	6.9 million	32.1 million	461,000
Areas affected	31 out of 64 districts	4 states (Bihar, West Bengal, Uttar Pradesh, Assam)	35 out of 75 districts

Source: Relief Web (2017).

significant, in terms of fatalities and economic impacts, are summarized in Figure 1-1. Disasters that affected the region over this period included:

Cyclones – In 1970, cyclone Bhola devastated Bangladesh, with more than 300,000 fatalities.

In 2008, cyclone Nargis hit Myanmar, and in 2013 typhoon Haiyan struck the Philippines.

Earthquakes and tsunamis – In 1976, the Tangshan earthquake hit China, killing 242,000 people. In 2004, the Indian Ocean

Figure 1-1

Selected major disasters in Asia and the Pacific, 1970-2016



Source: Based on data from EM-DAT. (Accessed on 4 July 2017)

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

tsunami devastated many countries in Asia and Africa. Indonesia alone reported about 165,000 fatalities. In 2011, the Japan earthquake and tsunami caused the largest disaster-related economic loss in human history.¹⁰ Major earthquakes were also reported in the Islamic Republic of Iran (Manjil-Rudbar in 1990), Turkey (Izmit in 1999), India (Gujarat in 2001), Pakistan (Kashmir in 2005), China (Sichuan in 2008), and Nepal (Ghorka in 2015).

Floods – In 1995, Democratic People’s Republic of Korea witnessed devastating floods from torrential rain, which left over 100,000 families homeless.¹¹ In 2011, floods widely affected Thailand, with huge economic losses not only for Thailand but also for its economic partners in the region and around the world.

The human and economic cost

Since 1970, natural disasters in Asia and the Pacific have killed two million people – contributing 57 per cent of the global death toll. On average, the number of people killed annually was 43,000, though the number fluctuated considerably from year to year. As indicated in Figure 1-2, the principal causes of natural disaster deaths were earthquakes and storms, followed by floods. In the rest of the world the pattern was different: the death toll was lower and the principal killer was drought, followed by earthquakes. Epidemics were also more significant, as a result of cholera, malaria, and meningococcal meningitis as well as the Ebola outbreak in 2014.

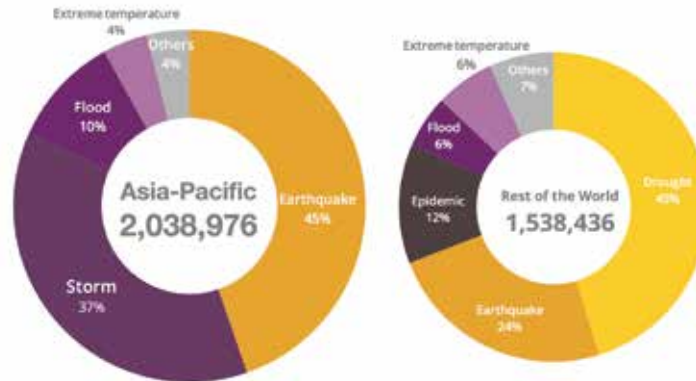
In addition to the large number of people who have lost their lives, millions more have been

affected. Affected refers to “people requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance”.¹² Asia and the Pacific, though having around 60 per cent of the global population had 88 per cent of the people affected (Figure 1-3).

This imbalance is largely a consequence of the region’s floods, droughts and storms. These affected around 6.3 billion people in Asia and the Pacific since 1970, while the rest of the world reported less than 0.9 billion people affected by these hazards. In particular, droughts affected almost 2 billion people in the Asia-Pacific region, but this did not lead to huge loss of life. In comparison, the rest of the world witnessed around half a billion people affected by droughts, which also resulted in a huge number of fatalities, especially in African countries where many people suffered from food insecurity.¹³

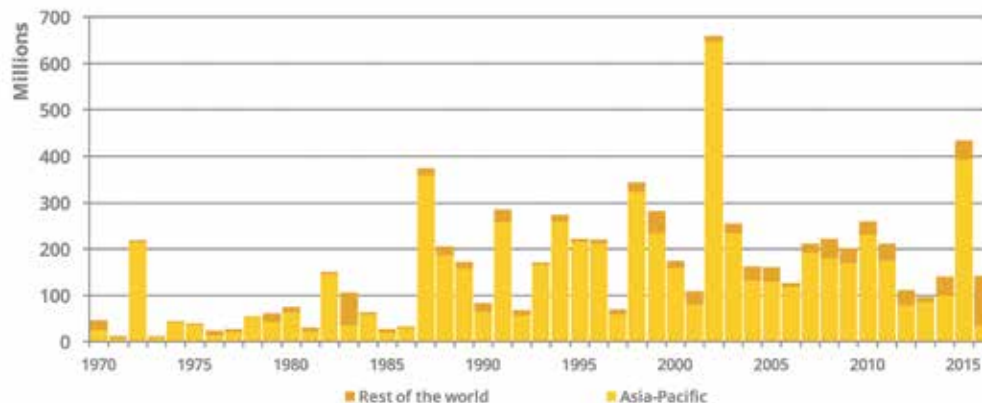
Indeed, since 1970 a person living in the Asia-Pacific region has been approximately five times more likely to be affected by natural disasters than a person living outside the region.

Figure 1-2
Fatalities from natural disasters, 1970–2016



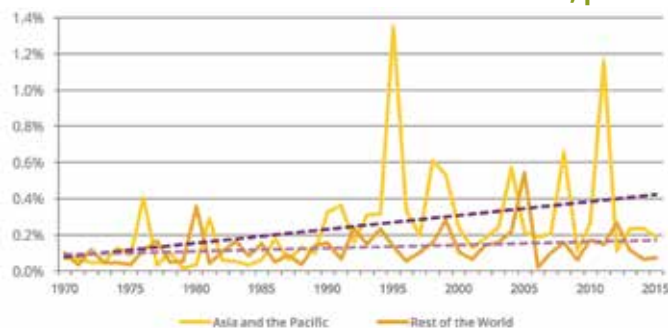
Note: From 1990, includes data from countries of the former Soviet Union.
Source: Based on data from EM-DAT. (Accessed on 4 July 2017)

Figure 1-3
People affected by natural disasters, millions, 1970–2016



Source: Based on data from EM-DAT. (Accessed on 4 July 2017)

Figure 1- 4

Estimated damage, Asia and the Pacific and the rest of the world, percentage of GDP, 1970-2016

Source: Based on damage data from EM-DAT. (Accessed on 4 July 2017) GDP data from ESCAP online statistical database.

Disasters also cause large-scale damage. Between 1970 and 2016, the region lost \$1.3 trillion.¹⁴ Almost all of this was the result of floods, storms, droughts and earthquakes including tsunamis. Such damage has been rising. This is partly because as GDP increases there are more physical assets at risk. However, disaster impacts have been outpacing the region's economic growth – rising as a proportion of GDP, from around 0.1 per cent in the 1970s to about 0.4 per cent in recent decades (Figure 1-4). The estimated damage fluctuates from year to year according to the nature and impact of disasters, but the trend is clear: disasters cause more damage in Asia and the Pacific than in the rest of the world, and this gap has been widening. The region's rapid economic growth has increased the exposure of people and assets to natural hazards, thereby increasing disaster risks.

Disruption to livelihoods of the vulnerable

Disasters can have complex and deeply disruptive effects on livelihoods – further disadvantaging those who are already in a vulnerable situation. Some of these are explored further in later chapters of this report.

Disasters displace many people, increasing socio-economic vulnerabilities. Between 2013 and 2015, for example, globally natural disasters

displaced 60.4 million people, of whom 52.7 million were in Asia and the Pacific. The largest numbers were in Philippines (15 million), China (13.1 million), and India (9.2 million), followed by Nepal, Bangladesh, Pakistan and Myanmar (Figure 1-5).

In many disasters, a high proportion of the victims are women and girls – who face disadvantages, institutional and socio-economic, with regard to disaster risk reduction policies and initiatives. As UN Women has explained, this imbalance in Asia and the Pacific is linked to gender roles.¹⁵ Women and girls often have limited access to information, financial services, land and property rights, health and education – structural disadvantages that reduce their resilience to disasters. In the 2004 tsunami in Aceh Indonesia, for example, 77 per cent of the deaths were of women. During earthquakes and tsunamis, women and girls are more likely to be at home in poorly constructed houses, while men are working in open spaces, or in stronger buildings such as offices. Women are also less likely to learn to swim or climb trees, or to receive disaster early warning information.

Typically, the greatest impacts are the poorest countries which have less capacity to prepare for, or respond to, their high disaster risks. These include the least developed countries (LDCs), the landlocked developing countries (LLDCs)

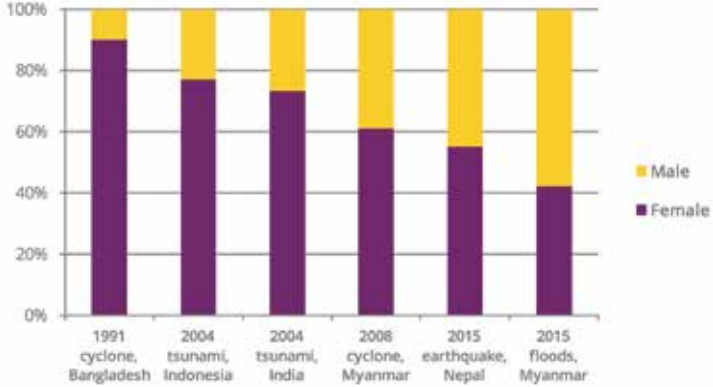
Figure 1-5

New displacements associated with natural disasters, 2013-2015



Data source: IDMC, 2017
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 1-6
Mortality distribution, by sex, selected disasters



Source: UNWomen, 2016.

and the small island developing States (SIDS). As a group, these are classified as countries with special needs (CSNs). Most exposed have been the SIDS which since 2000 have suffered damage from disasters of over 1 per cent of GDP, compared with 0.4 per cent for non-CSN countries (Figure 1-7).

These are countries with small populations and economies, and their vulnerability frequently

goes unrecognized. In future, however, the global agenda for sustainable development, which is based on the principle of leaving no one behind, will now be focusing on these countries and aiming to boost their resilience. Furthermore, many countries at high risk still lack capacities to absorb and manage disaster risks. According to the World Risk Report 2016, eight of the 10 countries at greatest disaster risk in Asia and the Pacific, had low coping capacity

(Table 1-2). The two exceptions were Japan and Brunei Darussalam. Even when countries have capacities to forecast and warn citizens of potential disasters, their capabilities can be overwhelmed by the scale and intensity of the event.

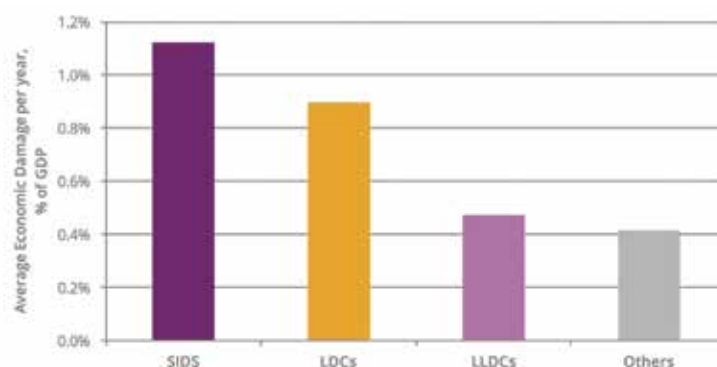
This was the case in Nepal for the Gorkha earthquake, in the Philippines for typhoon Haiyan (known locally as Yolanda), and even to some extent in Japan for the 2011 earthquake and tsunami. A common refrain after those events was that ‘we were prepared, but not for something like this’.

Subregional disaster risks

The Asia-Pacific region encompasses a vast geographical area – from the Russian Federation in the North, Australia and New Zealand in the South, Turkey in the West, to Japan and the Pacific SIDS in the East. Each subregion has its own vulnerabilities and hazards. As indicated in the estimates in Figure 1-8, over the period 2000–2016, most of the damage was in East and North-East Asia, while a high proportion of the fatalities were in South-East Asia.

Figure 1-7

Average estimated damage in countries with special needs, 2000-2016 (percentage of GDP)



Source: Based on damage data from EM-DAT. GDP data from ESCAP online statistical database.

Table 1-2

Exposure and coping capacity, Asia-Pacific countries at greatest risk

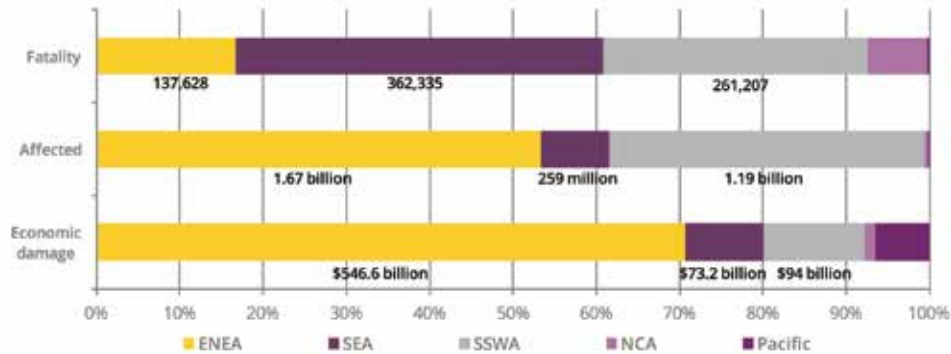
Country	Exposure (%)		Coping Capacities
Vanuatu	64	Very High	Low
Tonga	55	Very High	Low
Philippines	53	Very High	Low
Japan	46	Very High	Very High
Brunei Darussalam	41	Very High	High
Bangladesh	32	Very High	Very Low
Solomon Islands	30	Very High	Very Low
Fiji	28	Very High	Low
Cambodia	28	Very High	Very Low
Timor-Leste	26	Very High	Low

Note: Exposure refers to entities (population, conditions of built-up areas, infrastructure component, environmental area) being exposed to the impacts of one or more natural hazards.

Source: Based on Alliance Development Works & UNU-EHS (2016) World Risk Report 2016, p64.

Figure 1-8

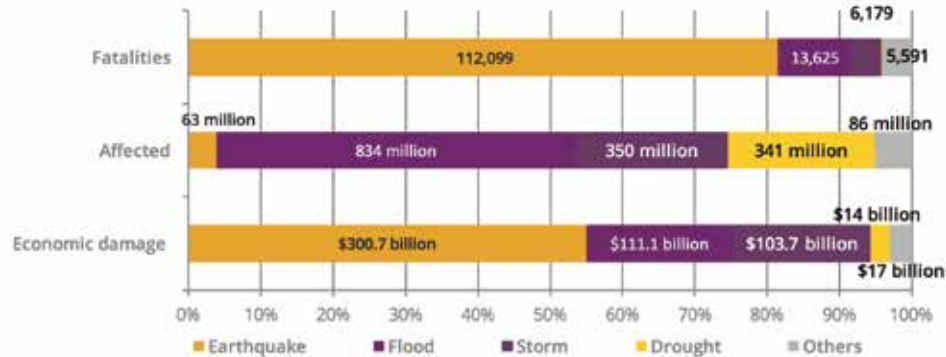
Disaster impacts by subregion, 2000–2016



Source: Based on damage data from EM-DAT.

Figure 1-9

Disaster impacts in East and North-East Asia, 2000–2016



Source: Based on damage data from EM-DAT.

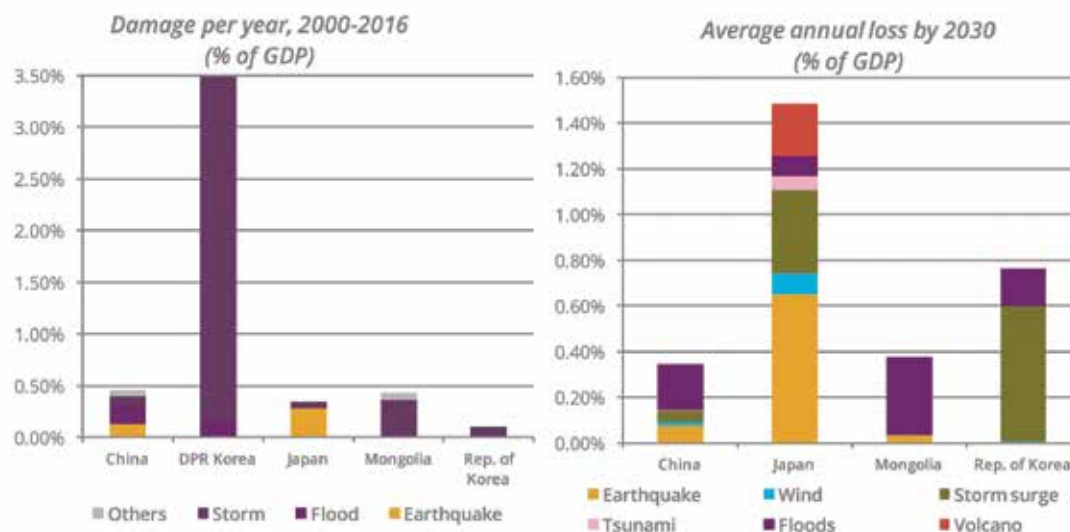
East and North-East Asia

Since 2000, the subregion has lost over 130,000 lives, mainly from earthquakes and tsunamis including the 2008 Sichuan earthquake and the 2011 earthquake and tsunami in Japan (Figure 1-9). During this period, 1.67 billion people were affected by natural disasters, around half from floods. Storms and droughts each affected around 350 million people. In 2016, East and North-East Asia reported 1,900 fatalities, 14 million people were affected and damage reached \$65 billion (in 2016 US dollars) – from earthquakes, floods, storms, droughts, extreme temperatures and landslides.¹⁶

Over the period 2000–2016, this subregion accounted for more than 70 per cent of the total Asia-Pacific estimated damage – \$547 billion. This was mainly due to the exposure of assets in large economies, in particular those of China, Japan and the Republic of Korea – on average they lost 0.35 per cent of GDP. More than half of total estimated damage was from earthquakes.

Since 2000, Democratic People’s Republic of Korea has had the highest estimated damage, with annual damage of close to 3.5 per cent of GDP (Figure 1-10). This was largely a consequence of typhoon Prapiroon in 2000 which cost about \$6.5 billion.¹⁷ China and Japan reported damage of less than 0.5 per cent of GDP.

Figure 1-10

Damage and future estimates in East and North-East Asia

Source: Based on damage data from EM-DAT. GDP data from ESCAP online statistical database. Average annual loss data from UNISDR (2015)

These countries also face significant future risks. By 2030, Japan is expected to lose around 1.5 per cent of its GDP annually, mainly from earthquakes and tropical cyclones. The Republic of Korea is likely to lose around 0.8 per cent of GDP, mostly from tropical cyclones. All four countries will face losses from floods, though there are no estimates available for the Democratic People's Republic of Korea.

Mongolia also faces the risk of a dzud, a severe winter, which in 2009-2010, for example, killed 9.7 million animals and affected large numbers of people.¹⁸ Many were also affected during the 2016-2017 winter season (Box 1-2). In 2005, the World Bank launched an index-based livestock insurance scheme. However, as of 2016, only around 12 per cent of herding households were insured, probably due to the high costs and the vaccination requirements.¹⁹

South-East Asia

Since 2000, the subregion has had 362,000 deaths and 259 million people affected, largely from earthquakes, storms and floods (Figure

1-11). Estimated damage over this period was also mainly from these disasters. In 2016, countries in South-East Asia lost more than 700 lives from natural disasters. Nearly 12 million people were affected, principally by floods, tropical cyclones and droughts, with \$2.1 billion (in 2016 US dollars) in damage. South-East Asia has been the most disaster-prone subregion in terms of fatalities.

The Philippines has around 20 tropical cyclones per year – with serious implications for development.²⁰ The areas affected by typhoon Haiyan in 2013, for example, have not yet fully recovered. Tropical cyclones are less frequent in Myanmar, but can be devastating, as with cyclone Nargis in 2008, which over the period 2000–2016 accounted for most of the estimated damage of over 1.2 per cent of GDP.

Flood risks are widespread in the Mekong river basin, affecting the riparian countries of Cambodia, Thailand and Viet Nam which reported large economic losses. Lao People's Democratic Republic is also expected to have large losses from floods.

Box 1-2

The 2016-2017 dzud in Mongolia

In Mongolia, a severe winter is called a dzud. The 2016–2017 temperatures were lower than normal and there was a thick layer of snow over the grassland used for open grazing. In the affected regions, 6 per cent of livestock died and 157,000 people were affected, including 2,500 pregnant women, 26,000 children under five and 13,000 elderly people who had less access to basic services.²⁹

Herders attempted to sell off their livestock, leading to a 50 per cent drop in meat prices. At the same time prices of essential food items increased by 10 per cent. Accordingly, Mongolia requested \$6.6 million of rapid humanitarian assistance.³⁰

Dzud affected areas



Source: International Federation of Red Cross and Red Crescent Societies, *Mongolia: Severe Winter*, 26 December 2016.
 Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Slow onset disasters like droughts are not well reported (and not included in calculating annual average losses) but they can have considerable impact. In addition, erratic monsoons and El Niño-induced droughts affected most countries in South-East Asia over the period 2015–2017 (Box 1-3). Viet Nam had its worst drought in 90 years, affecting 52 out of 63 provinces with a state of emergency declared in 18, affecting over 2 million people.²¹

South and South-West Asia

This is the least urbanized subregion, with only

around a third of its population living in towns or cities. But it is now experiencing rapid urban population growth – around 2.5 per cent per year over the past decade.²² Rapid urbanization needs to be well managed if it is not to increase disaster risks.

Over the period 2000–2016, the subregion reported more than 260,000 disaster deaths, 70 per cent from earthquakes (Figure 1-13). Estimated damage was \$94 billion, which was mainly from floods. During this period, 1.19 billion people in the subregion were affected.

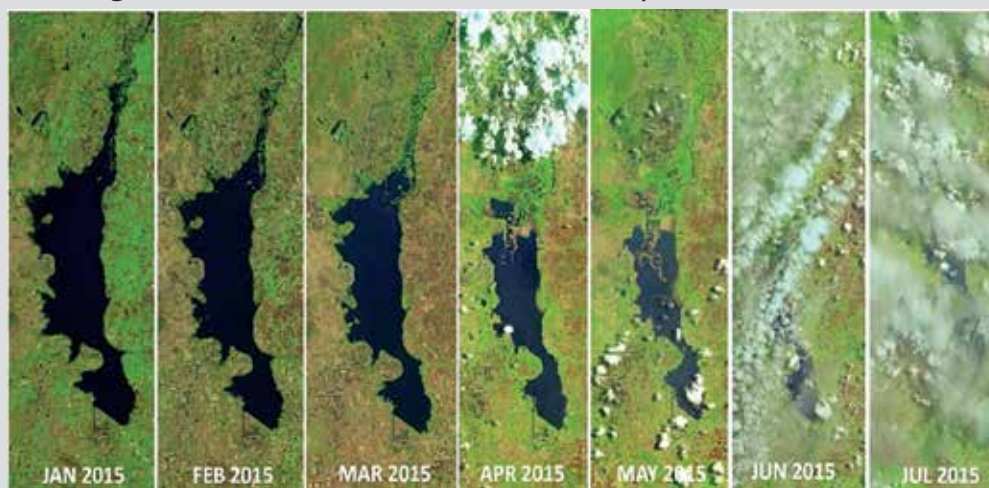
Box 1-3

Impacts of El Niño in South-East Asia and the Pacific

El Niño has had huge socio-economic impacts, leading to severe drought conditions in many parts of the region. In 2014, for example, the Philippines lost around 800,000 tons of rice.³¹ During the El Niño years, 17 of Thailand's reservoirs only had between 1 and 20 per cent of usable storage.³²

The El Niño also provoked outbreaks of disease. In August 2016 in Viet Nam, an increase in dengue fever was reported, particularly in the Central Highlands and in South-Central Viet Nam, requiring \$17 million in emergency assistance.³³ The El Niño also increased the risk of forest fires. In Indonesia in 2015, the toxic haze affected more than 40 million people and caused illness to more than 500,000 people.³⁴

Diminishing water levels in Pasak Chonlasit Dam, Lopburi Province, Thailand, 2015.



El Niño-induced droughts also caused considerable damage in the Pacific. In February 2016, this led to severe food shortages for 4,700 people in Marshall Islands.³⁵ There were also critical water shortages in Micronesia (Federated States of), Palau, and Papua New Guinea. Warmer Pacific water also intensified tropical cyclones. Vanuatu and Fiji were devastated by cyclone Pam in 2015 and cyclone Winston in 2016. In Fiji, subsequent floods washed away up to 80 per cent of replanted crops.³⁶

Source: GISTDA 2015 cited in ESCAP (2016)

Droughts affected 692 million, and floods 428 million. Extreme temperatures resulted in more than 14,000 fatalities. The largest numbers were in Pakistan with 84,000 and India with 75,000. However, there were also many fatalities in Sri Lanka, Nepal and Afghanistan. In 2016 alone, countries in the subregion lost 2,300 lives from 42 natural disasters, with \$4.85 billion (in 2016 US dollars) in damage.

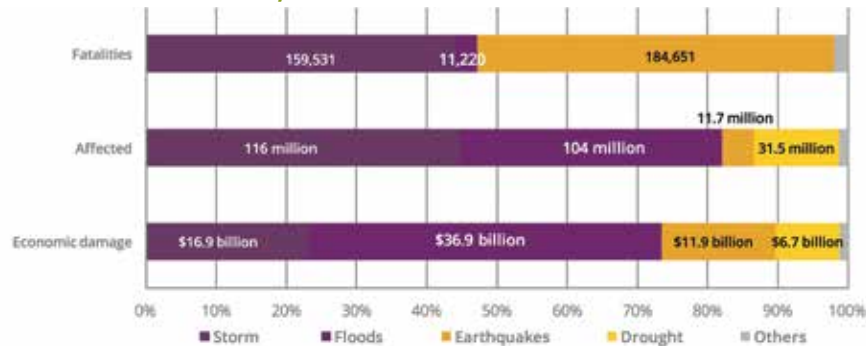
and high overall disaster losses as a proportion of GDP for the subregion's smaller countries.

North and Central Asia

Over the period 2000–2016, in North and Central Asia disasters caused close to 60,000 deaths, almost all from extreme temperature, particularly in the Russian Federation (Box 1- 5). More than 13 million people were affected, and there was \$9.8 billion in estimated damage, mostly from floods and droughts (Figure 1-15). There was also damage from extreme temperature and earthquakes.

In Maldives, Nepal and Sri Lanka, most of the estimated damage was from earthquakes and tsunamis (Figure 1-14). However, by 2030 there are also likely to be high impacts from floods – Figure 1-11

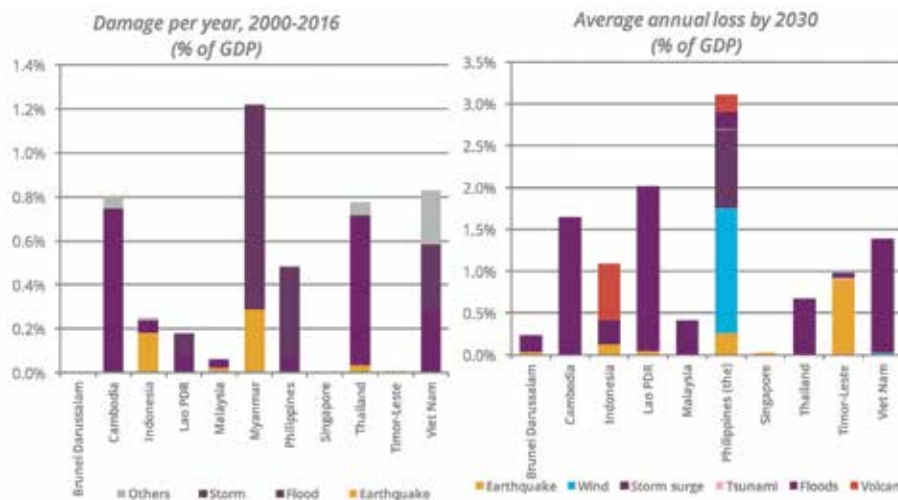
Disaster impacts in South-East Asia, 2000-2016



Source: Based on damage data from EM-DAT.

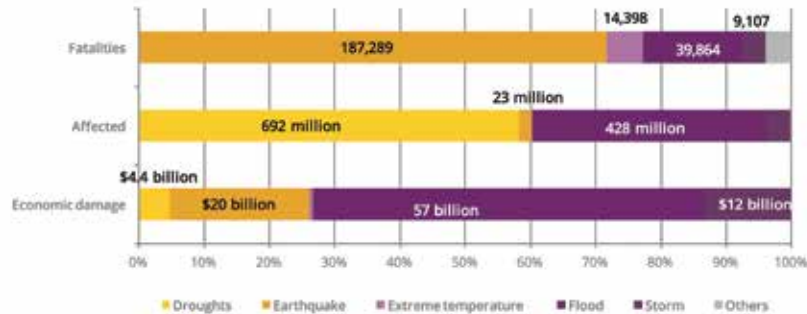
Figure 1-12

Damage and future estimates in South-East Asia



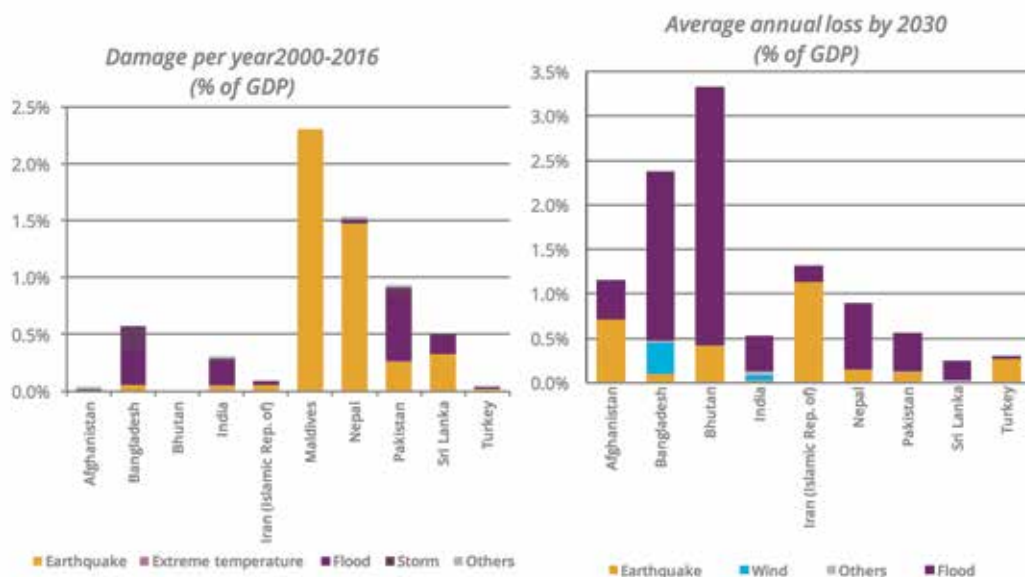
Source: Based on damage data from EM-DAT. GDP data from ESCAP online statistical database. Average annual loss data from UNISDR (2015)

Figure 1-13
Disaster impacts in South and South-West Asia, 2000–2016



Source: Based on damage data from EM-DAT.

Figure 1-14
Damage and future estimates in South and South-West Asian countries



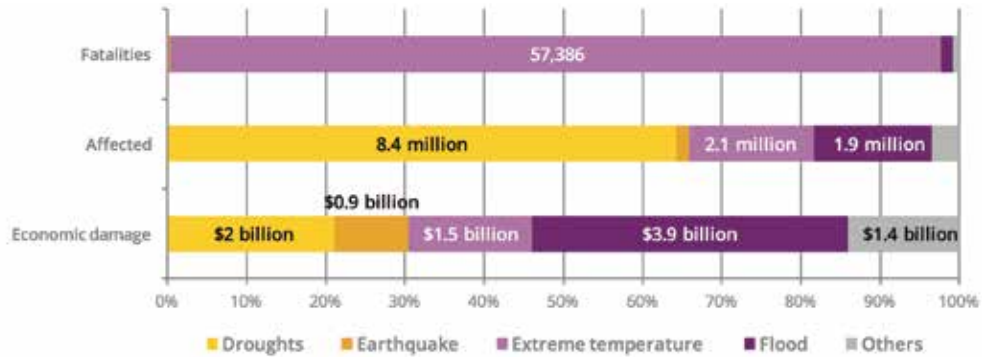
Source: Based on damage data from EM-DAT. GDP data from ESCAP online statistical database. Average annual loss data from UNISDR (2015)

As a percentage of GDP, the highest estimated damage was in Tajikistan, followed by Georgia (Figure 1-16). Armenia, Azerbaijan, Georgia and Tajikistan had widespread droughts.

By 2030, all countries in this subregion are expected to have considerable asset losses from

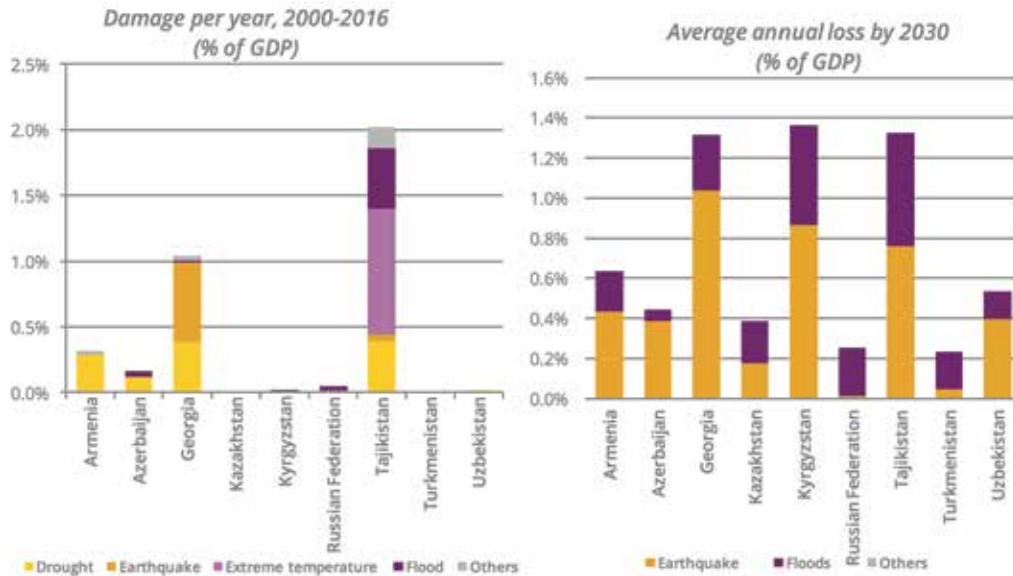
earthquakes and floods: estimated annual losses average more than 1.3 per cent of GDP in Georgia, Kyrgyzstan, and Tajikistan. However, this does not include droughts so the overall impact is likely to be significantly higher.

Figure 1-15
Disaster impacts in North and Central Asia, 2000–2016



Source: Based on damage data from EM-DAT. (Accessed on 4 July 2017)

Figure 1-16
Damage and future estimates in North and Central Asia



Source: Based on damage data from EM-DAT. GDP data from ESCAP online statistical database. Average annual loss data from UNISDR (2015)

Box 1-4

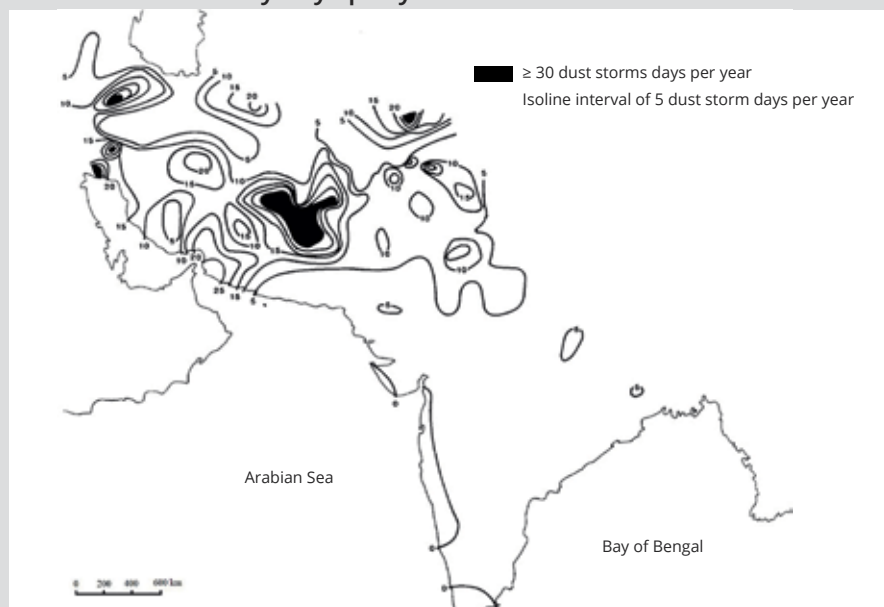
Sand and dust storms

Sand and dust storms (SDS) arise when the speed of wind is high enough to carry soil particles. Recent studies demonstrate that sand and dust storms are changing and expanding, creating new areas and pockets of risk. Many countries in Asia and the Pacific are experiencing severe and, in some cases accelerating, desertification.^{37, 38}

Sand and dust storms have significant impacts on human health, the environment, and economy; inhaling fine particles can cause or aggravate diseases such as asthma, bronchitis, emphysema, and silicosis. Such storms may damage buildings, as well as paralyze airports, communication networks, and power and water supply systems.³⁹ The dust further affects the climate system, possibly changing the earth's radiative balance and modifying tropical cyclones, which intensify droughts. Major effects of sand and dust storms include crop damage, livestock mortality, soil erosion, reduced soil quality, and soil pollution through deposition of pollutants.⁴⁰

Sand and dust storms are widespread across the Asia-Pacific region, particularly in South and South-West Asia. Hotspots include the Sistan Basin in south-eastern Islamic Republic of Iran, south-western Afghanistan and north-western Baluchistan in Pakistan. Sand and dust storms originate within the subregion but some also come from West Asia and North Africa. The impacts are not fully reflected in disaster inventories but they appear to be increasing.

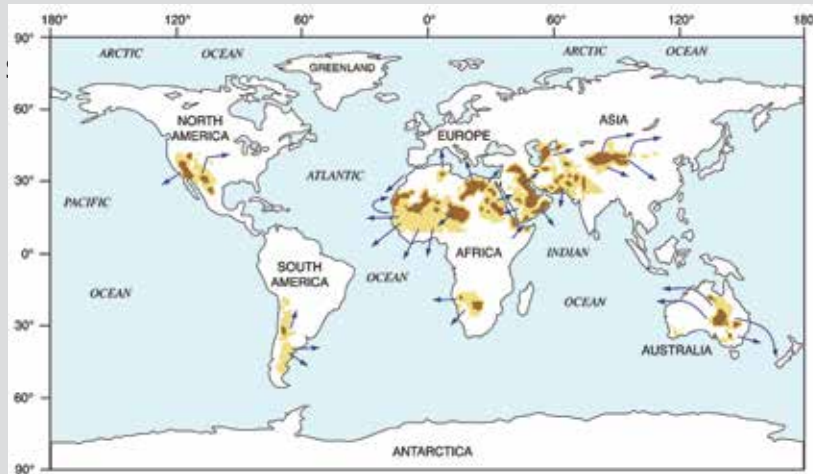
Number of dusty days per year in South and South-West Asia



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

Box 1-4 cont'd

Sand and dust storms



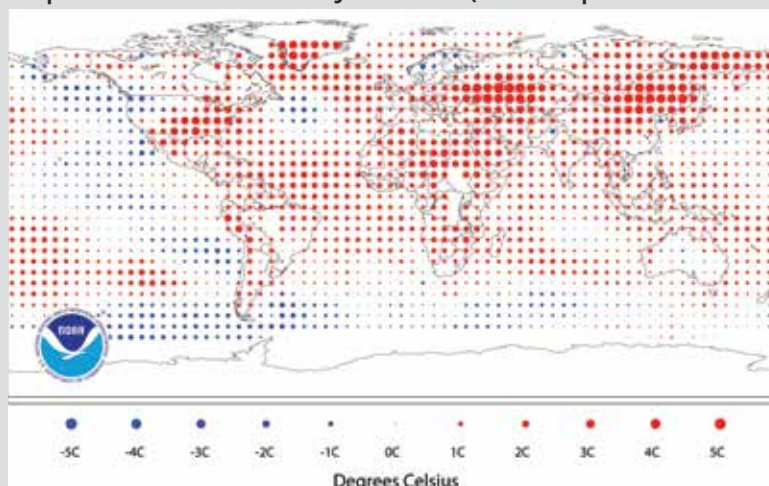
Source: Muhs, D. R., Prospero, J. M., Baddock, M. C., & Gill, T. E. (2014). Identifying Sources of Aeolian Mineral Dust: Present and Past. In J. Stuut, & P. Knippertz (Eds.), *Mineral Dust- A Key Player in The Earth System* (pp. 51-74). Springer.

Box 1-5

Wildfires and extreme temperatures in the Russian Federation

The summer of 2010 was the hottest recorded. The extreme temperature promoted the outbreak of wildfires that started in late July and lasted until early September, costing around \$630 million (19 billion roubles) in damage. The smoke contributed to heavy smog in large urban areas. This, together with the long heat wave and extreme dryness, put pressure on the healthcare system. MunichRe estimated that 56,000 people lost their lives as result of the smog and the heat wave.⁴¹ There were also extreme temperatures and associated wildfires in 2012 and in 2015.

Global temperature anomalies in June 2010 (with respect to 1971-2000 base)



Source: National Climatic Data Center, National Oceanic and Atmospheric Administration. Available at <http://www.noaa.gov/stories2010/images/map-blended-mntp-201006.gif>. (Accessed on 4 August 2017)

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 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.

Pacific

Over the period 2000–2016, the Pacific subregion reported over 2,300 fatalities from various hazards, including tropical cyclones, earthquakes, floods, and extreme temperatures (Figure 1-17). Among the most damaging were tropical cyclones which affected over 1.2 million people with over \$10 billion estimated damage. Earthquakes and floods had considerable impacts. The year 2016 proved perilous: around 490,000 people suffered from tropical cyclones, droughts and earthquakes, with estimated damage of \$5.1 billion (in 2016 US dollars),

largely due to the earthquake in New Zealand which caused damage of \$3.9 billion.²³

Except for Australia, countries in the Pacific subregion recorded significantly higher average damage per year between 2000 and 2016 as a percentage of GDP than countries in other subregions. Vanuatu recorded more than 3.5 per cent of GDP of average damage per year from tropical cyclones, while Samoa and Tonga also recorded over 2 per cent of average damage per year from tropical cyclones and earthquakes (Figure 1-18). Future estimates for average annual loss by 2030 indicate similar outcomes.

Box 1-6

Disaster losses in Fiji

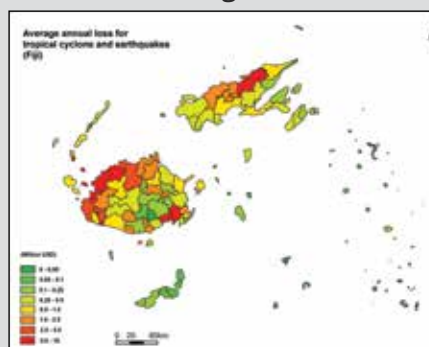
Located in a tropical cyclone belt, Fiji experiences frequent disasters but the impacts vary across the country. This is indicated in the estimated average annual loss. These are greater in the coastal cities, including the capital, Suva, and the north-western cities of the main island, including Nadi and Lautoka, and areas near Labasa.

Cyclone Winston, which struck Fiji in 2016, caused higher losses in cities in the north-western part of the main island. Around one-third of damage and losses were in the Ba district—\$311 million.²⁸ This time, Suva and Labasa were not in the cyclone track, but sub-national annual average loss predictions suggest that government policies on disaster management should also target these areas.

Source: ESCAP based on Government of Fiji (2016).

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

Estimated average annual loss



Source: ESCAP based on Pacific Catastrophe Risk and Financing Initiative – Country Risk Profile Fiji.

Losses from cyclone Winston, 2016

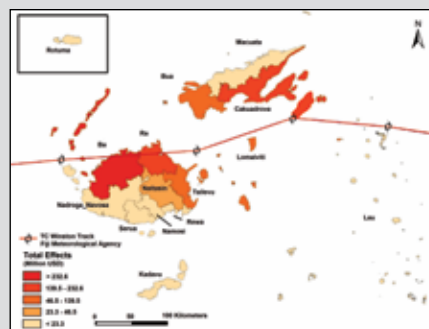
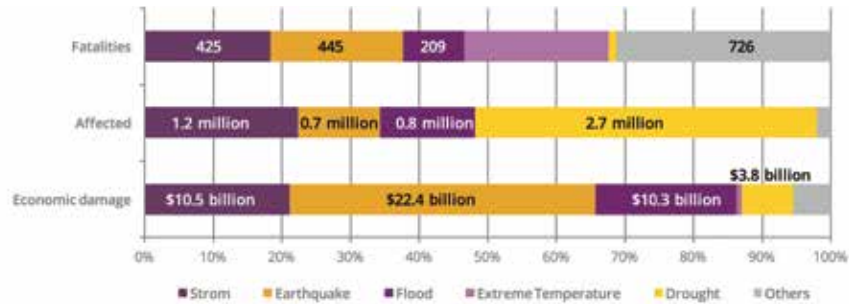


Figure 1-17

Disaster impacts in the Pacific, 2000–2016



Source: Data from EM-DAT.

Vanuatu, Tonga and Palau are expected to have average annual loss more than 5 per cent of GDP, mainly from tropical cyclones. Countries in the Pacific are also particularly at risk from the impacts of climate change, including sea-level rise.

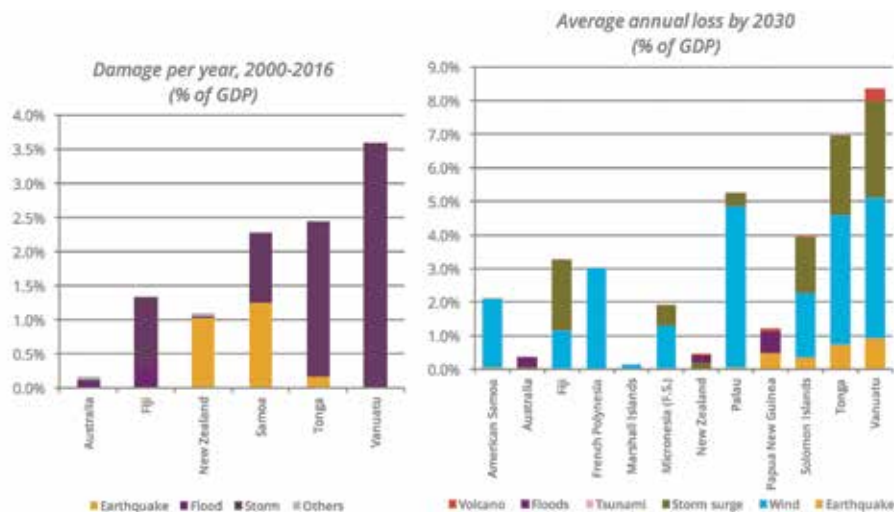
Understanding future disaster risks

Governments can anticipate future risks based partly on the historical record. Such analysis however faces a number of constraints. One is that disaster reporting lacks consistent international standards. Another is that the most catastrophic

disasters are infrequent – and thus likely to fall outside regular reporting periods. This was demonstrated by the 2015 earthquake in Nepal. The *World Risk Report 2014*, which provides a risk index for 171 countries, considered Nepal relatively safe and had ranked the country at number 108.²⁴ In 2015 however, the Gorkha earthquake killed close to 9,000 people and affected 8 million others, around one-third of the entire population, with economic losses of around \$7 billion, one-third of GDP (in 2015 US dollars).²⁵ Disaster risks also change over time, for example, in response to climate change.

Figure 1-18

Damage and future loss estimates for Pacific countries



Source: Based on damage data from EM-DAT. GDP data from ESCAP online statistical database. Average annual loss data from UNISDR (2015)

Table 1-3

Mortality rate and affected population rate, 2005-2015 and estimate for 2020-2030

Rank	Mortality rate (per million people per year)				Affected population (per million people per year)			
	Country	2005-2015	2020-2030	Change	Country	2005-2015	2020-2030	Change
1	Philippines	3.652	3.575	-0.077	Bangladesh	5,430	5,329	-101
2	Bangladesh	2.194	2.195	0.001	Philippines	6,079	5,043	-1036
3	Viet Nam	1.455	1.451	-0.004	Viet Nam	3,615	3,237	-378
4	Lao PDR	1.184	1.163	-0.021	Lao PDR	3,034	2,702	-332
5	Japan	1.244	1.162	-0.082	Bhutan	2,929	2,679	-250
6	Myanmar	1.084	1.081	-0.003	Myanmar	2,452	2,058	-394
7	Rep. of Korea	1.018	1.013	-0.005	Nepal	1,933	1,885	-48
8	Bhutan	1.078	0.982	-0.096	India	1,907	1,794	-113
9	India	0.671	0.664	-0.007	Cambodia	1,732	1,581	-151
10	China	0.659	0.660	0.001	DPR Korea	1,456	1,250	-206

Source: Shi, P. et al (2016)

One study has estimated future impacts for the period 2020 to 2030 – based on annual multi-hazard intensity and other indicators of vulnerability and exposure. This suggests that most of the Asia-Pacific countries at higher risk will make limited progress – in terms of reducing either fatalities or the affected populations (Table 1-3). Among the 43 countries studied, those listed as most seriously affected were the Philippines, Bangladesh, Viet Nam and Lao People's Democratic Republic; all were expected to see only small decreases, either in fatalities or in the number of people affected.

Estimating economic losses

Beyond measuring the human cost, there have been efforts to predict future economic costs. UNISDR has calculated the average annual loss (AAL) over the long term for each country.²⁶ This indicates a global average annual loss of \$415 billion. Of this, 40 per cent will be in Asia and the Pacific, with the largest losses in the largest economies – Japan and China, followed by the Republic of Korea and India. However, when considered as a proportion of GDP, the burden of losses is greatest in countries with special needs, and in particular in the SIDS, led by New Caledonia and Vanuatu (Figure 1-19).

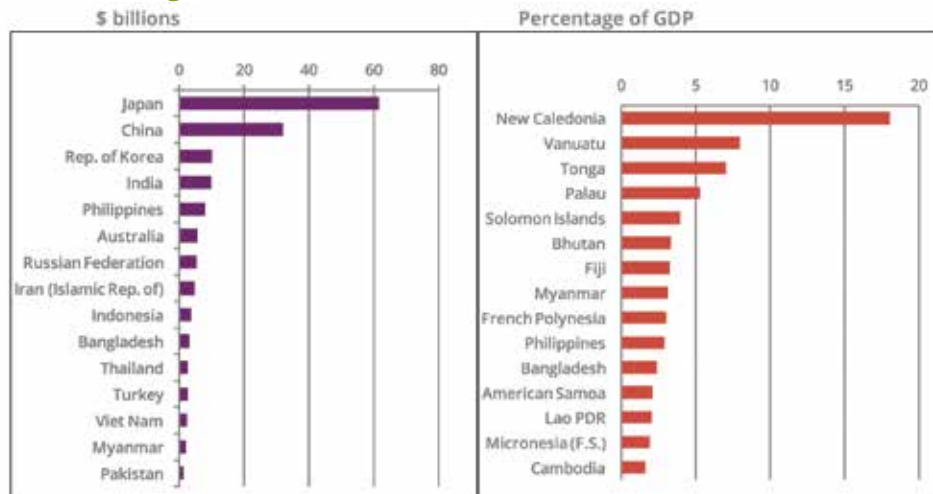
The SIDS as a whole are expected to have AALs close to 4 per cent of their GDP, equivalent to around 16.5 per cent of gross fixed capital formation. The LDCs are expected to have AAL of around 2.5 per cent of GDP equivalent to around 10.2 per cent of gross fixed capital formation (Figure 1-20).

Losses from natural disasters vary considerably within countries, with different areas having differing degrees of exposure and vulnerability to natural hazards: some areas may be well-equipped while others struggle to cope. National policies thus need to take these differences in exposure, vulnerability and coping capacities into account.

The concept of average annual loss also fails to register the scale of devastation from single catastrophic episodes. This can be assessed instead as the 'probable maximum loss' (PML) that could be expected in each period. The SIDS, for example, are very exposed to tropical cyclones which can be considered to happen once every 100 years. For Palau, for example, the PML from a cyclone has been estimated at 54 per cent of GDP (Table 1-4). Other SIDS at risk from tropical cyclones include Tonga, New Caledonia, American Samoa, Solomon

Figure 1-19

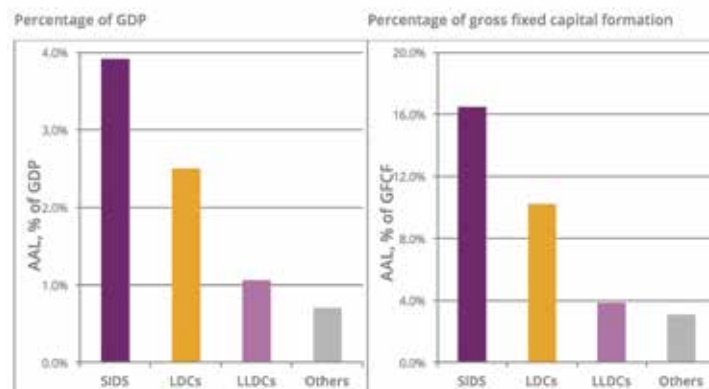
Estimated annual average future losses



Source: UNISDR (2015)

Figure 1-20

Average annual loss in countries with special needs, by 2030



Source: UNISDR (2015)

Table 1-4

Probable maximum loss over a 100-year period, by disaster, selected countries, percentage of GDP

	PML-wind	PML-storm surge	PML-earthquake	Government expenditure	Total government revenue
Palau	54.18	4.31	0.17		43.5
Tonga	31.29	5.00	3.91	26.6	
New Caledonia	26.28	7.67	0.21		
American Samoa	25.73	0.00	0.37		
Solomon Islands	20.08	6.93	1.32	41.8	38.4
Vanuatu	19.39	3.37	3.37	20.6	24.6
French Polynesia	12.34	0.00	0.00		
Fiji	8.31	7.85	0.22	32.3	27
Micronesia (F.S.)	6.53	5.05	0.06	55.4	37
Philippines	3.86	0.68	1.35	16.6	15.4
Bangladesh	3.55	0.08	0.68	13.6	11.6

Source: Based on PML data from UNISDR (2015). Government expenditure and total government revenue data from ESCAP Online Statistical Database.

Islands and Vanuatu. Tonga and Vanuatu are also exposed to earthquakes. Governments can try to deal with disasters partly from their own revenues but these will be insufficient for this purpose – often a much smaller proportion of GDP.

Rethinking disaster resilience

Analysis of historical disaster records and future disaster risks provide only a partial understanding of the complexities of disasters and their impacts on societies, economies and the environment. A better understanding of disaster risks requires a more integrated approach that includes socio-economic, structural and conceptual considerations. For example, estimates for disaster impacts can be incomplete, since they consider losses in assets and not in people's socio-economic well-being – in their health, education and livelihoods. A World Bank report estimates, for example, that, compared with high-income countries, a \$1 asset loss causes a greater loss in well-being in LDCs – twice as great in Cambodia, for example, and over 1.5 times in Bangladesh and Nepal. This is because poorer people with fewer assets who live close to subsistence cannot use savings to smooth the impacts, putting their health and education at greater risk, and they may need more time to recover and reconstruct. The report uses the concept of 'socio-economic resilience' which is the ratio of asset losses to well-being losses. This tends to be greater in richer countries. The highest resilience is in Denmark at 82 per cent, but the global average is 62 per cent. Estimates for Asia-Pacific LDCs and LLDCs are in Table 1-5.

As well as being exposed to natural hazards, countries are also at risk from man-made disasters through wars and violent conflicts. These broader risks have been incorporated into the INFORM index which includes the risks

from both natural and man-made disasters (Box 1-7). The results by Asia-Pacific subregion are indicated in Figure 1-21. On this basis, the greatest risks are in South and South-West Asia and South-East Asia, largely because of natural hazards, for which the rating is higher than for man-made disasters. However, countries such as Afghanistan, have a higher rating for conflict (Figure 1-22).

In his vision statement on prevention, the Secretary-General of the United Nations pointed out the importance of reducing inequalities and building resilience and preventing the fraying of social fabrics that increases the risk of conflict. This will mean investing in inclusive and sustainable development, including concerted climate action.²⁷

Historical experience has demonstrated that even the richest countries suffer devastating blows from natural disasters – and future climate change is likely to increase the risks. Countries cannot tame the forces of nature, but they can anticipate the blows and aim to protect people, and make their property and infrastructure as well as livelihoods more resilient. In particular, it is necessary to protect the poorest citizens, who are the subject of the next chapter.

Table 1-5

Socio-economic resilience

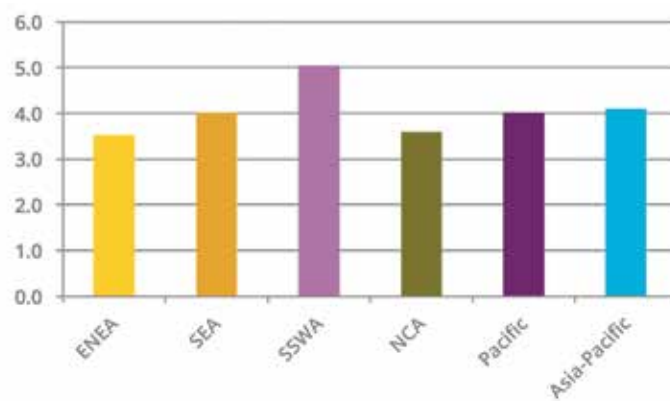
	Country	Socio-economic resilience (%)
LDCs	Bangladesh	66
	Cambodia	53
	Lao PDR*	73
	Nepal*	63
LLDCs	Kazakhstan	62
	Kyrgyzstan	55
	Mongolia	57
	Tajikistan	56
	Uzbekistan	44

Notes 1. 'socio-economic resilience' is the ratio of asset losses to well-being losses.
2. Lao People's Democratic Republic and Nepal are both LDCs and LLDCs.

Source: Hallegatte et al. (2017)

Figure 1-21

Risk from natural and man-made disasters, INFORM index, by subregion

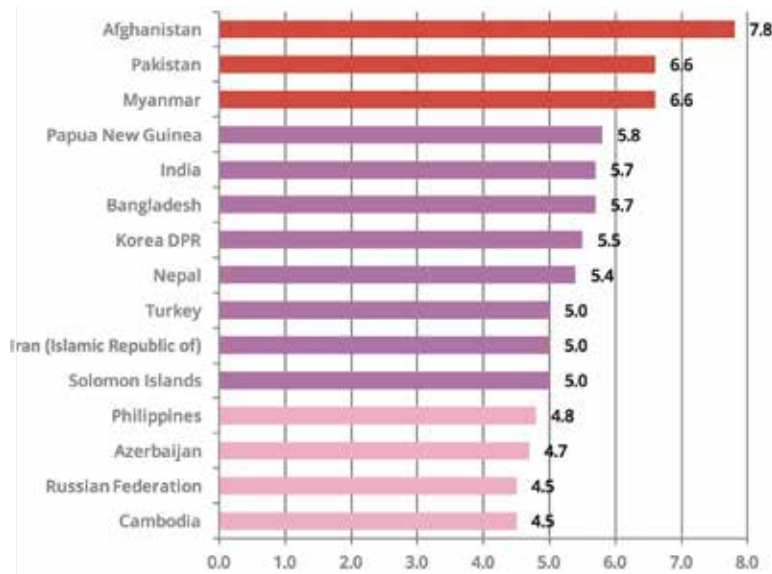


Note: Every country has an overall risk rating between 0 and 10.

Source: INFORM index (2017)

Figure 1-22

Risk from natural and man-made disasters, INFORM index, by countries



Note: Every country has an overall risk rating between 0 and 10.
 Source: INFORM index (2017)

Box 1-7

INFORM – index for risk management

INFORM is a global, open-source risk assessment index for humanitarian crises and disasters. INFORM is a collaboration of the Inter-Agency Standing Committee Task Team for Preparedness and Resilience and the European Commission. It is the first global, objective and transparent tool that includes the risk of humanitarian crises – simplifying crisis risk information so that it can be easily used for decision-making. The INFORM model envisages three dimensions of risk: hazards and exposure, vulnerability and lack of coping capacity dimensions.



Notes: 1. 'socio-economic resilience' is the ratio of asset losses to well-being losses.
 2. Lao People's Democratic Republic and Nepal are both LDCs and LLDCs.
 Source: Hallegatte et al. (2017)

ENDNOTES

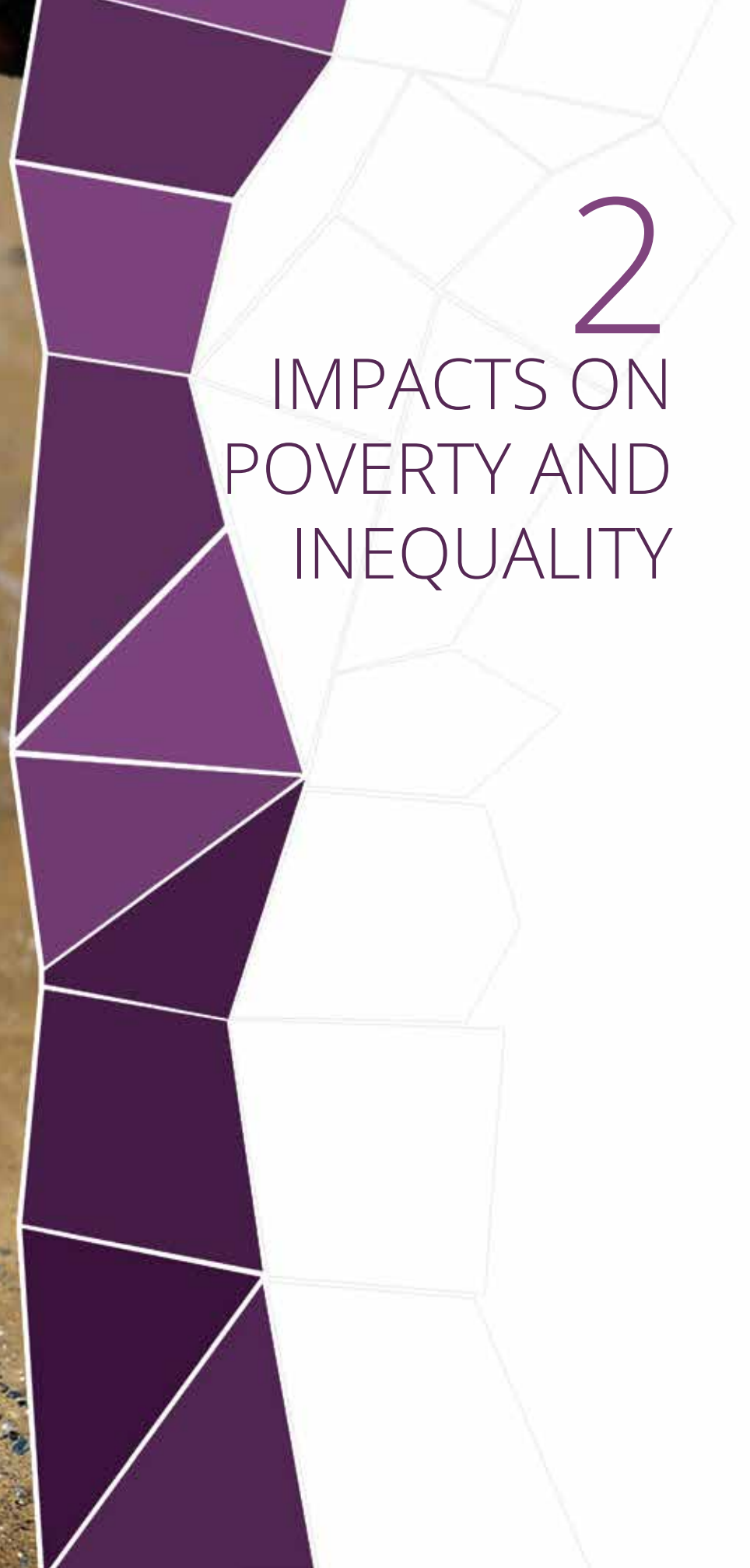
- 1 Population and GDP data from ESCAP, 2017a, and land area data from the World Bank, 2017.
- 2 Unless noted otherwise, disasters in this report includes drought, earthquakes (including tsunamis), epidemic, extreme temperature, flood, landslide, mass movement (dry), storm, volcanic activity and wildfire. “Fatalities (or deaths)” refers to persons confirmed as dead and persons missing and presumed dead as defined by EM-DAT. “Damage” 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.
- 3 Relief Web, 2017a.
- 4 Government of Fiji, 2016.
- 5 Relief Web, 2017c.
- 6 Relief Web, 2017d.
- 7 Relief Web, 2016c.
- 8 Relief Web, 2016b.
- 9 Relief Web, 2017e.
- 10 International Tsunami Information Center, n.d.
- 11 Koppel, 1995.
- 12 Guha-Sapir et al.
- 13 Ibid.
- 14 Ibid.
- 15 Dankelman, 2017.
- 16 Guha-Sapir et al.
- 17 Ibid.
- 18 Win, 2017.
- 19 Ibid.
- 20 ADRC, 2017.
- 21 ReliefWeb, 2017f.
- 22 ESCAP, 2017a.
- 23 Guha-Sapir et al.
- 24 Alliance Development Works and UNU-EHS, 2014.
- 25 Government of Nepal, NPC, 2015a.
- 26 Average annual loss (AAL) refers to the estimated average loss annualized over a long time period considering the full range of loss scenarios relating to different return periods. Unless noted otherwise, AAL in this chapter is in 2012 constant US dollars from UNISDR, 2015b.
- 27 United Nations Secretary General Vision Statement on Prevention. 2017.
- 28 Government of Fiji, 2016.
- 29 Relief Web, 2017b.
- 30 Ibid.
- 31 ESCAP & RIMES, 2015.
- 32 ESCAP, UNDP & RIMES, 2016.
- 33 Relief Web, 2016d.
- 34 Farr, 2015.
- 35 ReliefWeb, 2016a.
- 36 Ibid.
- 37 Indoitu et al., 2015
- 38 ESCAP, n.d.
- 39 Jung, 2016.
- 40 UNEP, WMO & UNCCD, 2016
- 41 Munich Re, 2010.





2

IMPACTS ON POVERTY AND INEQUALITY



IMPACTS ON POVERTY AND INEQUALITY

The extent of disaster damage is closely connected with poverty. The poorest communities tend to live in places and conditions that expose them to natural hazards so are least able to withstand disaster impacts. At the same time, disasters destroy many of their already meagre assets, increasing inequality and trapping people in poverty that can be transmitted from one generation to the next. As expressed in the Sustainable Development Goals, reducing disaster risk and reducing poverty and inequality are part of the same process.

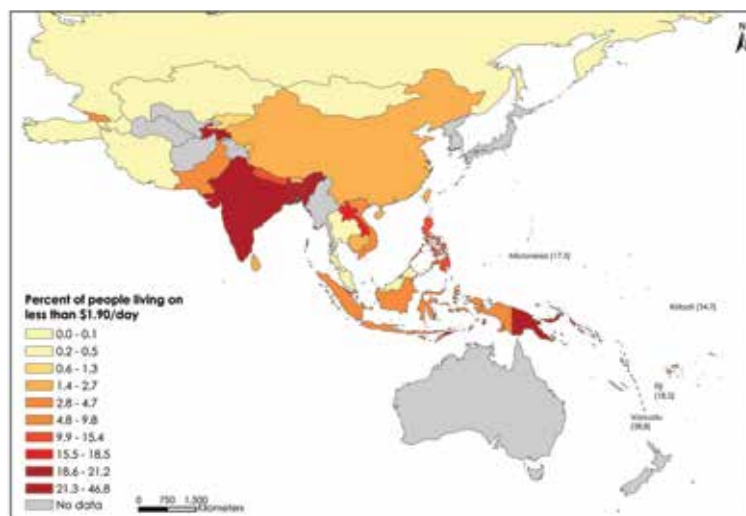
The first Sustainable Development Goal has the ambitious aim of ending poverty entirely – in all its forms, everywhere. The Asia-Pacific region has already made remarkable progress in reducing poverty. Between 2000 and 2013, the proportion of people living under the \$1.90 per day poverty line fell from 29.7 to 10.3 per cent.¹ One billion people exited extreme poverty. Nevertheless, 400 million people still live in extreme poverty – and 36 per cent of the

population live close to the poverty line, on less than \$3.10 per day.

Moreover, poverty reduction has been uneven across countries (Figure 2-1). Much of the success has been in China while progress has been slower elsewhere. In South and South-West Asia, between 2000 and 2013, the poverty rate fell from 34.2 to 17.3 per cent, but this still left 325 million people living in extreme poverty.²

Figure 2-1

Extreme poverty in Asia and the Pacific



Source: ESCAP statistical database (2017).

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 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.

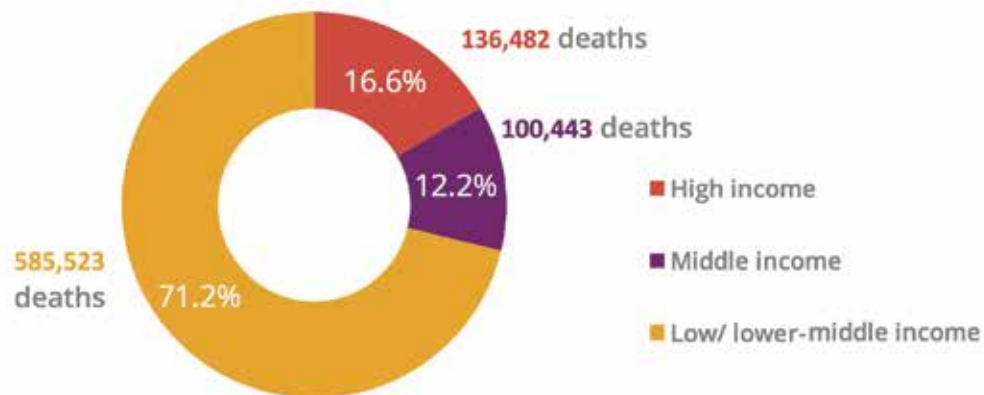
Convergence of disasters and poverty

There is a close two-way connection between disasters and poverty. The poorest nations and the poorest people have less capacity to mitigate the impact of disasters and are thus often the worst affected. Between 2000 and 2015, in Asia and the Pacific, the low- and lower middle-income countries experienced by far the most disaster deaths (Figure 2-2).³ At the same time, disasters also drive people into poverty.^{4,5,6}

These countries also lost more people per disaster event: on average, more than 8,000 people died per disaster – almost 15 times the average toll in the region’s high-income countries. There was also an upward progression in the number of deaths per 100,000 inhabitants: low and middle-income countries had five times more disaster deaths than high-income countries (Figure 2-3). In fact, the actual death toll in the poorest countries is probably even higher than these data suggest, since many countries lack the resources to record the number of deaths.

Figure 2-2

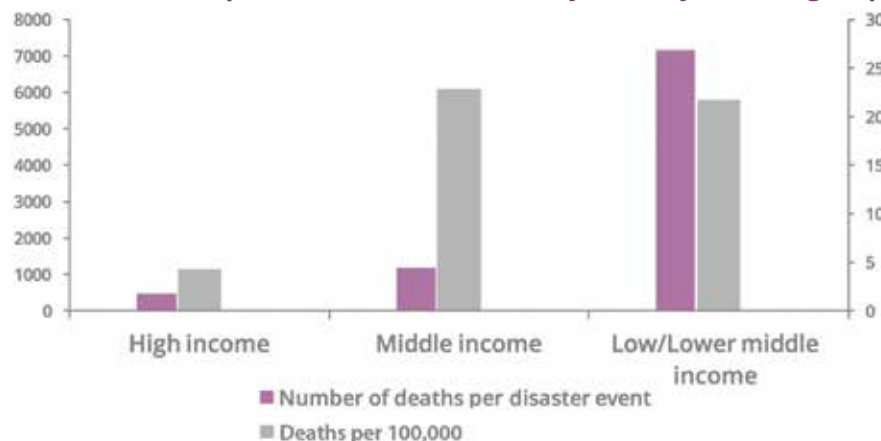
Deaths from natural hazards, by country income group, 2000–2015



Source: Based on EM-DAT. (Accessed on 4 July 2017)

Figure 2-3

Deaths per disaster event and per 100,000 inhabitants, by country income group, 2000–2015



Source: Based on EM-DAT. (Accessed on 4 July 2017).

Note: High-income countries, 3.1 billion people, middle-income 0.4 billion, low-/lower-middle income 2.7 billion.

While there are differences between rich and poor countries, the contrasts can be even more striking within countries, where the people more likely to be affected by disasters are the poorest. As illustrated in Figure 2-4 for Nepal and Pakistan, mortality from disasters is higher in the poorer districts.

Natural disasters hit poor people harder because they live in vulnerable overexposed areas, have lower-quality assets, and in rural areas are more dependent on vulnerable agriculture and ecosystems; thus, they have less ability to cope and recover. In cities, poverty forces low-income households to occupy low-value land that may be exposed to floods, landslides and other hazards. Faced with recurring disasters, many

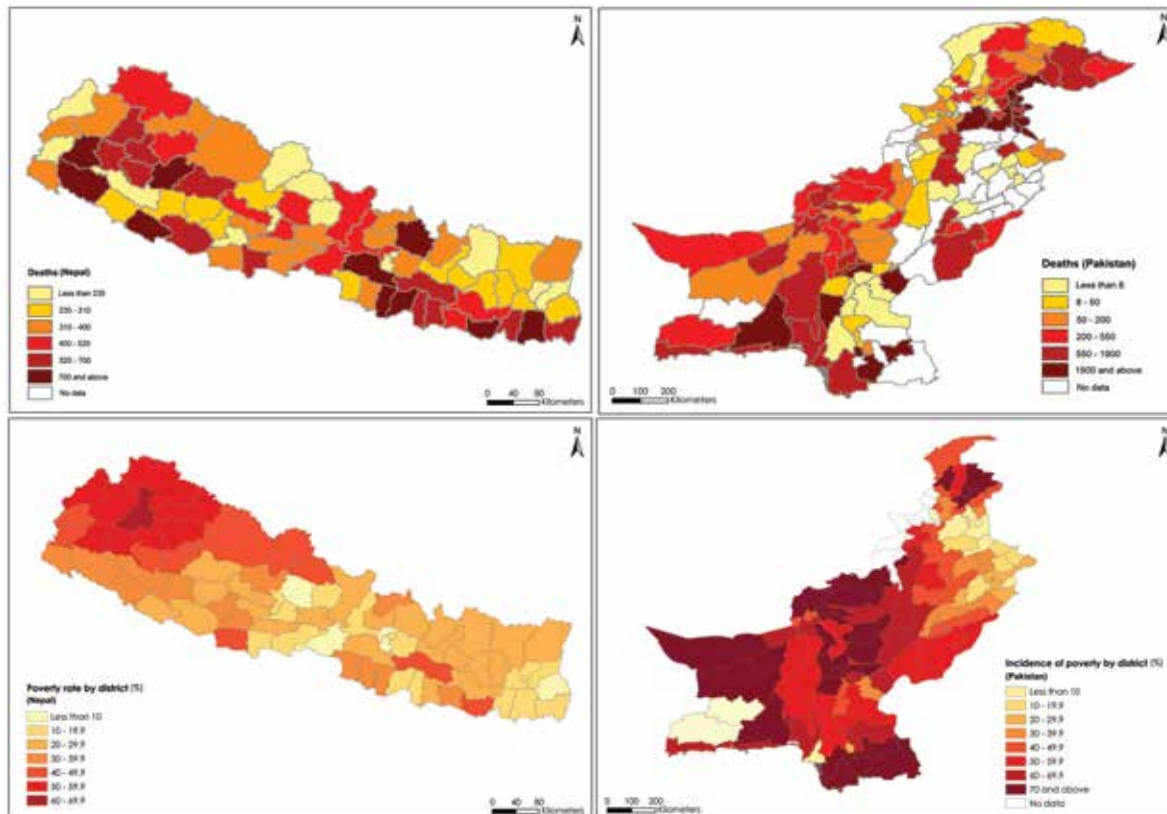
households are often unable to break out of the poverty cycle. In addition to hitting the poorest, disasters can also cause the near poor – those living on between \$1.90 and \$3.10 per day – to fall into poverty. Figure 2-5 maps out the countries that have the highest concentrations of these vulnerable near poor.

Many post-disaster needs assessments have shown that disasters hit hardest at the poor and vulnerable – and can also become a tipping point for those who are living at the cusp of poverty (Figure 2-7).

Nepal earthquake 2015 – Nine of the 14 severely affected districts had human development index scores lower than the national average.

Figure 2-4

Deaths from disasters and poverty, by province, Nepal and Pakistan, 2000-2015

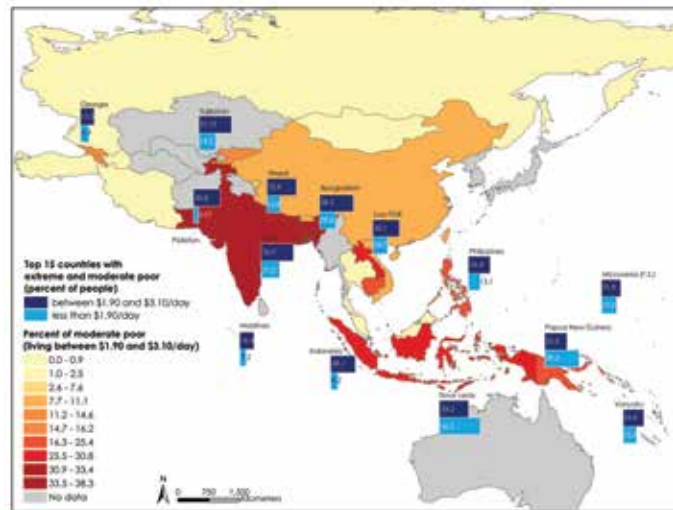


Source: Humanitarian Data Exchange, DesInventar, UNISDR and poverty data based on Nepal Central Bureau of Statistics, 2011; UNDP District Maps: Incidence of poverty, 2014–2015.

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

Figure 2-5

Vulnerable populations, living between \$1.90 per day and \$3.10 per day



Source: ESCAP statistical database (2017).

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 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.

Apart from the Kathmandu Valley, the central and western regions that were affected by earthquakes and the ensuing landslides were mostly rural and heavily dependent on agriculture. The widespread loss of livestock was a severe income shock.⁷ The earthquake is estimated to have pushed an additional 750,000-900,000 Nepalese living close to the poverty line into poverty.⁸

Myanmar, cyclone Nargis, 2008– The poorest suffered extensive damage and loss of livelihoods, employment and income. Many lost income-earning opportunities for a substantial period of time – including smallholder farmers, communities dependent on small-scale inshore and off-shore fishing, and the landless poor and skilled workers. The jobs lost were largely in the informal sector such as seasonal work in agriculture, short-term jobs in community works, as well as in small-scale fishing, rice mills, fish processing, salt production, and wood cutting.

Pakistan, floods, 2011 – In the poor districts of Sindh and Baluchistan, the floods pushed many

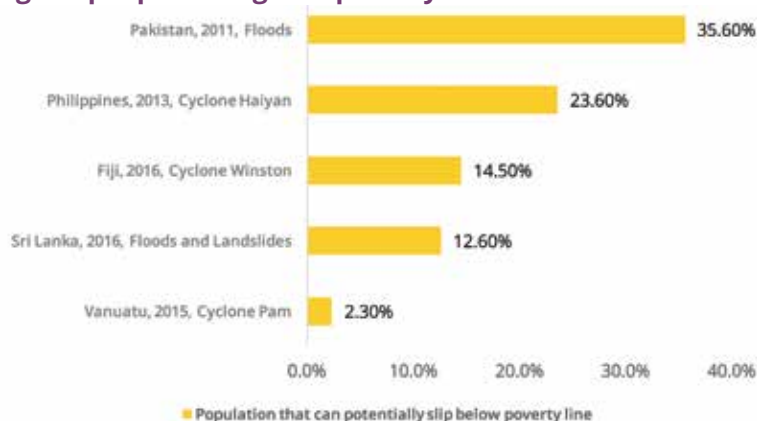
households deeper into poverty.⁹ In Sindh, where a higher proportion of rural workers are land-less, the floods increased unemployment. The floods increased land salinity and degradation, reducing crop productivity. Small farmers, already under heavy debt, were unable to get new loans because they lacked collateral.¹⁰ ESCAP estimates that around seven million of the near poor could have slipped below the poverty line.¹¹

Fiji, cyclone Winston, 2016 – Hardest hit were the Northern and Eastern Divisions which had the highest poverty rates – at 48 and 40 per cent respectively. The path of the cyclone was primarily across rural areas where average household incomes are lower and housing is less robust. The poor fell deeper into poverty and many of the near poor fell below the basic needs threshold.¹² Around 14 per cent of the population could have slipped below the poverty line as a result.¹³

Philippines, typhoon Haiyan, 2013 – The typhoon hit the central Visayas region of the Philippines on 8 November 2013, with devastating effect.

Figure 2-6

Estimated percentage of people falling into poverty from selected disasters



Source: ESCAP Statistical database and country post-disaster damage assessments.

Between 6,000 and 8,000 people were killed and some 4 million were left homeless, in an area that was already suffering high levels of poverty – 40 per cent of those living in the areas affected by Haiyan lived below the poverty line before the typhoon struck.¹⁴ Around three million people living close to the poverty line could have been pushed into poverty.¹⁵

Vanuatu, cyclone Pam, 2015 – Tropical cyclone Pam disproportionately impacted vulnerable populations, including the poor. Poverty and unemployment in Vanuatu are expected to worsen.¹⁶ These groups are at risk of sliding into poverty or deeper poverty, and given their disadvantages and scant access to resources, they are unlikely to recover their former standards of living.¹⁷ ESCAP estimates that around 4,000 people could have slipped below the poverty threshold as a result.¹⁸

Well-being losses to the poor

In absolute terms, the rich may lose more because they have more to lose. What matters more, however, is the proportion of income or assets lost. The same absolute loss will matter more to a poor household than a rich one and widen the disparities (Figure 2-7).

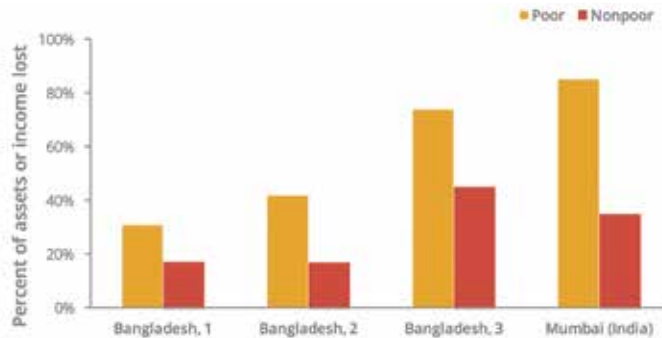
Poorer households have greater losses in well-being because they have fewer assets (which are worth more to them), their consumption is closer to subsistence levels, they cannot rely on savings to smooth disaster impacts, and their health and education are at greater risk.²¹ Poor households have less ‘socioeconomic resilience’ and are thus less able to minimize the impact of well-being losses. This resilience decreases with income.²² In Bangladesh, for example, during and after floods, poorer households have less food available, reduce their meals and rely on less expensive food, and sell their assets at a much higher rate than their wealthier counterparts (Figure 2-8).²³

Nutrition – In rural eastern India, in Odisha, for example, the prevalence of wasting and underweight were significantly higher in repeatedly flooded areas than in non-flooded areas (Figure 2-9).²⁴ Similarly in Nepal, poverty and child stunting have been strongly associated with floods.²⁵

Education – Under pressure of poverty, families hit by disasters may take their children out of school. In Pakistan, for example, there was a significant drop in school enrolment with each progressive disaster – 2005 earthquake, and 2010 floods (Figure 2-10).

Figure 2-7

Percentage of asset or income loss by the poor and non-poor in floods

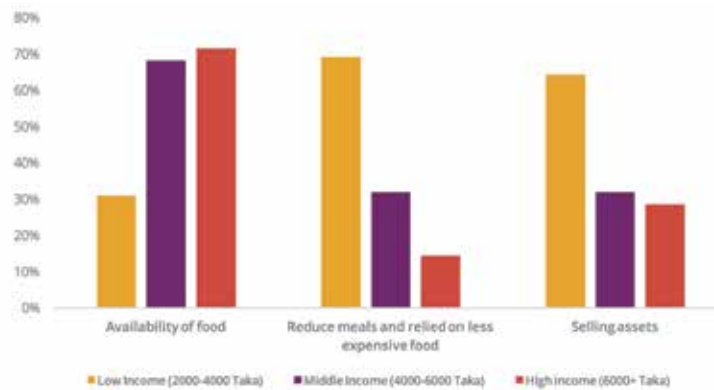


Source: World Bank (2016).

Note: Data generated by World Bank from three sources- Bangladesh 1: del Ninno et.al 2001; Bangladesh 2: Brouwer et.al. 2007; Bangladesh 3: Rabbani, Rahman, and Mainuddin 2013; Mumbai: Patankar and Parwardhan 2016^{19,20}

Figure 2-8

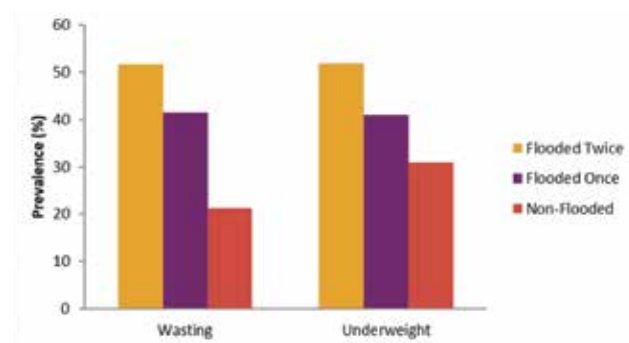
Household income level and food availability, changes in eating behaviour, and selling of assets during and after floods, Bangladesh



Source: Paul S.K. (2010). (64 Taka = \$1, approximate average exchange rate for 2005).

Figure 2-9

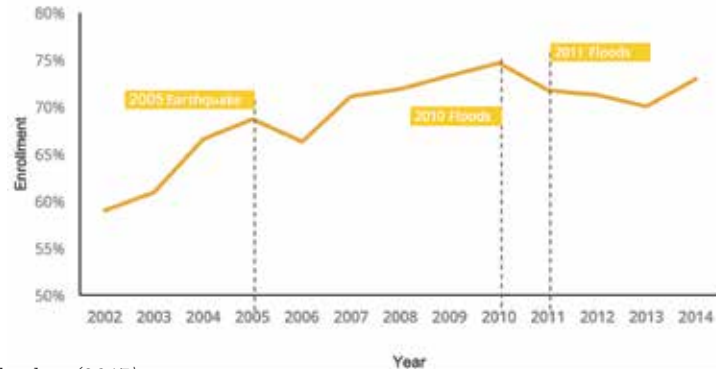
Child wasting and underweight in Jagatsinghpur district, Odisha, India



Source: Rodriguez-Llanes JM (2016).

Figure 2-10

Pakistan primary school enrolment drops following disaster



Source: ESCAP statistical database (2017).

In Sri Lanka in late 2016 and early 2017, due to a severe drought an average of 15 per cent of affected households had to reduce expenditures on education for their children to cope with income losses from floods; in Mannar district the proportion was 44 per cent and in Vavuniya it was 39 per cent.²⁶

damage, particularly for the poor, is often greater for ‘extensive’ disasters such as droughts, persistent flooding, and small or medium-sized storms that deliver low-intensity but recurrent shocks. Sectors such as agriculture, health and education are the hardest hit by extensive disasters (Figure 2-11, Figure 2-12). Data from 18 countries in Asia and the Pacific show that while mortality rates and housing damage are higher for intensive disasters; extensive disasters make up a higher proportion of the damage in productive and social sectors.²⁸

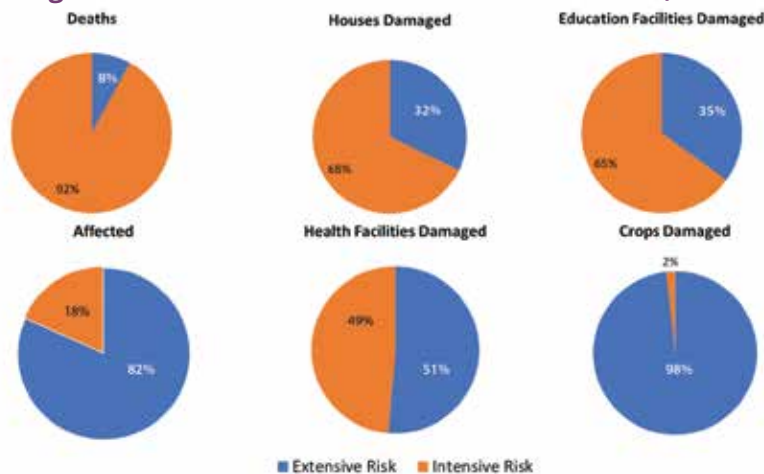
Extensive disasters

‘Intensive’ disasters like earthquakes and cyclones receive the most attention because they cause immediately visible damage to public assets – such as schools, health facilities and other infrastructure.²⁷ But the cumulative

While intensive disasters attract donor attention, extensive disasters are underreported

Figure 2-11

Distribution of damage between extensive and intensive disasters, 18 Asia-Pacific countries, 2000–2013

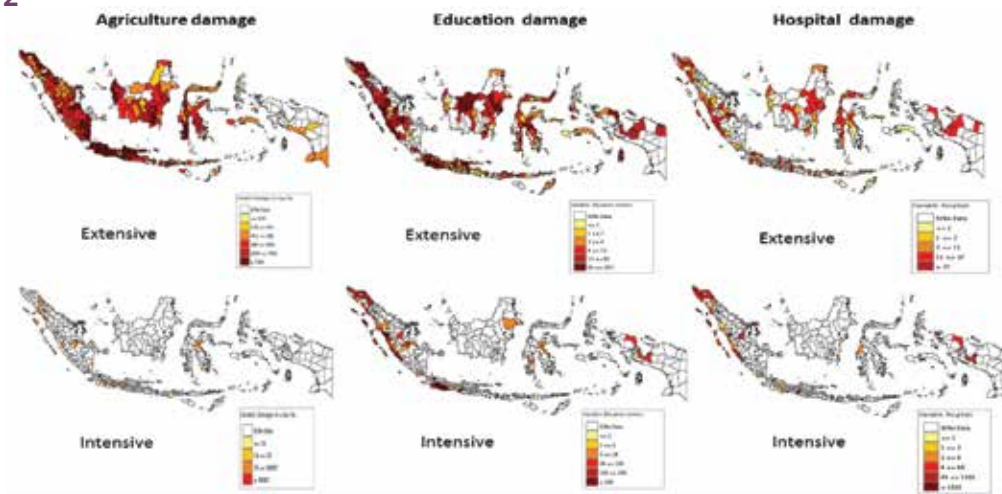


Source: DesInventar database (2017).

Note: Intensive disasters are those causing more than 30 deaths and destroying more than 600 houses.

Figure 2-12

Damage to agriculture, health, and education from extensive and intensive disasters, Indonesia 2000-2012



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

and neglected. Severe storm damage to a poor household’s roof can, for example, ruin harvested grains but government support is often not forthcoming because the storm was not considered a disaster. The poorest are the worst hit since their agriculture-based livelihood systems, which are already vulnerable to food insecurity, face crop failure, loss of livestock, and new patterns of pests and diseases.²⁹

Cambodia, for example, experiences recurrent floods when heavy monsoon rains cause the banks of the Tonle Sap lake and the Mekong river to overflow resulting in high levels of crop damage undermining the livelihoods of farming households – and contributing to malnutrition, intergenerational transmission of poverty and widening inequalities.³⁰

Similarly in Nepal, absolute poverty is closely linked with damage from two of the most common extensive disasters – flooding and drought.³¹ Disruption of normal education and a lack of housing and food increased exposure to disease and imposed enormous psychological stress, adding to serious productivity and income losses.³² Poorer women often work at home so

housing losses simultaneously affect their assets, livelihoods and well-being.

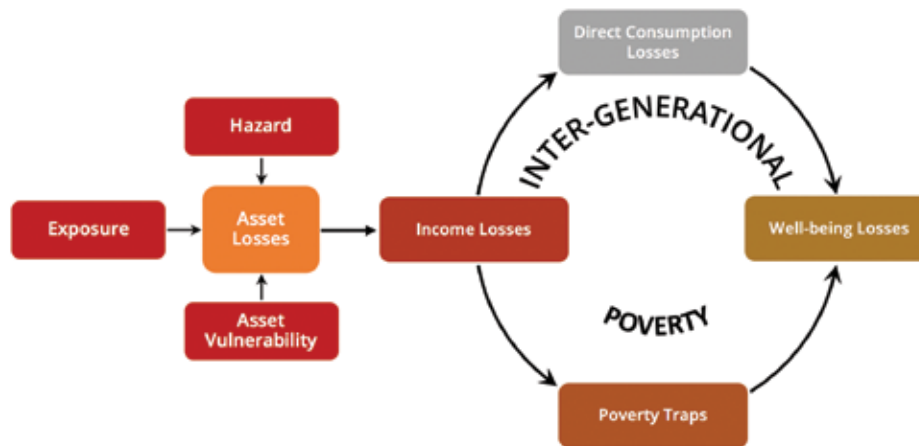
Intergenerational transmission

Poverty, like wealth, is often transmitted from one generation to the next.^{33,34} This process will be sustained by disasters that deplete or destroy the assets and resources of the poor, increasing food insecurity, and eroding both parental and child health (Figure 2-13). Extensive disasters are particularly insidious. Droughts, for example, can last for years, even a decade, and lead to chronic, persistent malnutrition.

Potential pathways for intergenerational transmission are indicated in Figure 2-14. Households that lose assets because of disasters are more likely to be trapped in poverty, and less able to cope with subsequent shocks. This will also affect their children’s well-being and prospects if it reduces their levels of nutrition or causes them to be withdrawn from school. This, in turn, affects their health and reduces their employment prospects and their opportunities for escaping poverty.

Figure 2-13

Intergenerational poverty: a conceptual map



Disasters widen inequality

Disasters cause disproportionately greater losses to poorer countries and people. More frequent and severe disasters will thus exacerbate inequalities. A common measure of inequality is the Gini index which ranges from 0 to 1, where 1 represents complete inequality. An analysis for 86 countries globally from 1965 to 2004 found that a natural disaster increased the Gini coefficient by 0.01 in the next year. Analysis by ESCAP among 19 countries in Asia and the Pacific suggests a similar significant relationship of 0.13, with disasters potentially widening existing inequalities (Figure 2-15) (See Appendix).

Disasters are especially likely to widen inequalities in urban areas. The region's cities already have striking disparities between rich and poor, but disasters are likely to increase these still further. Based on the UNEP/UNISDR multi-hazard risk index, 170 cities across Asia and the Pacific are located in areas of extreme risk, while 314 are in high-risk areas and 154 are in medium-risk areas. This risk emanates from tropical cyclones/typhoons, earthquakes,

floods and land-slides (Figure 2-16). Because of the opportunities for trade, many of these cities have developed from ports, and these infrastructure links make coastal areas attractive even today for new economic zones (Figure 2-17).

Many cities are located in the areas where multi-hazard risks are growing rapidly. In the Asia-Pacific region by 2015-2030 it is estimated that the population in the 'extreme-risk' areas, is expected to grow more than 50 per cent in 26 cities, and by 35 to 50 per cent in 72 cities. As a result, the number of city dwellers exposed to extreme and high risks is likely to increase significantly, particularly in East and North-East Asia, South and South-West Asia, and South-East Asia.

Outside city limits, there are also risks in peri-urban areas. These are attractive for residents because they have low land and rental rates, but they also lack municipal building and development regulations and, as a result, often have unsafe buildings and inadequate infrastructure. In practice, they usually operate as extensions of cities, whose services are still called upon to respond to emergencies. These

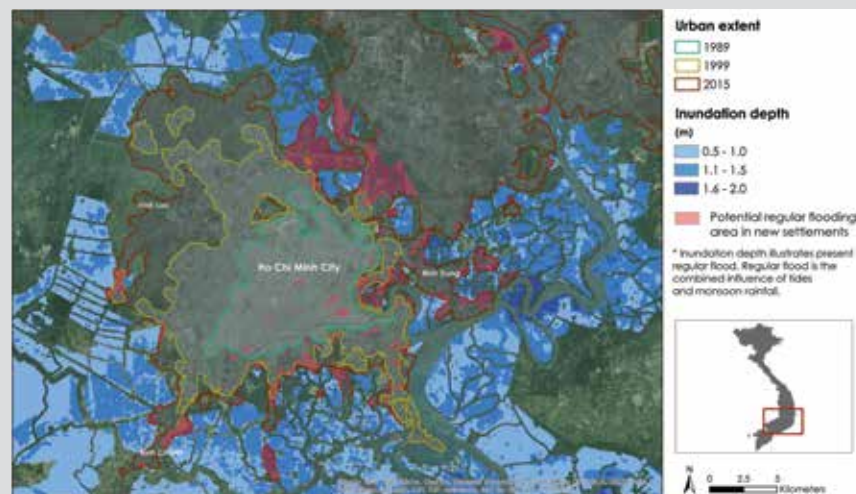
Box 2-1

Urban expansion and increased flood risk in Ho Chi Minh City, Viet Nam

The urban extent of Ho Chi Minh City of Viet Nam has been increasing at a rapid rate from 8,430 hectares in 1989 to 22,015 hectares in 1999 and 99,391 hectares in 2015.¹ Currently, approximately 63 per cent of the city area is in low-lying areas, at an altitude of less than 1.5 meters above sea level.²

As the available space is limited to accommodate the rapidly growing urban population, residential neighbourhoods continue to develop in low-lying areas that are prone to regular flooding (defined as inundation depth of less than two metres). In 1999, only 578 hectares of built up areas were exposed to regular flooding events and by 2015, this area has expanded to around 4,242 hectares.

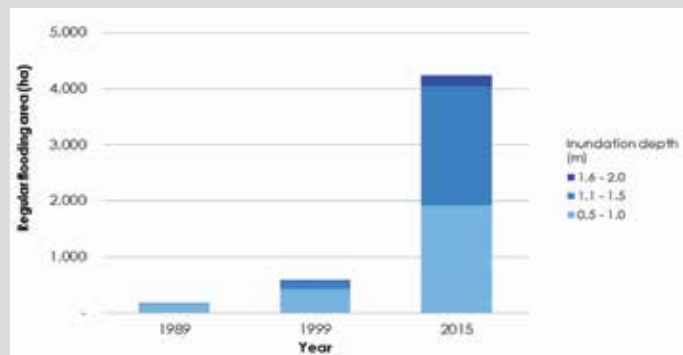
Potential regular flooding areas in new settlements



Source: ESCAP adapted from ICEM for regular flood levels. Available from <http://www.icem.com.au/documents/MapCatalogue.pdf>, and urban extent data from *Atlas of Urban Expansion* Available from <http://www.atlasofurbanexpansion.org/>

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

Regular flooding area in new urban settlements

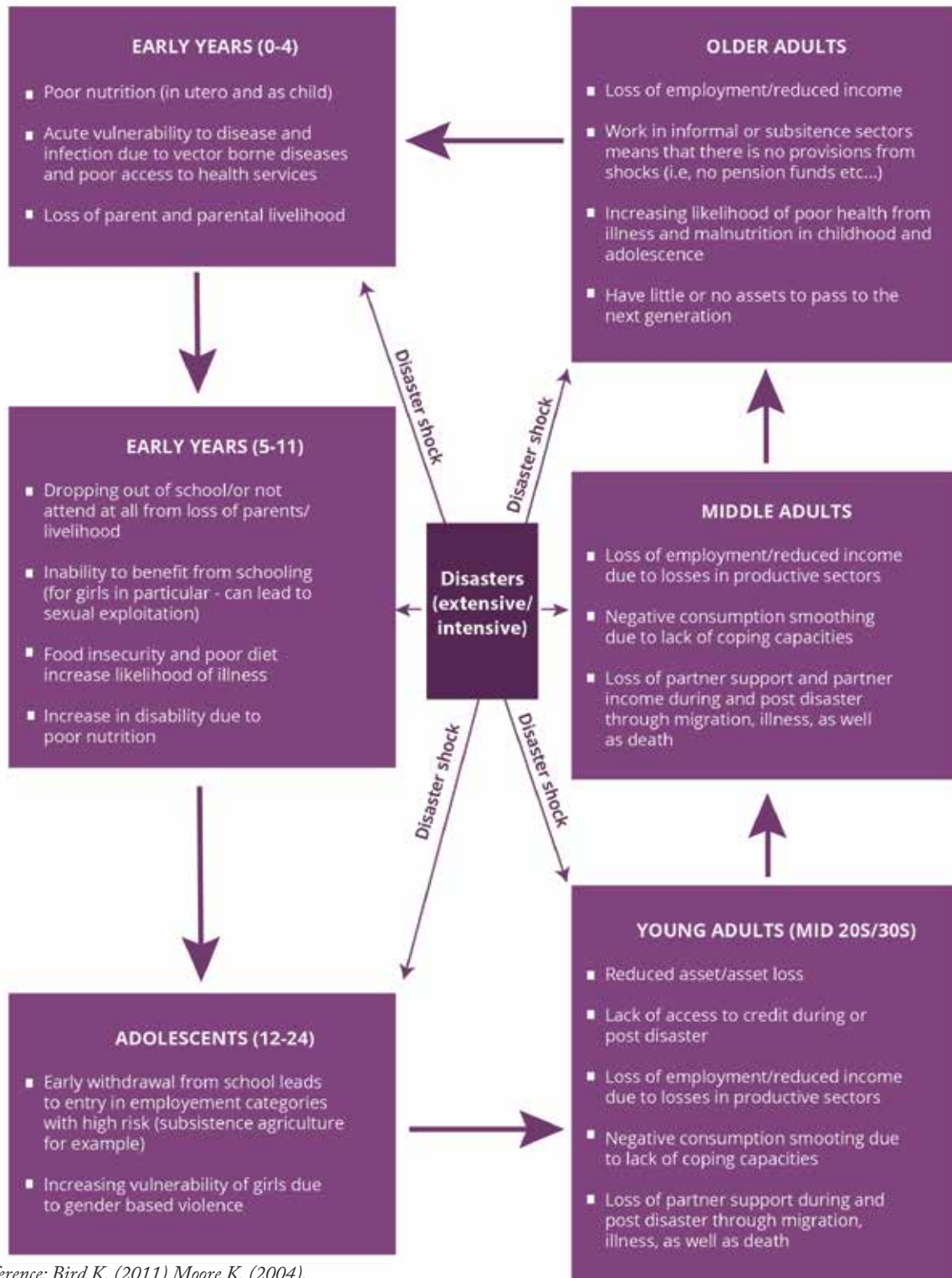


1. Angel et al., *Atlas of Urban Expansion—2016 Edition, Volume 1: Areas and Densities*, New York: New York University, Nairobi: UN-Habitat, and Cambridge, MA: Lincoln Institute of Land Policy, 2016.

2. Mekong Commons, *Stemming the rising tide: Flooding and local lives in HCMC*, 13 March 2016. Available at <http://www.mekongcommons.org/stemming-rising-tide-flooding-local-lives-hcmc/> (accessed on 23 August 2017)

Figure 2-14

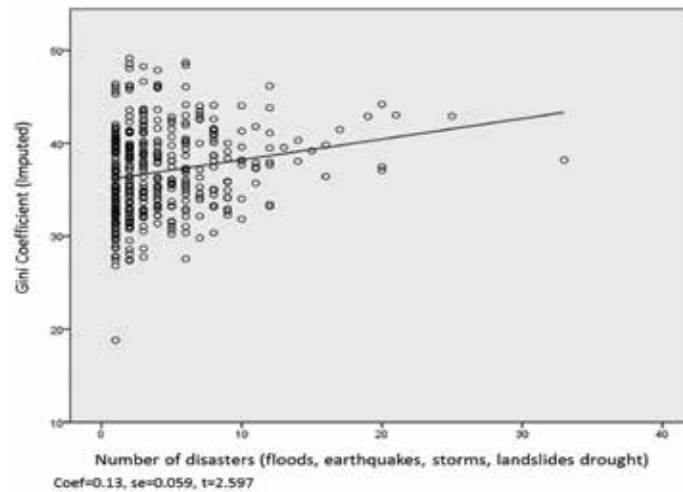
Intergenerational transmission of poverty



Reference: Bird K. (2011) Moore K. (2004).

Figure 2-15

Relationship between number of disaster occurrences and Gini coefficient in 19 selected countries in Asia and the Pacific



Source: Based on EM-DAT and World Bank Indicators data.
Note: For further explanation, see Appendix.

transitional zones between urban areas and rural zones provide critical ecosystem services that if eroded or mismanaged can heighten the risks of floods, droughts and landslides.³⁵ Even when peri-urban areas are formally subsumed into cities it is difficult to correct constructions or rebuild to meet planning and safety standards. In Ho Chi Minh City, for example, land and markets pushed the poor and vulnerable to settle in peri-urban areas with higher risk and exposure to floods. As a result, the area exposed to flood increased by more than 24 times between 1989 and 2015 (Box 2-1).

Disasters in cities and peri-urban areas are likely to exacerbate inequalities. This can be illustrated by an analysis of 57 Asia-Pacific cities. For the group of nine megacities (10 million or more people) 56 per cent of their inhabitants live in cities that have medium or high levels of in-equality and are located in extreme disaster risk areas (Figure 2-18). For the group of nine large cities (5 to 10 million people) 78 per cent of their inhabitants live in cities that have medium to extreme inequality

and are located in extremely high disaster risk areas. But it is not only large cities that have poor and vulnerable populations, have high levels of in-equality and are at high risks from disasters. In the group of 23 medium-sized cities 37 per cent of inhabitants live in cities that have high inequality coupled with extreme disaster risks. This number increases to about 60 per cent of the population living in cities of 0.5-1 million.

Reducing disaster risk in cities

Urban risks and disasters are often very different from the rural events with which most governments are more familiar. And compared with those in developed countries, disasters in urban areas of developing countries tend to be more destructive and much harder to recover from.³⁶ This is due to poor quality development, lack of resources and political will. Disaster management is made more difficult in urban areas by the complexities in land tenure, high densities and more high-rise structures, as well as the need to support floating populations due to rapid migration.

Figure 2-16

Multi-hazard disaster risks of cities in Asia and the Pacific



Source: ESCAP based on urban data from UN-DESA (2014). *World Urbanization Prospects: The 2014 Revision, CD-ROM Edition*; and multi-hazard risk index from UNEP/UNISDR (2013). *Global Risk Data Platform*. Available at <http://preview.grid.unep.ch/> (Accessed on 7 August 2017).

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 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.

Figure 2-17

Coastal cities and economic zones in China



Source: Based on "University of Texas Libraries"

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Figure 2-18

Classification of population in mega and large cities in Asia-Pacific according to disaster risk and inequality



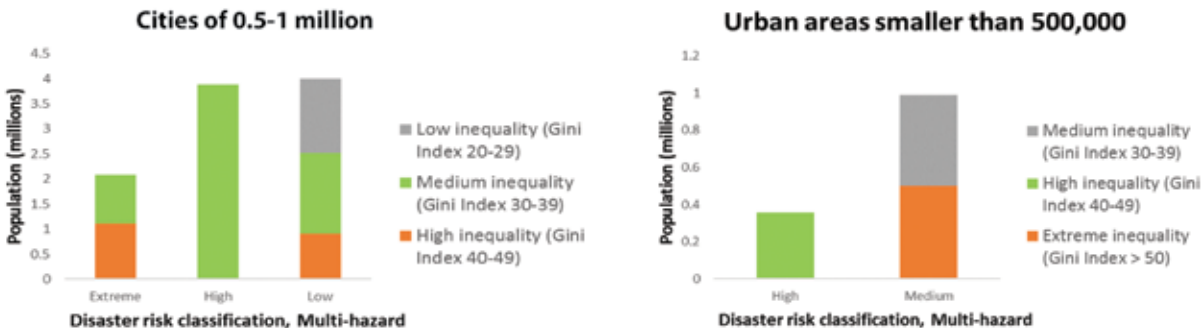
Source: Based on city Gini Index from State of World Cities 2010/2011, population data from UN-DESA, 2014, and estimated risk index for multiple hazard from UNEP and UNISDR, 2013.

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).

Notes: 9 Megacities of 10 million or more, Total population=140 million; 9 Large cities of 5-10 million, Total population=73 million; 23 medium sized cities of 1-5 million, Total population = 47 million

Figure 2-19

Classification of population in medium-sized and small cities in Asia-Pacific according to disaster risk and inequality



Source: ESCAP based on city Gini Index from State of World Cities 2010/2011, 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).

Notes: 13 cities of 0.5-1 million, Total population = 9.9 million; 3 cities smaller than 500,000, Total population = 1.3 million.

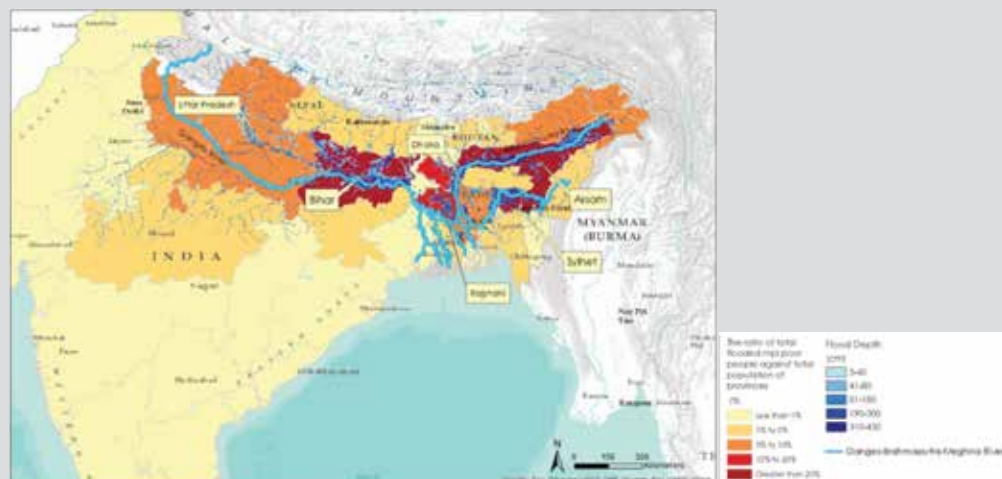
Box 2-2

Disasters and poverty in the Ganga, Brahmaputra and Meghna basin

The Ganga, Brahmaputra and Meghna basin demonstrates an amalgamation of poverty, in-equality and vulnerability to disaster. This is one of the richest basins in the world in terms of the potential of its natural resources – hydropower generation, fisheries, forestry, irrigated agriculture, navigation, environmental amenities, tourism, minerals, oil and gas. Nevertheless, three of the basin countries are among the poorest nations in the world.⁴⁵ Average GDP per capita in the basin is less than \$2 per day. In India and Bangladesh, for example, national poverty rates are higher in the states and districts surrounding the Ganges basin than elsewhere in the country.⁴⁶

The basin is perennially hit by hydro meteorological disasters. In the Indian state of Bihar, for example, there have been floods from the basin's rivers every year since 1979 (with over 20 million people affected in 1987, 2004, and 2007).⁴⁷ Around 35 million poor people in this area are exposed to flood risks.

Floods and poverty in the Ganga, Brahmaputra and Meghna basin



Source: ESCAP based on Multidimensional poverty index, ESRI, GAR PI, ESRI base map admin boundaries, and Worldpop
 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 grey) 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.

Much emphasis is placed on floods that affect the basin's rural poor, but it also has large urban areas with high levels of poverty and inequality and which are exposed to high flood risk. Protecting people in the basin will mean building disaster resilience into agriculture, irrigation, infrastructure, water resources management, and urban planning. Recent advances in weather forecasting, based on space applications, have enabled longer lead times of five to eight days for flood forecasts. However, these advances in science rarely reach the communities who live along these vast rivers.

Pro-poor development in the basin will also require solutions that cut across national boundaries. Countries can cooperate on data sharing, joint investments, benefit sharing, joint monitoring, and joint operations and management.

This was evident, for example, after the Nepal earthquake of 2015. The Government had to assess damage for over 40 urban centres, identify the affected populations, and work out compensation for dwellers in commonly owned high-rise buildings.³⁷

While much discussion takes place around the risk posed to the urban poor, there are also serious risks for other segments of urban populations. Even the not-so-poor are living and working in buildings of suspect quality: many of modern high-rise buildings that pierce the skylines of the region's cities may not be very robust. Construction workers often fail to understand or execute building drawings, contractors and designers may have a poor understanding of building codes and regulations, and city governments often lack the capacity to enforce them. Earthquakes in India, Nepal, Indonesia, and Taiwan, Province of China, have clearly exposed such vulnerabilities.

Asia-Pacific cities have millions of people at risk, but they are also emerging as leaders for community-based disaster risk reduction, as well as for climate change mitigation and adaptation.

CITYNET, for example, the regional network of local authorities for the management of human settlements, has a disaster cluster with over 35 Asia-Pacific cities. This trains city managers in disaster risk reduction and management, facilitates urban risk profiling, and disseminates best practices in disaster preparedness.³⁸ These efforts are reflected in the New Urban Agenda of Habitat III.³⁹

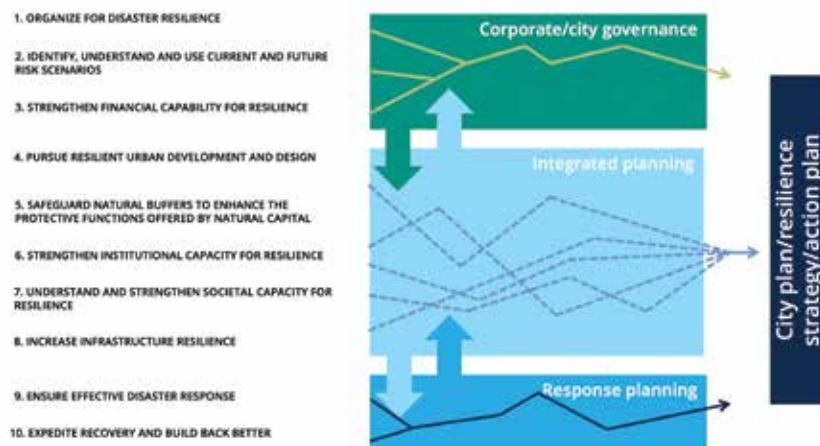
UNISDR has identified ten essentials for making cities resilient (Figure 2-20).⁴⁰

It is also important to involve the private sector in disaster risk management. ARISE, for example, is a private sector stakeholder group, with over 140 companies and organizations, headquartered in 38 countries and active in 150, which is currently working with UNISDR to realize disaster-resilient societies.⁴¹

Another example is MIT's Urban Risk Lab which is working with three cities in Indonesia – Greater Jakarta, Bandung and Surabaya – as well as Chennai in India, to use social media for gathering, sorting and displaying information about flooding in real time.⁴² The

Figure 2-20

Ten essentials for making cities resilient



Source: UNISDR (2017).

disaster mapping platform for Indonesia, www.petabencana.id, is based on Google maps and easily customizable for any city in the world. It uses a simple phone app through which people can log incident reports that then get collated to generate decision support data as well as useful public information. A similar platform is being piloted in India.

In recent years, city-to-city partnerships have been instrumental in sharing experiences and gaining access and knowledge to policy tools for risk-sensitive and pro-poor urban development. The partnerships include sharing strategies on strengthening institutions, risk assessments, and effective practices. Such partnerships are particularly beneficial to smaller and more remote cities to bridge technical and other knowledge gaps.⁴³

Reducing poverty, inequality and disaster risks – together

Building resilience of the poor and vulnerable means ensuring that they have the wherewithal and coping capacity to survive and bounce back from disasters. This will require multi-faceted interventions to enhance their capacity ‘to resist, to absorb, to accommodate and to recover’.⁴⁴ These interventions are the subject of later chapters in this report, starting from the next chapter which is concerned with agriculture and the rural poor.

ENDNOTES

- 1 ESCAP, 2016c.
- 2 Ibid.
- 3 Low and lower-middle income countries are Bangladesh, Bhutan, Cambodia, India, Indonesia, Lao PDR, Micronesia, Nepal, Myanmar, Pakistan, Papua New Guinea, the Philippines, Solomon Islands, Sri Lanka, Tajikistan, Timor-Leste, Tonga, Uzbekistan, Vanuatu, and Viet Nam.
- 4 Hallegatte et al., 2016.
- 5 Shepherd et al., 2013.
- 6 CRED and UNISDR, 2016.
- 7 Government of Nepal, NPC, 2015a.
- 8 Ibid.
- 9 Government of Pakistan, ADB & World Bank, 2011.
- 10 Ibid.
- 11 Using the same methodology as Government of Nepal, NPC, 2015a & 2015b.
- 12 Government of Fiji, 2016.
- 13 Using the same methodology as Government of Nepal, NPC, 2015a & 2015b.
- 14 UNICEF, 2014.
- 15 Using the same methodology as Government of Nepal, NPC, 2015a & 2015b.
- 16 Vanuatu Daily Post, 2015.
- 17 Ibid.
- 18 Using the same methodology as Government of Nepal, NPC, 2015a & 2015b.
- 19 Brouwer et al., 2007.
- 20 Patankar et.al., 2016.
- 21 Ibid.
- 22 Hallegatte et al., 2016.
- 23 Paul, 2010.
- 24 Rodriguez-Llanes, 2016.
- 25 Gaire et al., 2016.
- 26 Government of Sri Lanka & WFP, 2017.
- 27 UNISDR, 2015b.
- 28 The variables used to define the threshold between intensive and extensive disaster losses are mortality and housing destruction. Statistically, the threshold is fixed at: Mortality: less than 30 people killed (extensive); 30 or more killed (intensive); or Housing destruction: less than 600 houses destroyed (extensive); 600 or more houses destroyed (intensive). This threshold has proved robust even as the universe of national disaster databases continues to grow (UNISDR, 2015b).
- 29 FAO, 2008.
- 30 Phuong et al., 2015.
- 31 Ibid.
- 32 Karna, 2017.
- 33 Kabeer, et al. 2009.
- 34 Bird, 2011.
- 35 ACCCRN, n.d.
- 36 UNISDR, 2015c.
- 37 Government of Nepal, NPC, 2015a.
- 38 CITYNET, 2017.
- 39 UN, 2017.
- 40 UNISDR, 2017.
- 41 UNISDR, ARISE, 2017.
- 42 MIT, Urban Risk Lab, 2017.
- 43 ESCAP, 2014.
- 44 UNISDR, 2009.
- 45 Dinar et al., 2007.
- 46 World Bank, 2015.
- 47 Ibid.





3

ACTION FOR RESILIENCE IN AGRICULTURE

ACTION FOR RESILIENCE IN AGRICULTURE

In many countries in Asia and the Pacific the poorest people are to be found in rural areas working in agriculture, where they are exposed to the elements and to the power of natural forces. The major risks are droughts and floods that destroy crops and livelihoods and undermine rural economies. Added to this is the impact of climate change which is likely to reshape agriculture and the prospects for food security.

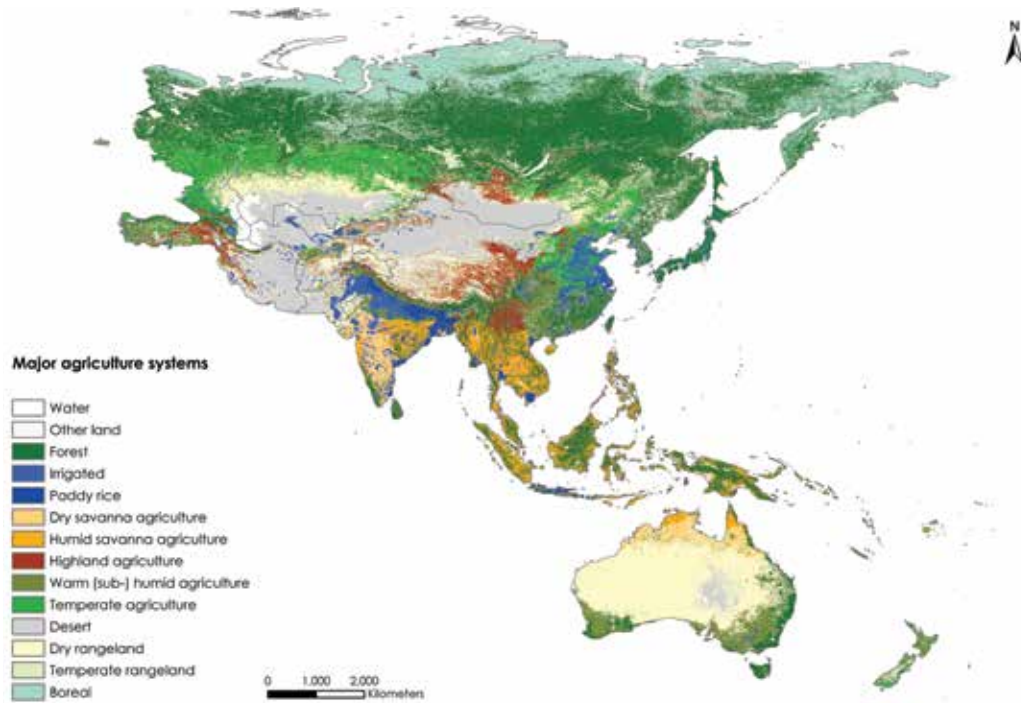
Over the past two decades, rapid economic growth and increased agricultural productivity have helped reduce hunger. Between 1990 and 2013, the value of food produced in Asia and the Pacific increased by more than 80 per cent. Nevertheless, of the world's 795 million undernourished people, 490 million are in Asia and the Pacific. And 500 million people are expected to be added to the region's population by 2030, putting further pressure on food security.¹

Around 40 per cent of the Asia-Pacific landmass is used for agriculture. The range of agricultural production systems is indicated in Figure 3-1, and the major crops in Figure 3-2. Agriculture is also a major employer. In Cambodia, India, Indonesia, Philippines, Sri Lanka, and Viet Nam, for example, agriculture employs over 30 per cent of the labour force.

However, the amount of land available for agriculture has been shrinking. Between 1993 and 2013, the region lost 5.3 per cent of its arable land – 35 million hectares– due to land degradation and conversion to other uses such as industrial parks and urban centres.² Between 1992 and 2014, the amount of arable land fell from 0.28 to 0.21 hectares per person – equivalent to every person losing a small garden, allotment or vegetable patch. Asia has less potential than other global regions for expanding arable land, so this will have major implications for future food security. Building disaster resilience for agriculture thus has greater significance beyond the economic impacts; it is also critical for improving livelihoods and reducing poverty.

Figure 3-1

Major agriculture systems in Asia and the Pacific



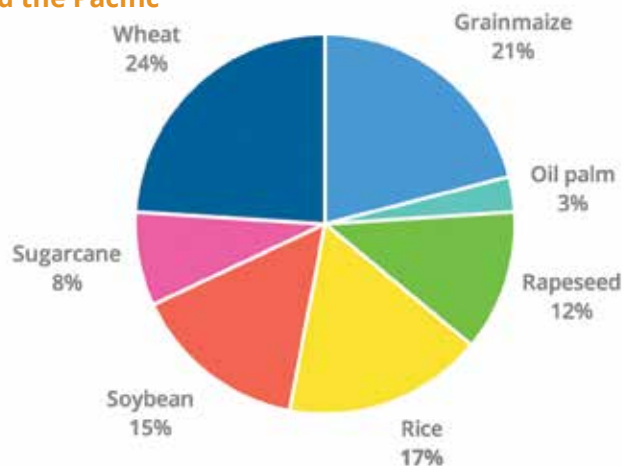
Source: FAO, *the State of the World's Land and Water Resources for Food and Agriculture*, 2011. Available from <http://www.fao.org/geonetwork/srv/en/main.present?from=11&to=20> (Accessed August 2017).

Notes: Agricultural land is composed of dry rangeland (14 per cent), temperate agriculture (7 per cent), humid savanna agriculture (4 per cent), temperate rangeland (3 per cent) irrigated (3 per cent), warm (sub-) humid agriculture (3 per cent), highland agriculture (3 per cent), dry savanna agriculture (1 per cent) and paddy rice (1 per cent).

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Figure 3-2

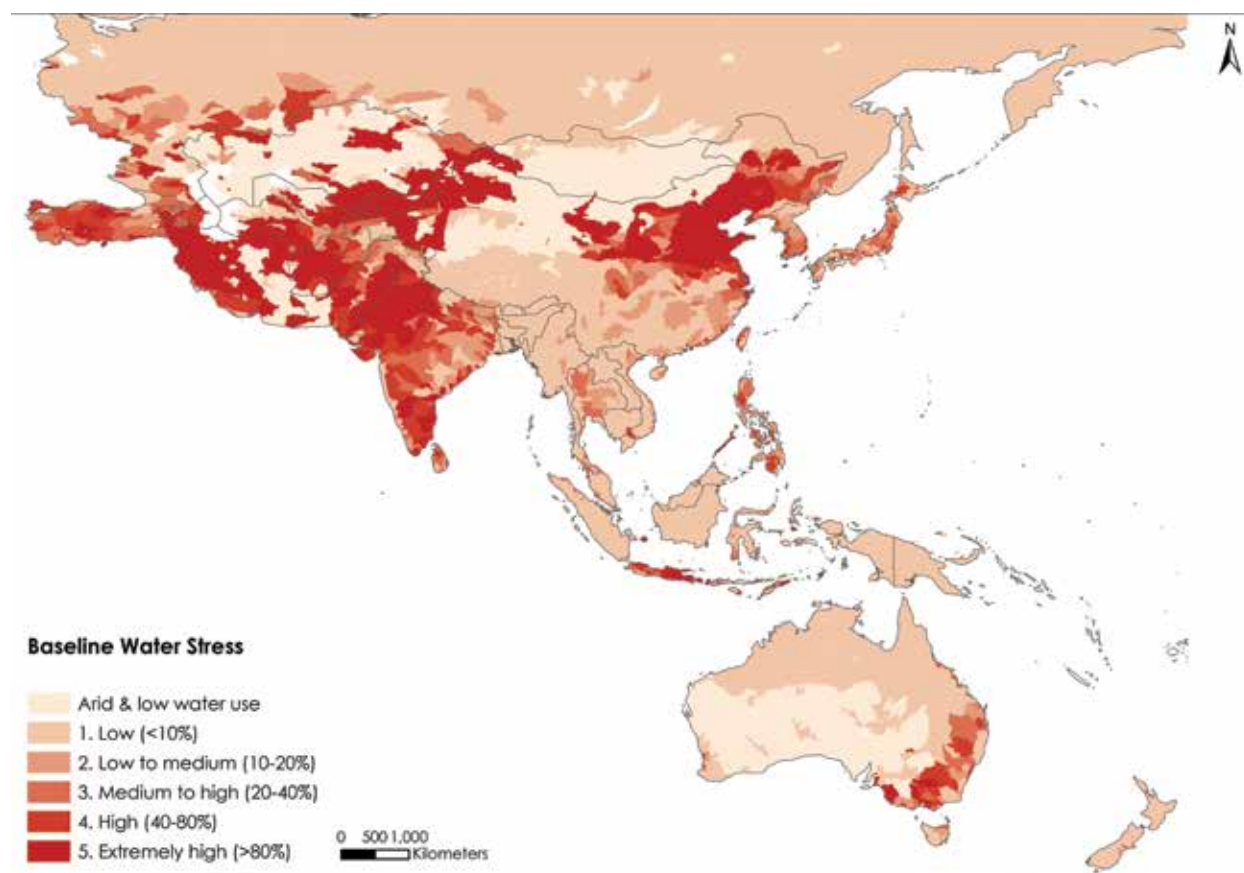
Major crops in Asia and the Pacific



Source: Based on data from Joint Research Center of European Commission (2016).

Figure 3-3

Water stress in Asia and the Pacific



Based on World Resource Institute, 2016.

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Another concern is the availability of water. Most water in Asia and the Pacific is used for agriculture; in 13 predominantly agrarian countries in the region the proportion is more than 90 per cent. Among the most water-intensive crops are wheat and rice. Because of growing populations and economic development, nearly all countries in the region are putting pressure on water resources and reducing the quantity per person. Between 1990 and 2010, per capita water availability dropped

in many countries: for example by 42 per cent in the Solomon Islands; by 36 per cent in Malaysia, Nepal and Pakistan; by 29 per cent in India and Bangladesh, and by 23 per cent in Viet Nam.³ Countries in South and South-West Asia and Central Asia are also facing high levels of water stress, primarily because of the demand from rising populations and other competing sectors (Figure 3-3).⁴ Around 40 per cent of wheat, rapeseed and grain maize areas are under high to extremely high water stress.⁵

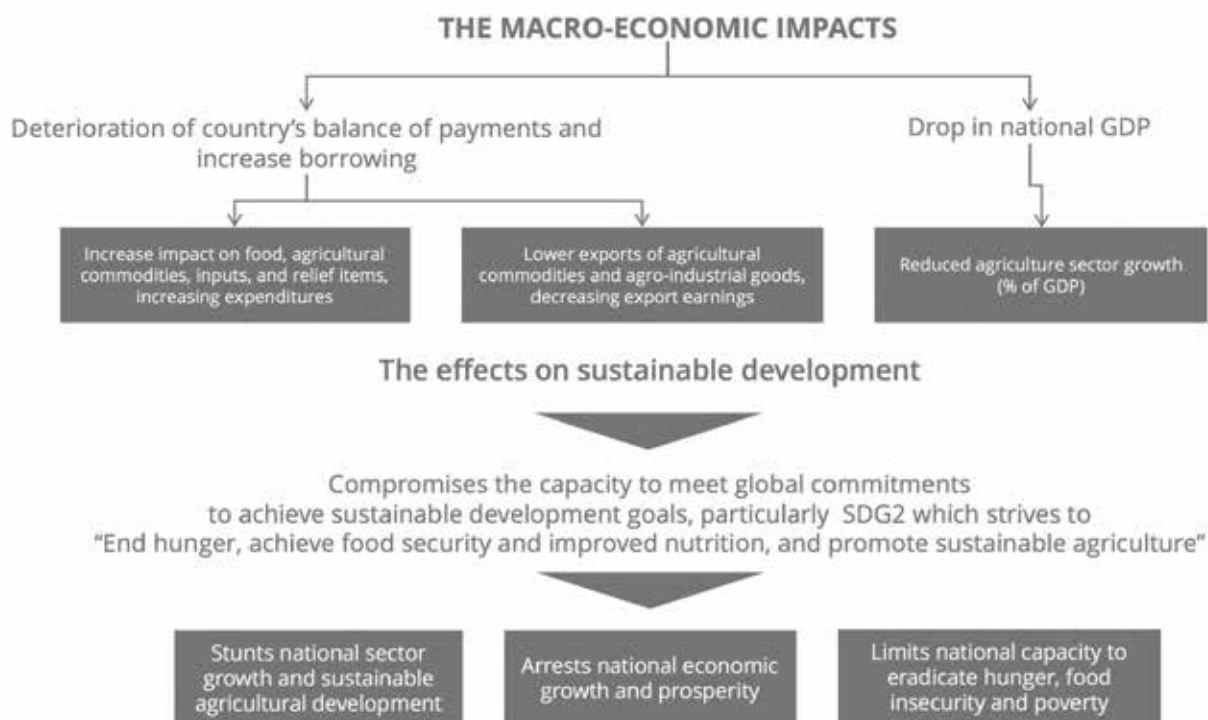
Impact of disasters on agriculture

Globally agriculture absorbs around one-fifth of the total economic impact caused by natural hazards.⁶ A review of recent disasters in Asia and the Pacific indicated a similar outcome: on average, agriculture absorbed 17 per cent of the total economic impact.

- *Solomon Islands, flash floods, 2014* – In 2013, crops and livestock made up 15 per cent of GDP, forestry 15 per cent, and fisheries 6 per cent. Of the total damage and losses of \$18 million for the three subsectors, 88 per cent was attributable to crops, 10 per cent to livestock, and 2 per cent to fisheries. Almost all of this was in the private sector.⁷
 - *Myanmar, floods and landslides, 2015* – Agriculture accounts for around a quarter of GDP and employs around half the labour force. In the impacted regions, the disaster damaged around one-fifth of the cultivated area, of which one-third was totally lost for production in 2015, while the rest was damaged but still able to produce crops. Of the total cultivated area in the 12 affected states and regions, the floods destroyed 6.6 per cent. Total damages and losses to crop production amounted to \$302,612. Total fishery-related damages and losses were \$256,298. Around one-fifth of the total aquaculture area was damaged.⁸
 - *Vanuatu, cyclone Pam, 2015* – Total agriculture damage and losses were \$56 million, of which 69 per cent were for crops, followed by forestry (16 per cent), livestock (9 per cent), and fisheries (6 per cent). The greatest impact was on permanent crops, such as kava, banana, coconut, cocoa, and coffee, but seasonal crops (vegetables) and annual crops (cassava, taro) also suffered major losses. Livestock damage and losses were mostly for commercial poultry farms and for pigs and apiculture. There were also losses for forestry and fisheries.⁹
 - *Fiji, cyclone Winston, 2016* – Total crop damage, for coconut, kava, cocoa and sugar cane was estimated at \$3.9 million. The estimated damage and losses to livestock, mainly in the Western and Central Divisions, was \$6.6 million. Fisheries production losses were over \$82.9 million, because of extensive damage to assets and to the production capacity of coral reef ecosystems and other fish habitats.¹⁰
 - *Nepal, Gorkha earthquake, 2015* – Total agricultural damages were \$164 million while the total lost value of production was \$119 million. The earthquakes increased the fragility of food production systems. Losses of farm land and other productive assets make poor and marginal farmers, including the elderly and women, more vulnerable to future disasters.¹¹
 - *Sri Lanka, floods and landslides, 2016* – Nearly two per cent of paddy cultivation area was affected, though fortunately the floods occurred early in the sowing season and many farming households were able to replant. The floods and landslides caused population displacements, damage to productive assets, loss of livelihoods, and reduced production for crops, livestock, fishery and aquaculture. The highest damage occurred to small-scale irrigation facilities, including the collapse of small-scale dams, the destruction of drainage systems and blockage of irrigation channels.¹²
- These losses refer to direct costs for agriculture. But the agriculture sector is also linked with industry and services through both demand and production (Figure 3-4).¹³ Reduced agricultural

Figure 3-4

Cascading disruption from disaster damage to agriculture



Source: Based on FAO, 2015.

output therefore also slows overall economic growth, leading to a deterioration of a country's balance of payments and increased borrowing.

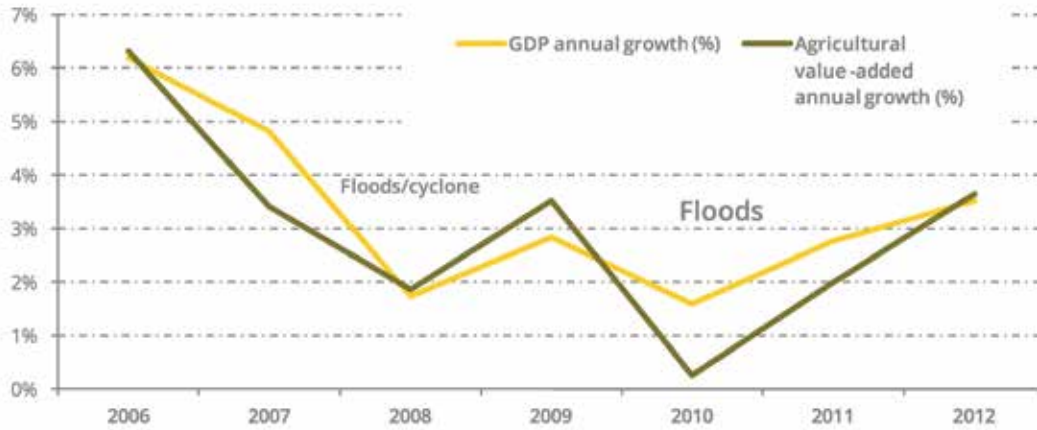
In India, for example, it has been estimated that a one per cent fall in agricultural output will decrease industrial output by 0.52 percentage points, and service sector output by 0.24 percentage points.¹⁴ In Tamil Nadu, it has been estimated that the 2012–2013 drought caused a 32 per cent drop in agricultural output which further cascaded to a 17 per cent fall in industrial output and an 8 per cent fall in the service sector.¹⁵ Similarly in Pakistan, where agriculture

contributes about one quarter of GDP, floods in 2010 cut agricultural growth from 3.5 to 0.2 per cent, while GDP growth declined from 2.8 to 1.6 per cent. Agricultural and GDP growth in Pakistan, with disaster occurrences, is illustrated in Figure 3-5.¹⁶

In the Marshall Islands, the 2015–2016 drought resulted in a 12 per cent drop in agricultural production, including subsistence and commercial sales, amounting to \$1.8 million. But this also triggered declines in output and higher production costs for other social and economic activities (Figure 3-6).

Figure 3-5

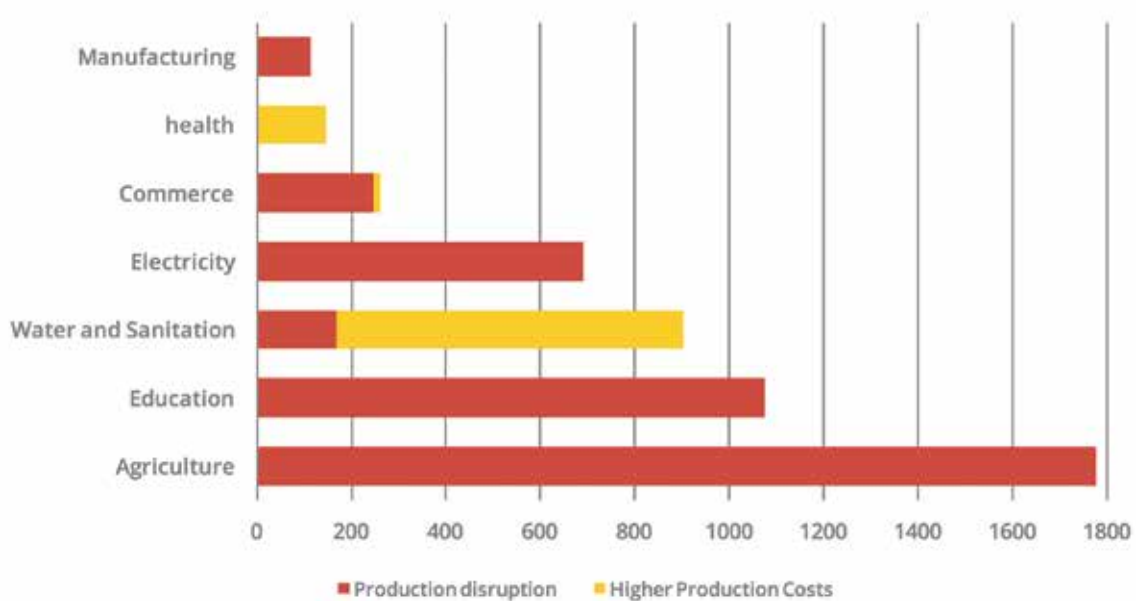
Agricultural value added and GDP in Pakistan, 2006-2012



Source: FAO, 2015.

Figure 3-6

Marshall Islands, costs of 2015-2016 drought cascading from agriculture, \$ '000s



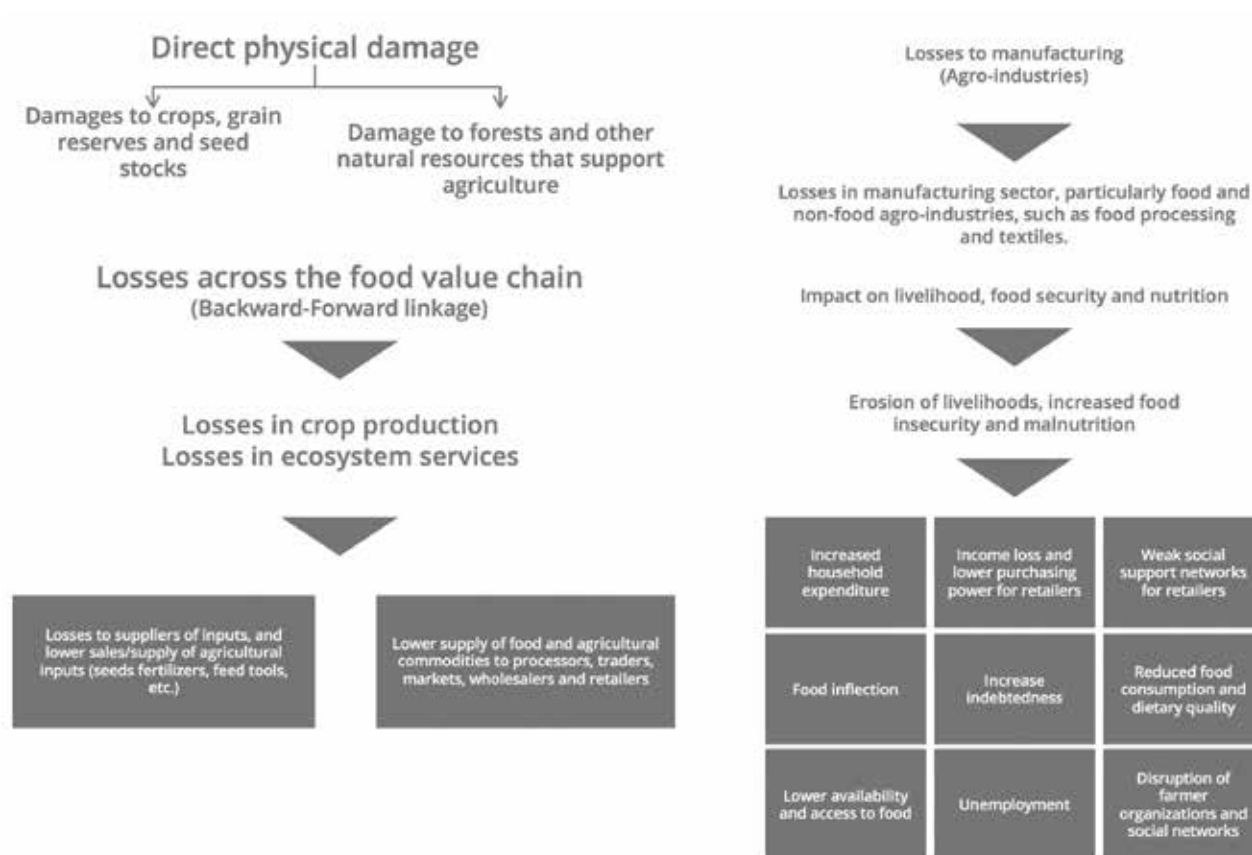
Source: Republic of Marshall Islands, 2017.

Disaster damage to agricultural assets and infrastructure, causes substantial disruptions in production cycles, trade flows, as well as in and livelihoods and employment opportunities (Figure 3-7). For overall economic losses, a large part is in agricultural trade. Pakistan, for example, is one of the world’s top five rice exporters. From 2009 to 2010 rice production

fell from 10.3 million to 7.2 million tons and exports fell by 30 per cent. There was also a surge in rice imports – from 1,925 tons in 2010 to 21,052 tons in 2011.¹⁷ Many of the losses were incurred by poor, small and marginal farmers who lacked insurance and the financial resources to regain lost livelihoods.

Figure 3-7

Disruptions of agricultural trade due to natural disasters



Source: ESCAP, based on FAO, 2015

Box 3-1

FAO report on disaster impacts on agriculture

FAO has estimated the impact on disasters on agriculture globally for the period 2003 to 2013. Most affected was the crop subsector with damages and losses of \$13 billion, almost 60 per cent of which were caused by floods, followed by storms with 23 per cent. Livestock was the second most affected subsector, accounting for \$1 billion, or 36 per cent, most of which resulted from drought. Around 6 per cent of all damage and losses within agriculture were for fisheries totalling \$1.7 billion. Forestry was also damaged by natural hazards. Twenty-six disaster events that took place between 2003 and 2013 caused \$737 million in damage and losses to forestry, which represents 2.4 per cent of all damage and losses within the agriculture sector – the greatest impact was from hurricanes, typhoons and storms.

Source: The impacts of natural hazards and disasters on agriculture and food security and nutrition – A call for action to build resilient livelihoods, May 2015, Food and Agriculture Organization of the United Nations (2015)

However, the export crop most affected is rice. More than 50 per cent of global rice exports are produced in South-East Asia. The 2011 floods in Cambodia, Thailand and Viet Nam seriously disrupted rice supplies. Overall, South-East Asian rice exports decreased by three million tons, resulting in shortages of rice and increased prices internationally.¹⁸

Impact of the 2015–2016 El Niño

The 2015–2016 El Niño was one of the strongest episodes of the last 50 years. It triggered severe weather anomalies across Asia and the Pacific, including more frequent and intense floods and cyclones (Table 3-1).

For agricultural production, much of the damage was caused by prolonged droughts which appeared in parts of the region at different times. The impact of the droughts can be captured in the FAO's agriculture stress index which is based on satellite data of vegetation and land surface temperature. This is illustrated in Figure 3-8 from the onset of El Niño in 2015 until its neutral phase in early 2017.¹⁹

South-East Asia – Many farmers faced substantial debt, and provinces across several countries were declared disaster zones during the El Niño period.²⁰ Drought affected large parts of the Mekong river basin.

Table 3-1

El Niño-related disasters, severity of impact, 2015-2016

Sub-region	Country	Flood & Landslide	Drought	Tropical Cyclone
Southeast Asia	Cambodia			
	Indonesia			
	Lao PDR			
	Malaysia			
	Myanmar			
	Philippines			
	Thailand			
	Viet Nam			
South Asia	Afghanistan			
	Bangladesh			
	Bhutan			
	India			
	Nepal			
	Pakistan			
	Sri Lanka			
North Pacific	Marshall Islands			
	Micronesia			
	Palau			
Central Pacific	Kiribati			
	Niue			
	Samoa			
	Tonga			
	Tuvalu			
South Pacific	Fiji			
	New Caledonia			
	Papua New Guinea			
	Solomon Islands			
	Vanuatu			

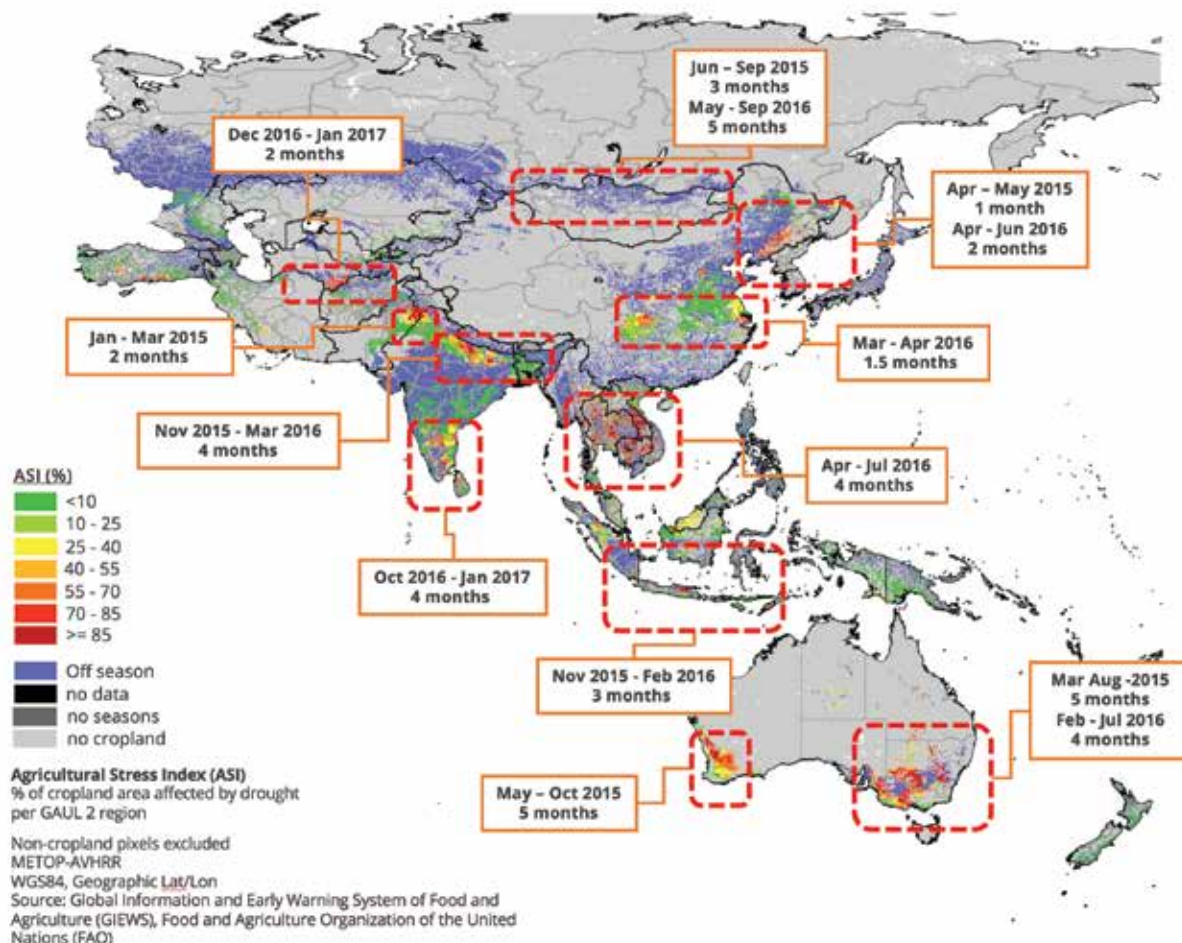
Source: *Enhancing Resilience to Extreme Climate Events: Lessons from the 2015–2016 El Niño Event in Asia and the Pacific – A multi-agency (UNDP, ESCAP, OCHA) study of lessons learnt 2017 – unpublished report.*

Note: Classification based on number of deaths, number of people affected, and total economic damage.

- *Viet Nam* – suffered a severe drought in the South Central and Central Highlands regions and extended saltwater intrusion in the Mekong Delta. In 2015, the country experienced negative agricultural growth for the first time since records began.²¹ The total economic impact was estimated at \$674 million, or 0.35 per cent of GDP.²²
- *Cambodia* – an estimated 2.5 million people, were affected by drought, water shortages, land degradation, loss of livestock and reduced agricultural productivity. In 2015, the drought affected almost 250,000 hectares of cropland, and destroyed over 40,000 hectares of rice.²³
- *Philippines* – 85 per cent of provinces were affected.
- *Thailand* – insufficient rainfall depleted water levels in reservoirs, and farmers postponed, or avoided, planting crops.^{24 25}

Figure 3-8

El Niño-related droughts in Asia and the Pacific, 2015/16



Source: Based on FAO ASI data.

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 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.

- *Timor-Leste* – a prolonged drought severely affected food security.

South Asia – India bore the brunt of the drought impact, with a second year of sub-par rains, recording a 14 per cent deficit in the south-west monsoon; around 19 million hectares of crop area and 330 million people in seven states were affected. Large parts of South Asia were also exposed to changes in the frequency and intensity of tropical storms (cyclones). In May 2016, cyclone Roanu caused severe flooding in Sri Lanka and Bangladesh.

North-East Asia – Mongolia suffered a severe drought in 2015, which reduced wheat harvests by almost 50 per cent from 2014, and 40 per cent below the five-year average.²⁶ The country experienced a dzud – severe winter weather that leaves no fodder or pasture for livestock.

Pacific Islands – This subregion is very vulnerable to the effects of El Niño because of dependence on subsistence agriculture and local fisheries. In 2015 and 2016, there was a range of El Niño-related impacts including a shift in the paths of tropical storms.²⁷ El Niño conditions also altered the location of fish populations and their migration patterns, corresponding to the availability of phytoplankton (Box 3-2). Extreme weather patterns and rising sea surface temperatures affected coral reefs and the wider ecosystems that provide livelihoods and generate income from tourism.

Long-term impacts of disasters on food production

Disasters undermine all aspects of food security, by reducing food supplies, and cutting the incomes of poor communities. The events can take several years to recover from – trapping poor communities in a cycle of hunger and poverty. In Bangladesh, for example, following

floods there was an increase in wasting and stunting among pre-school children, due to reduced access to food, increased difficulties in providing proper care and greater exposure to contaminants. In the Philippines over the last two decades, 15 times as many infants have died in the 24 months following typhoon events as have died in the typhoons themselves; most of the victims were infant girls.²⁸

There are also longer-term impacts. Prolonged drought contributes substantially to land degradation. Water and land scarcity, coupled with a succession of disasters, erodes traditional coping mechanisms, particularly for the poorest people who live on the most degraded land. Water and land resources are scarce in certain parts of the region, especially in rice and maize cultivation areas (Figure 3-9). And the pressures are expected to increase with expanding irrigation systems.

The impacts of disasters on food security have been documented for several countries.

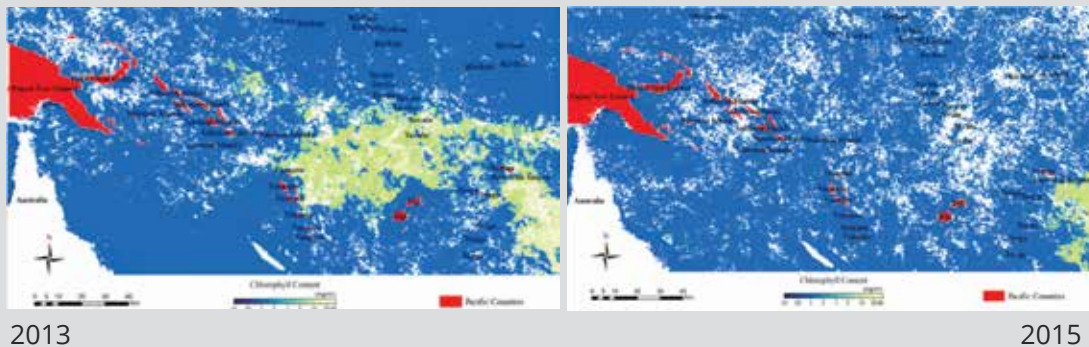
- *Sri Lanka* – Between 2012 and 2017, Sri Lanka was hit three times by droughts and twice by floods. As a result, the number of food insecure households tripled – from 66,550 to 227,500. Food insecurity was significantly higher among small and marginal farmers, landless labourers and female-headed households. Some households responded by selling livelihood assets, taking children out of school or reducing expenditures on health and hygiene.
- *Philippines* – Between 2006 and 2013, the country was hit by 78 natural disasters (two droughts, 24 floods, 50 typhoons/tropical storms, one earthquake and one volcanic eruption). Total damage and losses for agriculture were \$3.8 billion, with damage

Box 3-2

Impact of 2015–2016 El Niño on phytoplankton in the Pacific

One indicator of biological productivity in the oceans is the availability of phytoplankton which provide food for a wide range of sea creatures. A measure of the extent of phytoplankton is chlorophyll pigments which can be assessed through ocean colour monitor sensors. The maps below indicated the extent of chlorophyll during a normal year (2013) and the reduced amount in an El Niño year, 2015, due to the warming waters.

Impact of 2015–2016 El Niño on phytoplankton in the Pacific (2013 left, 2015 right)



Source: ESCAP based on the data from NASA on Chlorophyll Concentration (1 month - Aqua/MODIS)
https://neo.sci.gsfc.nasa.gov/view.php?datasetId=MY1DMM_CHLORA

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

to over six million hectares of crops. Most of the losses were caused by typhoons/storms.⁶

- *Pakistan* – Because of a series of droughts in Sindh province, farmers who rely on seasonal monsoon rainfall have been abandoning wheat and cotton cultivation.²⁹

Desertification, land degradation and drought, when compounded by poverty and inequality, can also affect political insecurity and conflict. Some of the world's most conflict-prone regions are drylands.³⁰ Drought and degradation drive people off their land, creating economic migrants

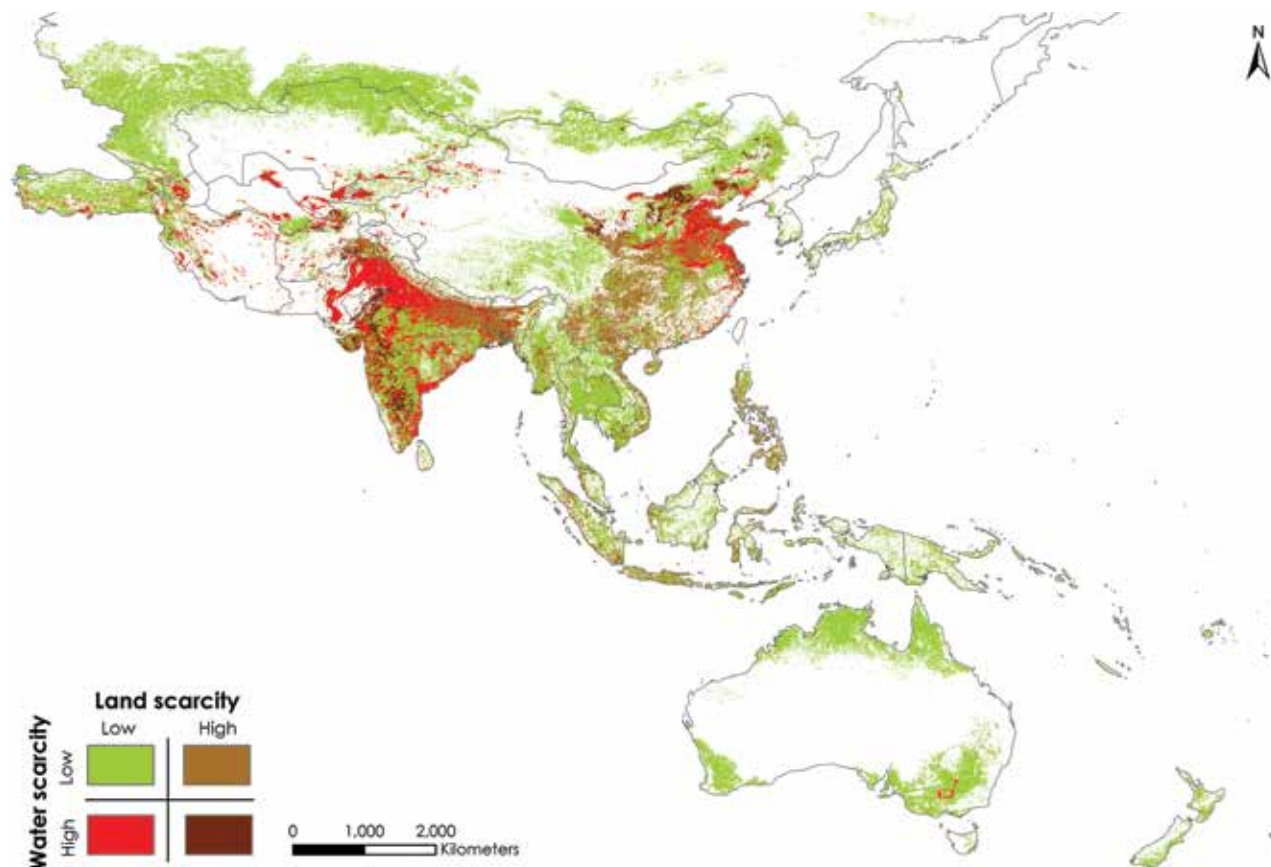
and environmental refugees. Temporary migration has long been an important element in rural livelihoods during times of stress, but more people are now migrating internationally, and for longer periods.

Disaster risk reduction and agriculture

Productive and efficient agricultural systems will need to preserve the productive base of natural resources and ecosystem services while increasing the capacity to withstand risks, shocks and climate variability. This will

Figure 3-9

Land and water scarcity in Asia and the Pacific



Source: FAO, 2011.

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require specific measures for DRR, as well as considerable changes in terms of governance, laws, policies, and private and public investment. These priorities are emphasised in the Sendai Framework which indicates a paradigm shift for agriculture – from reducing risk to managing risk for disaster prevention – and identifies the significance of slow onset and extensive disasters, such as drought, and the impacts of climate variability and drought that year after year erode the livelihoods of smallholders (Box 3-3).

Building climate-resilient agriculture

In its 2014 Assessment, the IPCC estimated that climate change could increase the risk of hunger and malnutrition by up to 20 percent by 2050.³¹ The evidence shows the high correlation between hunger and climate risk in Asia-Pacific region affected by food insecurity (Figure 3-10). It illustrates further that South Asian countries are extremely vulnerable due to high population density in vulnerable settings.³²

Box 3-3

Sendai Framework priorities for agriculture

For agriculture, the Sendai Framework of Disaster Risk Reduction has the following priorities:

Priority 1: Understanding disaster risk in the agriculture sector that requires

- Capacities for the multi-threat assessment of risks and vulnerabilities especially those related to weather and climate in the agriculture sector.
- Information systems that gather, monitor and share, periodically, information on disaster risk for the agriculture sector.

Priority 2: Strengthening risk governance in the agriculture sector with following key activities:

- National legal frameworks, policies, strategies and plans for DRM include the different sub-sectors of the agriculture sector.
- Participation of the agriculture sector in the governmental mechanisms for inter-sectoral coordination for disaster risk reduction and resilience.

Priority 3: Investment in disaster risk reduction for the resilience of the agriculture sector:

- Systematic planning of the use of natural resources and promotion of sustainable productive systems in all government interventions in the agriculture sector.
- Availability of formal mechanisms for risk retention and transfer (funds, insurance and social protection) adapted to the needs of the different types of smallholders.

Priority 4: Response preparedness and “build back better” in the agriculture sector

- Risk monitoring systems and multi-hazard early warning systems adapted to the different sub-sectors: agriculture, livestock, forestry, fisheries and food security.
- Inclusion of risk prevention and mitigation aspects in programmes and plans for the rehabilitation of livelihoods and development, as well as for sustainable development programmes.

Source: Guidelines and Recommendations for the Implementation of the Sendai Framework for Disaster Risk Reduction in the Agriculture and Food Security and Nutrition Sector. Latin America and the Caribbean, Food and Agriculture Organization of the United Nations United Nations Office for Disaster Risk Reduction Santiago, 2016

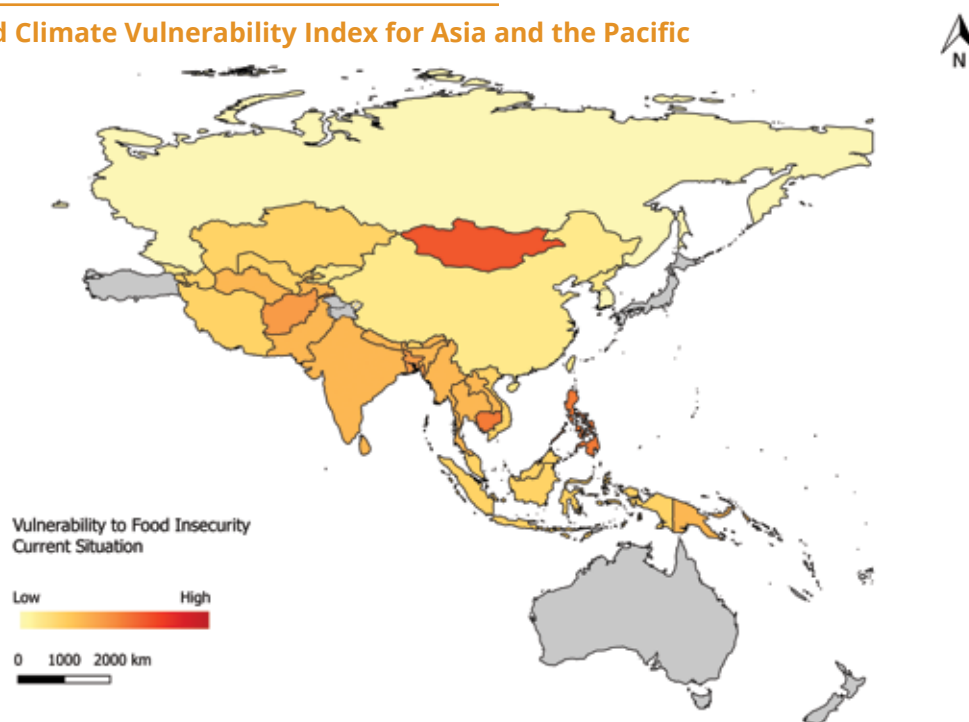
For example, ten out of the top 15 countries in the world with the most people and economic output exposed to annual river floods are in the Asia-Pacific region.³³ The transboundary river-basins in the region are also home to a large number of poor and vulnerable populations dependent on agriculture (Figure 3-11). Around 40 per cent of the world’s poor live on or close to the major transboundary river-basin

systems in South Asia.³⁴ Climate variability and change often manifest themselves in monsoon variability, incidence of El Niño and La Niña, and other extreme weather events - resulting in large-scale frequent flooding and increasing vulnerability of populations in South Asia.

Further, South Asian countries have very low adaptive capacity (Figure 3-12). While

Figure 3-10

Hunger and Climate Vulnerability Index for Asia and the Pacific



Source: ESCAP based on the data from P.K. Krishnamurthy, K. Lewis, R.J. Choularton, Office for Climate Change, Environment, and Disaster Risk Reduction, United Nations World Food Programme, Via C.G. Viola 68/70, Rome, 00148, Italy UK Met Office Hadley Centre, Fitzroy Road, Exeter, EX1 3PB, United Kingdom, 2014 <http://www.metoffice.gov.uk/food-insecurity-index/>

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subnational empirical analysis is needed to assess and identify the pockets of vulnerability hotspots, at country-level, it is evident that the most food insecure countries are also the most vulnerable to climate risk.

Further, in order to understand future vulnerability, a projection of climate scenarios for the year 2050 highlights that there may not be a major shift in the spatial landscape of climate vulnerability and the South Asia sub-region continues to be the most vulnerable (Figure 3-13). The vulnerabilities to food security due to climate change are likely to remain largest in South Asian countries.

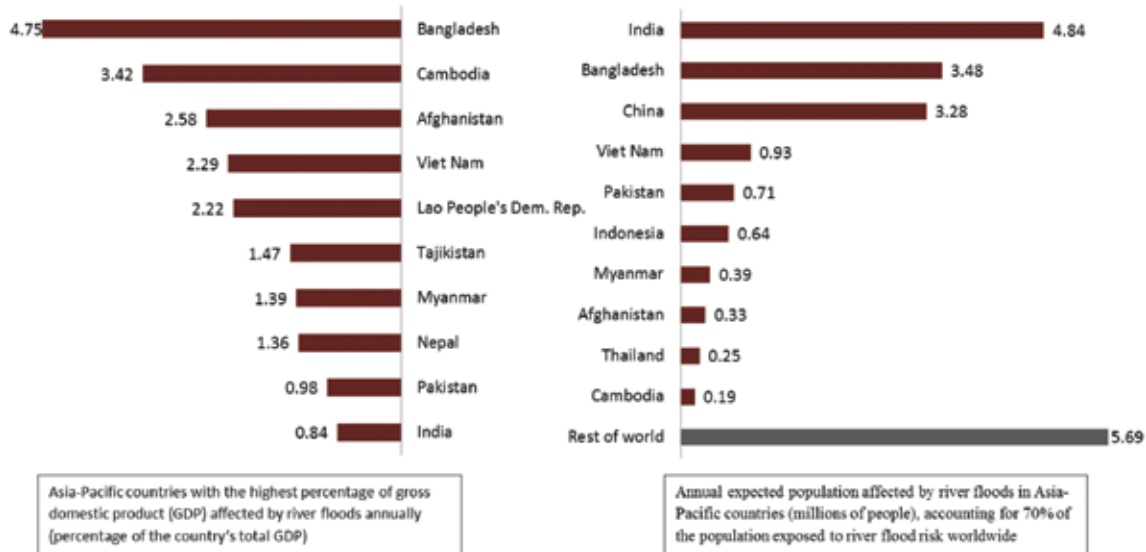
National strategies

Disaster risk reduction and resilience must be systematically embedded into agricultural development plans and investments – particularly in countries facing recurrent disasters and where agriculture is a critical source of livelihoods, food security and nutrition.

There are different strategies for achieving resilient agriculture. These include: boosting agricultural productivity with stress tolerant varieties; adjusting planting dates, expanding water harvesting, storage, and conservation to reduce land degradation; insurance and social protection schemes for farmers. At the regional level, countries can reduce variability in food availability through food reserves and trade

Figure 3-11

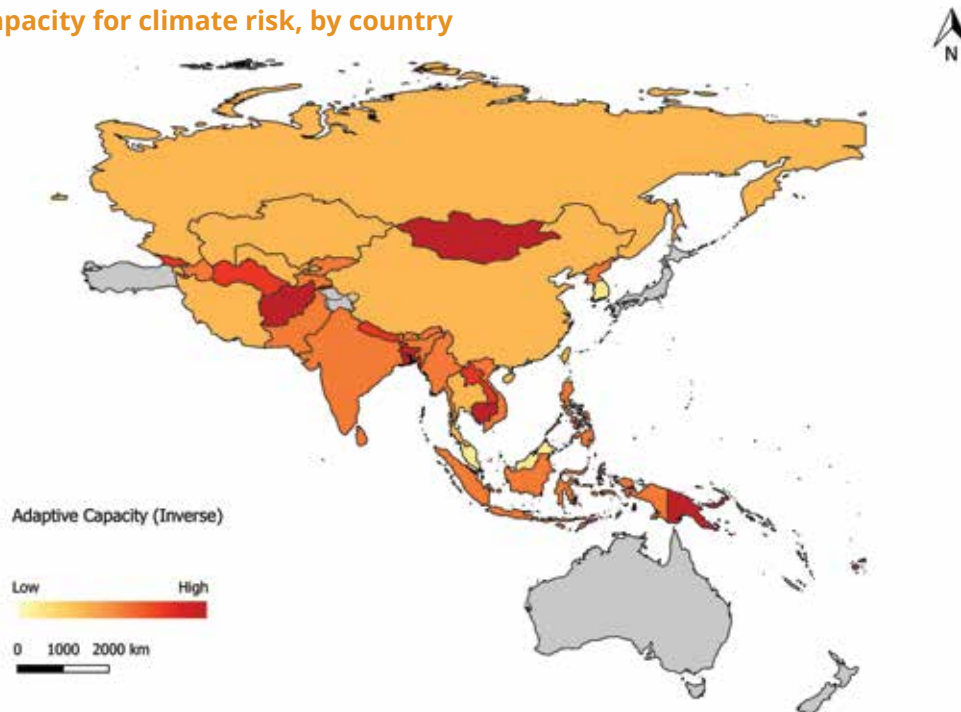
Asia-Pacific countries with highest percentages of GDP, and the number of people affected by floods



Source: ESCAP based on World Resource Institute Flood database, 2016.

Figure 3-12

Adaptive capacity for climate risk, by country

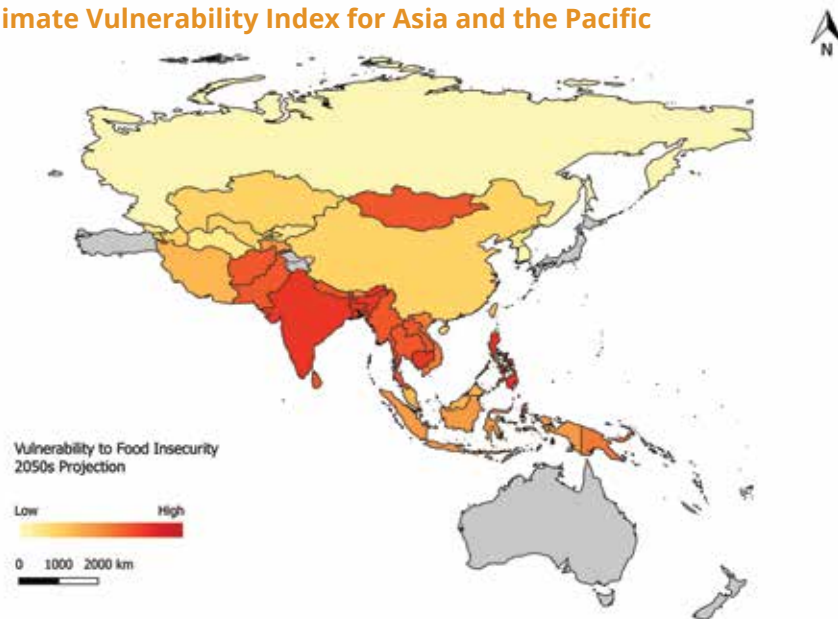


Source: ESCAP based on the data from P.K. Krishnamurthy, K. Lewis, R.J. Choularton, Office for Climate Change, Environment, and Disaster Risk Reduction, United Nations World Food Programme, Via C.G. Viola 68/70, Rome, 00148, Italy UK Met Office Hadley Centre, Fitzroy Road, Exeter, EX1 3PB, United Kingdom.

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Figure 3-13

Projected 2050 Climate Vulnerability Index for Asia and the Pacific

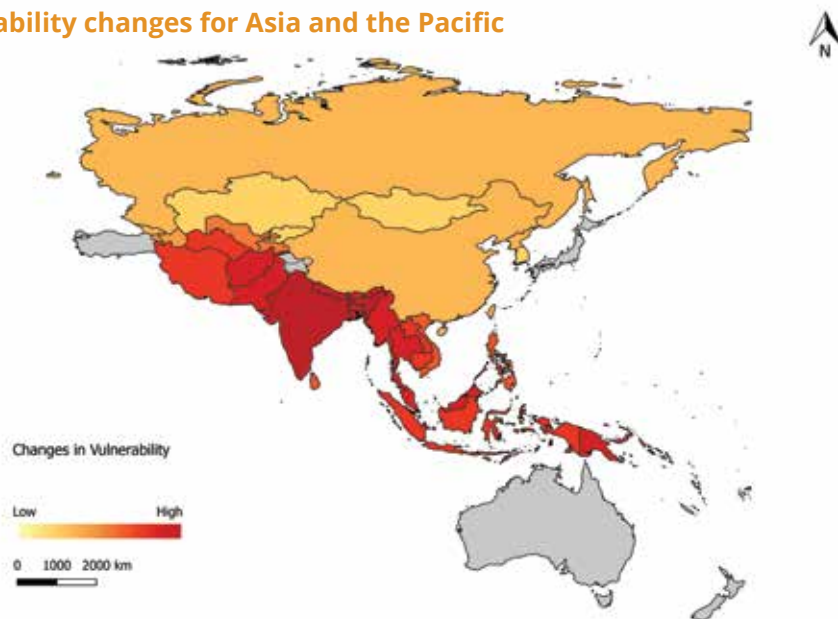


Source: ESCAP based on the data from United Nations World Food Programme and the UK Met Office United Kingdom.

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Figure 3-14

Projected vulnerability changes for Asia and the Pacific



Source: ESCAP based on the data from United Nations World Food Programme and the UK Met Office United Kingdom.

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schemes. In addition, there are some specific measures that countries can take. Examples of programmes in Asia and the Pacific are:

- *Afghanistan* – The country has \$280 million in agriculture losses due to disasters per year. It has been estimated that a severe (once in lifetime) drought could result in nearly \$3 billion in agricultural losses. A one-metre high flood retaining wall in Kabul would cost approximately \$180,000, but the net value of investing in a flood retaining wall would be \$13.5 million. One new embankment in Kabul could reduce flood damages by \$600,000 per year.³⁵
- *Bangladesh* – Despite frequent floods, cyclones and droughts, Bangladesh has made commendable progress over the past 40 years in achieving food security; between 1972 and 2014 food grain production tripled. Bangladesh has invested more than \$10 billion in enhancing community resilience, improving government response to emergencies, strengthening river embankments and coastal polders, building emergency cyclone shelters and resilient homes, adapting rural household farming systems, reducing saline water intrusion, especially in areas dependent upon agriculture, and implementing early warning and emergency management systems. In April 2017, the Government and the World Bank signed a \$113-million financing agreement to modernize weather forecasting, early warning systems, and delivery of weather and climate services.³⁶
- *India* – The Government has been taking measures to help the poor escape poverty and hunger and also adapt to risks, and withstand and recover from disasters. The National Rural Employment Guarantee Act (NREGA) has had positive effects in flood

and drought-prone areas – increasing rural wages, reducing gender wage gaps, enabling better access to food, and reducing distress migration from rural areas. Between 2006 and 2008, about half of the total projects supported by NREGA were for water conservation to help build the resilience of poor farmers and landless labourers.³⁷

- *Thailand* – In 2015/2016, Thailand experienced the worst drought in decades. However, the country was able to reduce the impact thanks to science-based actionable information. Government agencies used earth observation satellites, and monitored water levels in reservoirs to make seasonal forecasts and create climate scenarios. Farmers were warned about the emerging drought well in advance and advised not to plant a second crop because of water insecurity.

Regional strategies

There have also been measures at the regional level, particularly to provide timely information for slow-onset disasters – such as forest fires, haze, droughts, floods, and cyclones. Asia and the Pacific can take advantage of its strength as a hub for knowledge and technologies. This creates opportunities for using space technology, remote sensing and geographical information systems for assessing and monitoring impending disasters.

- In 2015, ESCAP and the Regional Integrated Multi-Hazard Early Warning System (RIMES) produced a joint report: 2015-2016 El Niño Impact Outlook and Policy Implications. This included regional and national and sector-specific risk profiles, and scientifically backed, customized country risk predictions. The outlook focused particularly on the imminent risk of the El Niño for Pacific SIDS.

An important adaption mechanism is weather insurance which can help farmers protect their investments against recurrent droughts.³⁸ With varying levels of support from their respective governments, farmers in China, India, and Thailand are at different phases of adopting weather insurance. Several ongoing pilot projects are using a combination of satellite technology and weather indices. However, some key issues remain to be addressed: reducing the basis risk; using risk-layered schemes; developing reinsurance markets; and targeting institutions as insurers instead of individual households (see Chapter 6 for more details on these tools and approaches).

Many disaster risks in Asia and the Pacific cut across national borders. 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 between countries.³⁹ A single cyclone can travel close to many countries, causing heavy rainfall and flooding, until it finally makes landfall. Similarly, drought and flooding can span river basins and agro-ecological zones beyond national boundaries. Many of the region's largest rivers emanate from the Tibetan Plateau and the Himalayas, fed by glacial and snow melting and monsoon rainfall. A total of 1.3 billion people in 15 countries depend on this natural 'water tower' which feeds into the Yellow, Yangtze, Mekong, Irrawaddy, Ganges, Brahmaputra, and Indus river basins, each of which is subject to severe flooding.

For transboundary river basins, recent advances in science and technology have enabled longer lead times of up to five to eight days for flood forecasts. However, these rarely reach the communities who live along these vast rivers. On average, communities receive only one day's

notice for evacuation. ESCAP, in collaboration with RIMES, has therefore launched a toolkit that uses real-time satellite data and state-of-the-art flood modelling to enable a longer lead time in flood forecasting, and enhance end-to-end early warning systems.⁴⁰ ESCAP also has a regional drought mechanism to fill in the knowledge and capacity gaps in risk assessment, monitoring and early warning (Box 3-4).

In the Pacific, the SIDS in 2016 developed a Framework for Resilient Development in the Pacific 2017-2030. This is an integrated approach to guide resilient development and in particular to build resilience to climate change and disasters.⁴¹ The framework recognizes that climate change and disaster risks cut across climate-sensitive sectors and thus require actions for the agriculture sector.

Cognizant of the importance of the resilient agriculture in Pacific SIDS and their sensitivity to climate-related risks, ESCAP has produced guidelines on disaster risk reduction and climate change adaptation in agriculture that will help share knowledge and good practices between Asia and the Pacific and vice versa.⁴²

Stepping stones out of poverty

Across Asia and the Pacific, small farmers and poor agricultural communities are exposed to the ferocity of the elements and face both intensive and extensive disasters that can trap them in poverty. But coping with disasters also opens up new opportunities. Many of the same measures that will make them more resilient to disasters can also act as stepping stones out of poverty. They will also be closely connected with efforts to address climate change, which is the subject of the next chapter.

Box 3-4

ESCAP Regional Drought Mechanism

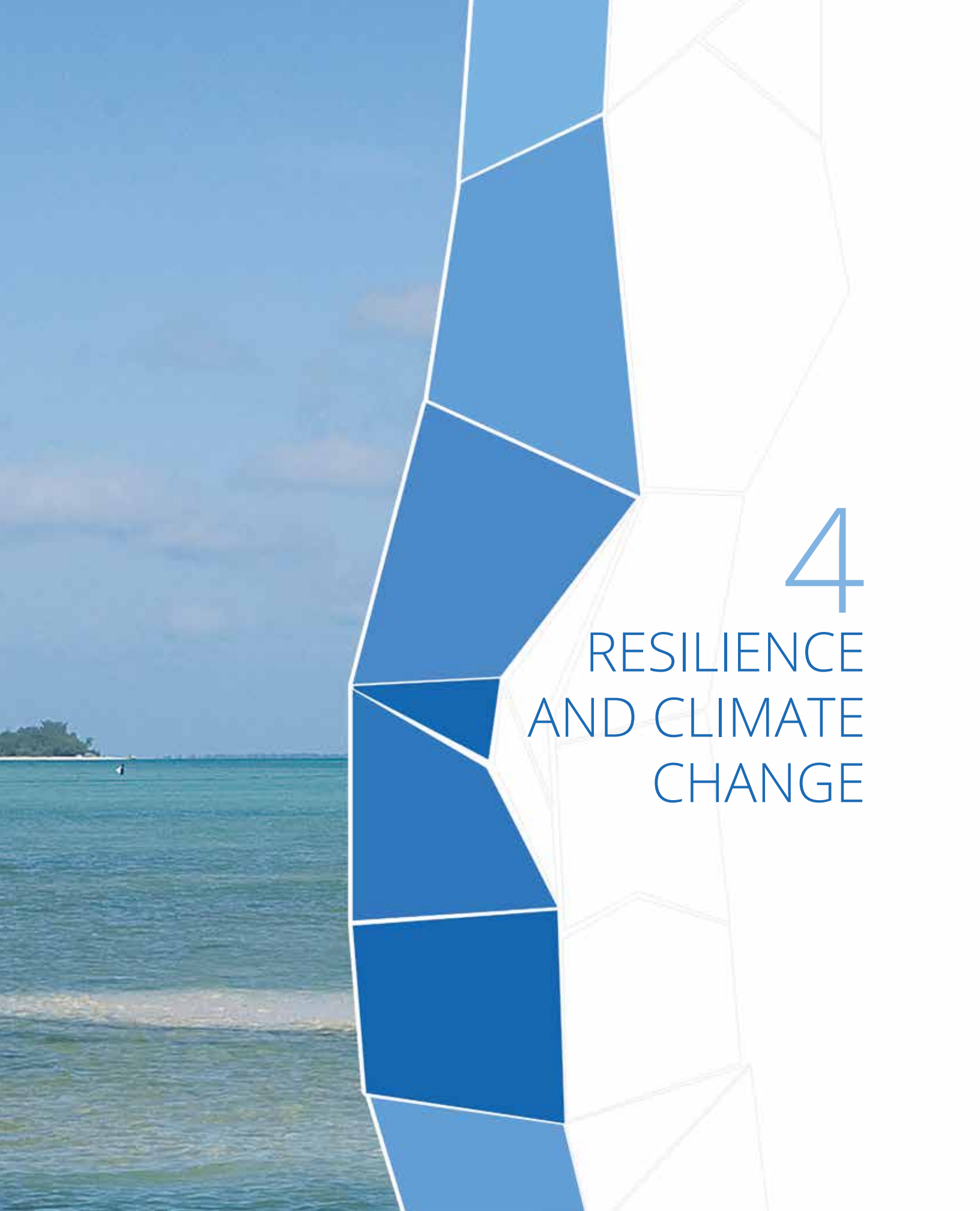
The ESCAP Regional Cooperative Mechanism for Disaster Monitoring and Early Warning, Particularly Drought, helps countries collaborate on space-derived information. Established under the Regional Space Applications Programme for Sustainable Development (RESAP), the mechanism uses data and imagery from the region's space-faring countries – China, India, Japan, Republic of Korea, Russian Federation and Thailand – and shares it with other countries, especially those prone to drought.

This service complements WMO's Global Framework for Climate Services by providing more detailed, localized forecasts that can be updated during the growing season to give more comprehensive real-time drought monitoring and early warning. Currently, the mechanism has two service nodes, in China and India, which provide space-based data, products, and capacity building. On request, experts from these nodes and ESCAP can work with member states to determine the most appropriate services, build their capacity to process and interpret the information, and disseminate the data to the people who need it most. Similar cooperative mechanisms could also be set up at the subregional level. The Pacific Island countries, for example, have the potential for establishing a subregional institution with the necessary technical capacity.

ENDNOTES

- 1 ESCAP, 2015d.
- 2 Ibid.
- 3 ESCAP, ADB & UNDP, 2017.
- 4 Gassert et al., 2014.
- 5 Joint Research Center (JRC) and World Resource Institute (WRI)
- 6 FAO, 2015c.
- 7 Government of Solomon Islands, 2014.
- 8 Government of the Union of Myanmar, 2015.
- 9 Government of Vanuatu, 2015.
- 10 Government of Fiji, 2016.
- 11 Government of Nepal, NPC, 2015b.
- 12 Government of Sri Lanka, 2016.
- 13 FAO, 2015c.
- 14 Sastry et al., 2003.
- 15 Tamil Nadu State Planning Commission, India
- 16 FAO, 2015b.
- 17 Government of Pakistan, ADB & World Bank, 2011.
- 18 ESCAP & UNISDR, 2012.
- 19 FAO, 2016a.
- 20 FAO, 2015a.
- 21 UNOCHA, 2016
- 22 Ibid.
- 23 Cambodia Ministry of Agriculture, Forestry and Fisheries, 2015.
- 24 Thaiwater, n.d.
- 25 Parpart, 2015.
- 26 FAO, 2017.
- 27 UNESCAP & RIMES, 2014
- 28 WFP, 2016.
- 29 NDMA of Pakistan et al., 2016.
- 30 United Nations General Assembly, 2011.
- 31 IPCC, 2014a.
- 32 IPCC, 2012.
- 33 WRI, 2015.
- 34 World Bank, 2015.
- 35 World Bank, 2016b.
- 36 World Bank, 2016a.
- 37 UNEP, 2010.
- 38 Sirimanne et al., 2015.
- 39 ESCAP, 2015a.
- 40 ESCAP & RIMES, 2016.
- 41 Pacific Community et al., 2016.
- 42 ESCAP, 2016a.





4

RESILIENCE AND CLIMATE CHANGE

RESILIENCE AND CLIMATE CHANGE

In future, the risks and scale of natural disasters will be heightened and reshaped by climate change. Building resilience to disasters and adapting to climate change should therefore go hand in hand.

Climate change magnifies the risk of disasters and increases their costs.¹ As the climate system has warmed, the number of weather-related hazards globally has tripled, and the number of people living in flood-prone areas and cyclone-exposed coastlines has doubled – and this trend is expected to increase.²

Over the past century, most of the Asia-Pacific region has seen warming trends and greater temperature extremes. The IPCC Synthesis Report 2014 assessed the risks and impacts of future climate change, applying different levels of confidence – from ‘very low’ to ‘very high’ – and assessing the likelihoods of various outcomes on a scale from ‘exceptionally unlikely’ to ‘virtually certain’.³ It concluded that future warming will increase the likelihood of extremely hot days and nights and result in greater evaporation that will exacerbate droughts as well as increase

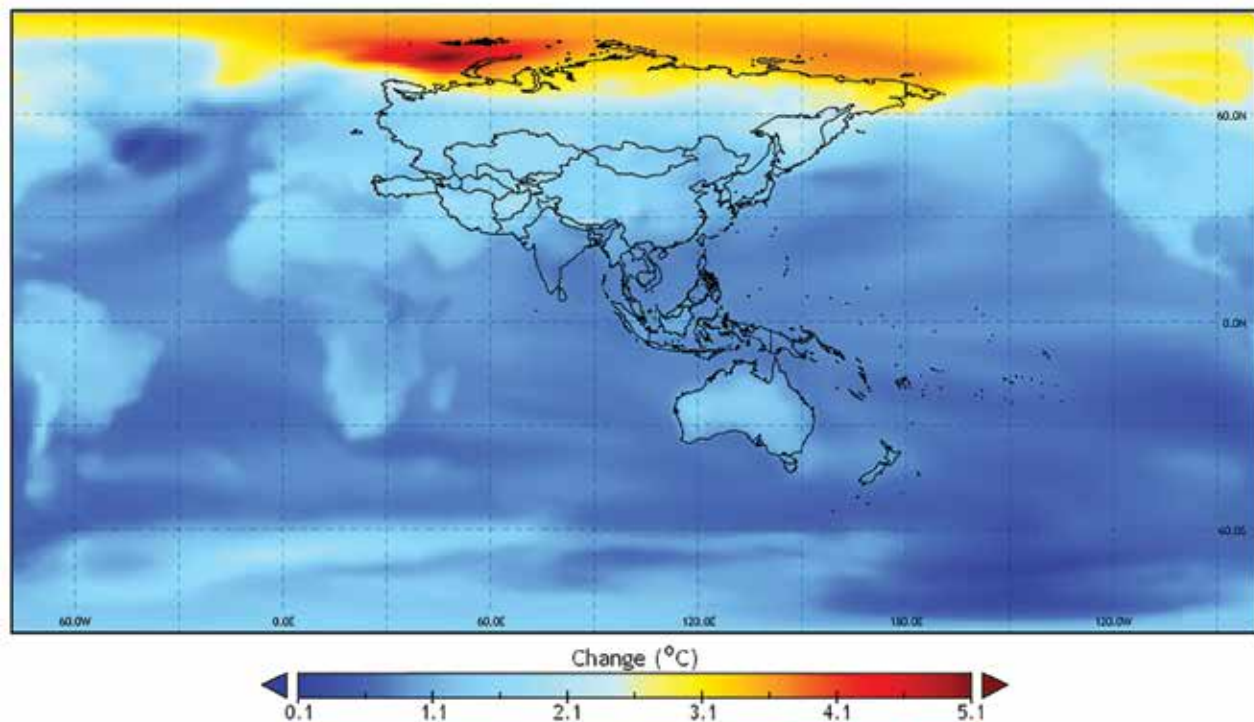
atmospheric moisture, resulting in more frequent heavy rainfall and snowfall.⁴

These changes will have a significant impact on human health. More frequent and intense heat waves will increase mortality and morbidity, particularly for vulnerable groups such as older people. Increases in heavy rain and temperature will also heighten the risk of diarrhoeal diseases, dengue fever, and malaria.

Climate change could also bring huge economic losses.⁵ For South-East Asia, for example, it has been estimated that climate change may reduce the region’s gross domestic product (GDP) by up to 11 per cent by 2100.⁶ Increases in floods and droughts that affect rice crops will increase food prices. By 2030, climate change could force more than 100 million people into extreme poverty.

Figure 4-1

Projected temperature changes by the 2030s, RCP4.5



Source: RIMES, based on datasets from CMIP 5 Modelling Groups, 2017.

Note: Changes in maximum temperatures (°C) over the Asia-Pacific region by the 2030s as compared to baseline (1980s) using an ensemble of CMIP5 GCMs for future scenario RCP 4.5

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Risk scenarios

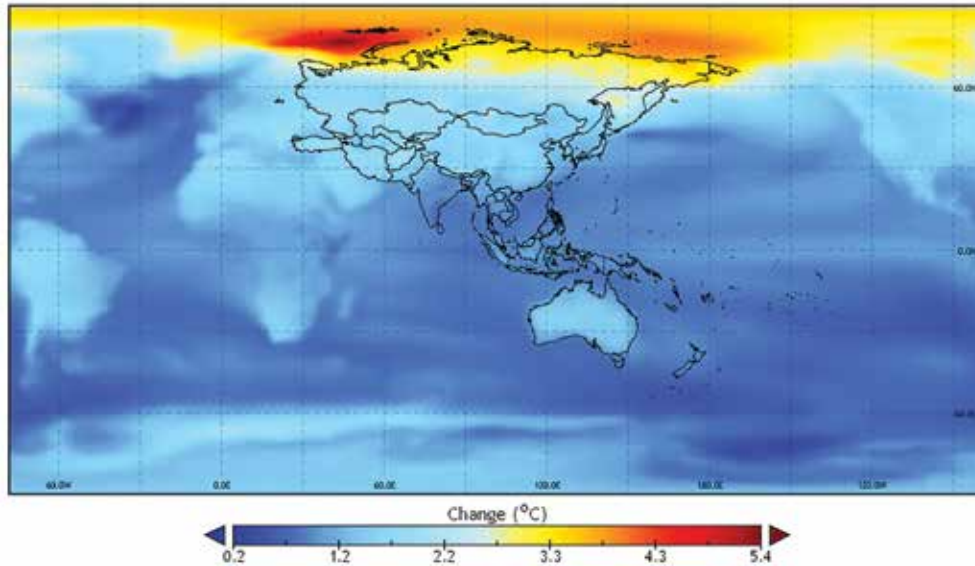
For estimates of future concentrations of greenhouse gases, the IPCC has developed five scenarios – referred to as ‘representative concentration pathways’ (RCPs). In conjunction with RIMES, ESCAP has developed climate risk scenarios for the 2030s for the Asia-Pacific region based on two of these – RCP 4.5 and RCP 8.5.⁷ Both indicate increases in temperature of 1.5 to 2.0 degrees centigrade over most of the oceanic and land areas, with higher increases at

higher latitudes. These will result in some hot and very hot days and periodic heat waves, with far-ranging impacts on agriculture, health, water and energy. For both scenarios, the increases are similar almost until the middle of the century (Figure 4-1 and Figure 4-2).

The corresponding scenarios for rainfall are shown in Figure 4-3 and Figure 4-4. These indicate only slight increases by 2030.

Figure 4-2

Projected temperature changes by the 2030s, RCP8.5



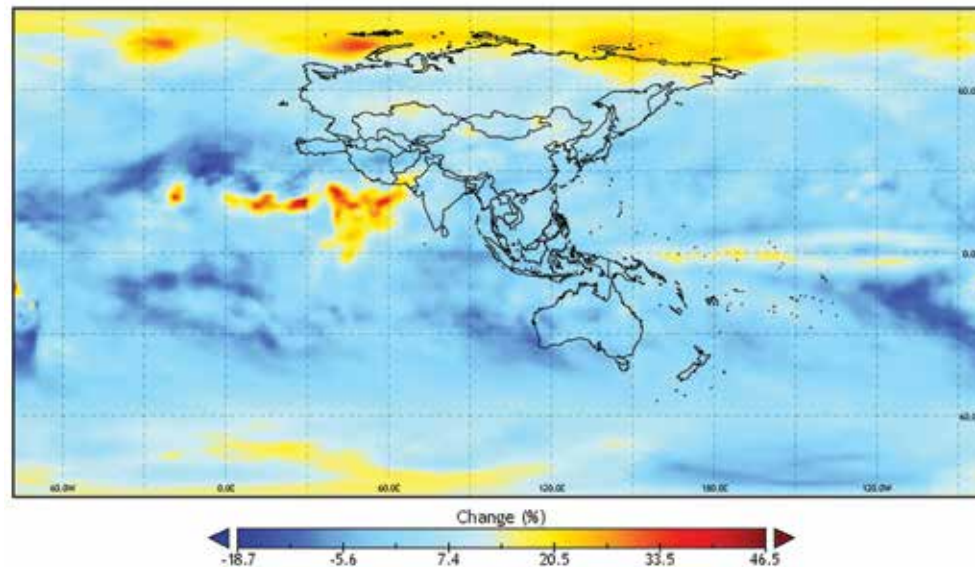
Source: RIMES, based on datasets from CMIP 5 Modelling Groups, 2017.

Note: Changes in maximum temperatures ($^{\circ}\text{C}$) over Asia and the Pacific region during the 2030s as compared to baseline (1980s) using an ensemble of CMIP5 GCMs for future scenario RCP 8.5

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Figure 4-3

Projected rainfall changes by the 2030s, RCP 4.5



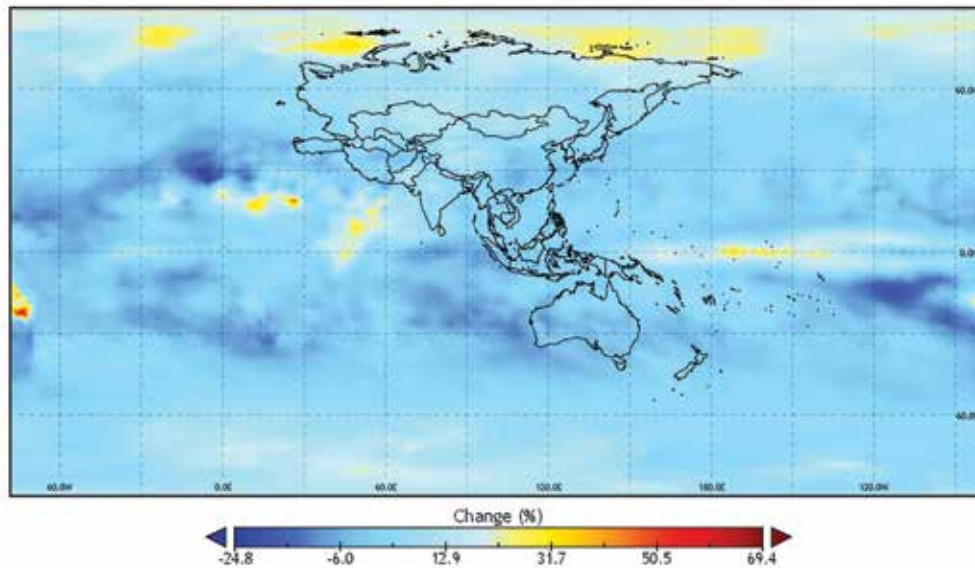
Source: RIMES, based on datasets from CMIP 5 Modelling Groups, 2017.

Note: Changes in annual rainfall (per cent change) over Asia and the Pacific region during the 2030s as compared to baseline (1980s) using an ensemble of CMIP5 GCMs for future scenario RCP 4.5

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Figure 4-4

Projected rainfall changes by the 2030s, RCP 8.5



Source: RIMES, based on datasets from CMIP 5 Modelling Groups, 2017.

Note: Changes in annual rainfall (per cent change) over Asia and the Pacific region during the 2030s as compared to baseline (1980s) using an ensemble of CMIP5 GCMs for future scenario RCP 8.5

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Climate change and increasing disaster risk

The impact of climate change will be felt particularly through periodic weather events that can be considered as climate risk fault-lines – monsoon rainfall and El Niño/La Niña events – as well as through heatwaves, sand and dust storms, floods, cyclones and droughts.

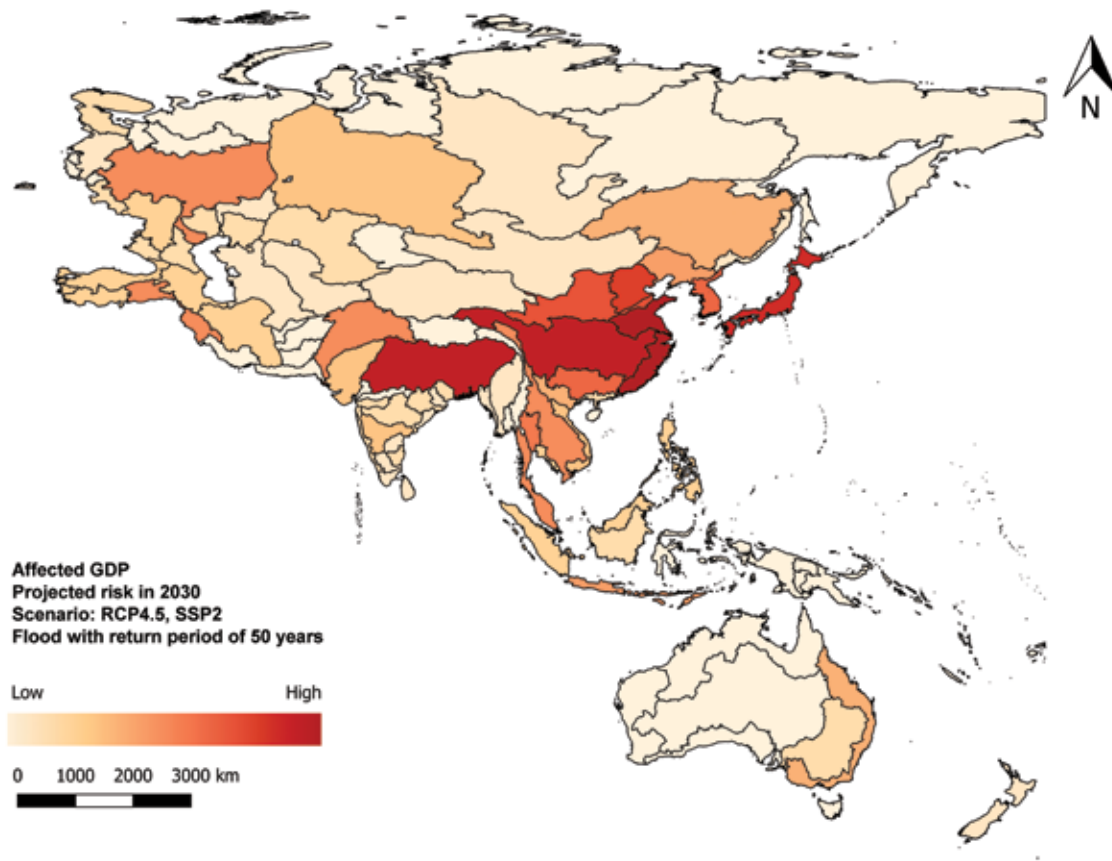
Monsoons – Increases in precipitation extremes are very likely in East, South, and South-East Asia. For East Asia, most models show an increase in mean precipitation in the summer monsoons and an increase in heavy precipitation events. For India, all models and scenarios project an increase in both mean and extreme precipitation in the summer monsoon.⁸ There

is also some evidence that climate change will affect the timing or seasonality of the monsoon.⁹ In addition, the increase in heavy precipitation events could offset the shortening of the rainy season.¹⁰

El Niño and La Niña – On land in many tropical and subtropical areas, El Niño events favour drought while La Niña events promote wetter conditions. In a warming climate, these variations are expected to become more extreme.¹¹ It is not clear whether rising global and ocean temperatures will intensify the El Niño – though they could affect the frequency: some modelling suggests that over the next 100 years extreme El Niño events could occur roughly every 10 years instead of every 20.¹² A better understanding of the relationship with

Figure 4-5

Estimated flood risk in 2030



Source: ESCAP, based on data from World Resources Institute, *Aqueduct Global Flood Analyzer*, (<http://floods.wri.org>).

Note: The boundaries in this map are depicted from river catchment areas based on WRI data.

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

climate changes should come from the World Climate Research Programme's Climate and Ocean: Variability, Predictability and Change projects.

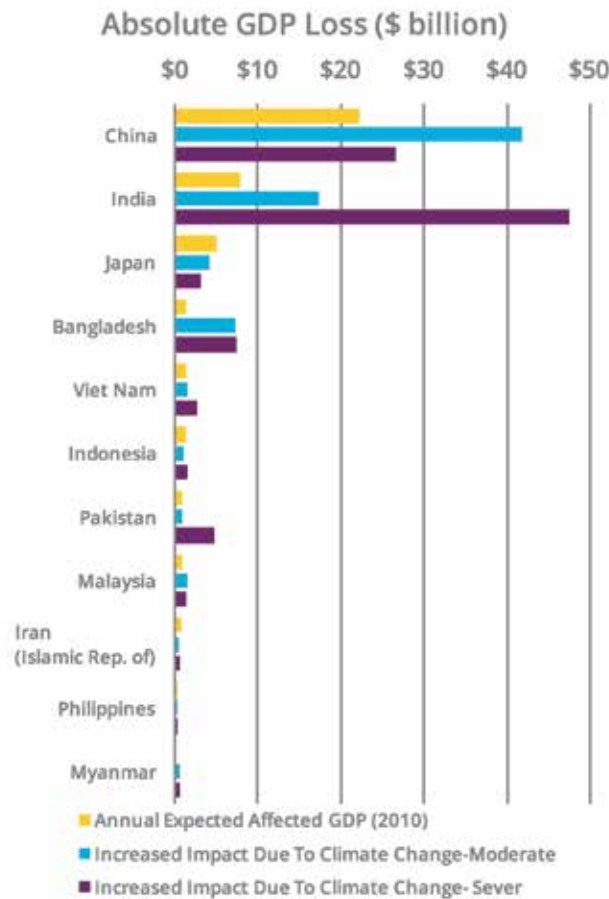
Heat waves – Climate change can increase the number of heat waves that cause substantial mortality.¹³ In 2015–16, Pakistan and India were hit by an extreme heatwave, resulting in 3,765 deaths, mostly amongst the elderly, and manual labourers.¹⁴ One cause was the unusual north-westerly wind movement, which spread hot air from the desert.¹⁵

Sand and dust storms – Higher temperatures reduce soil moisture which, combined with higher wind speeds, trigger large-scale sand and dust storms – especially in South-West Asia, and North and East Asia.

Floods – Using the World Resource Institute tools ESCAP has developed flood risk projections for moderate (RCP4.5) and severe (RCP8.5) scenarios.¹⁶ Both indicate a substantial increase in flood losses, particularly in East, South, South-West and South-East Asia with the problems becoming worse by 2030 (Figure 4-5). China, India, Bangladesh

Figure 4-6

Projected GDP losses due to floods for the year 2030



and Pakistan will experience losses two to three times greater than in the reference year of 2010. Under the severe scenario, India will be the country worst affected, with nearly \$50 billion in annual losses, followed by China, Bangladesh and Pakistan (Figure 4-6).

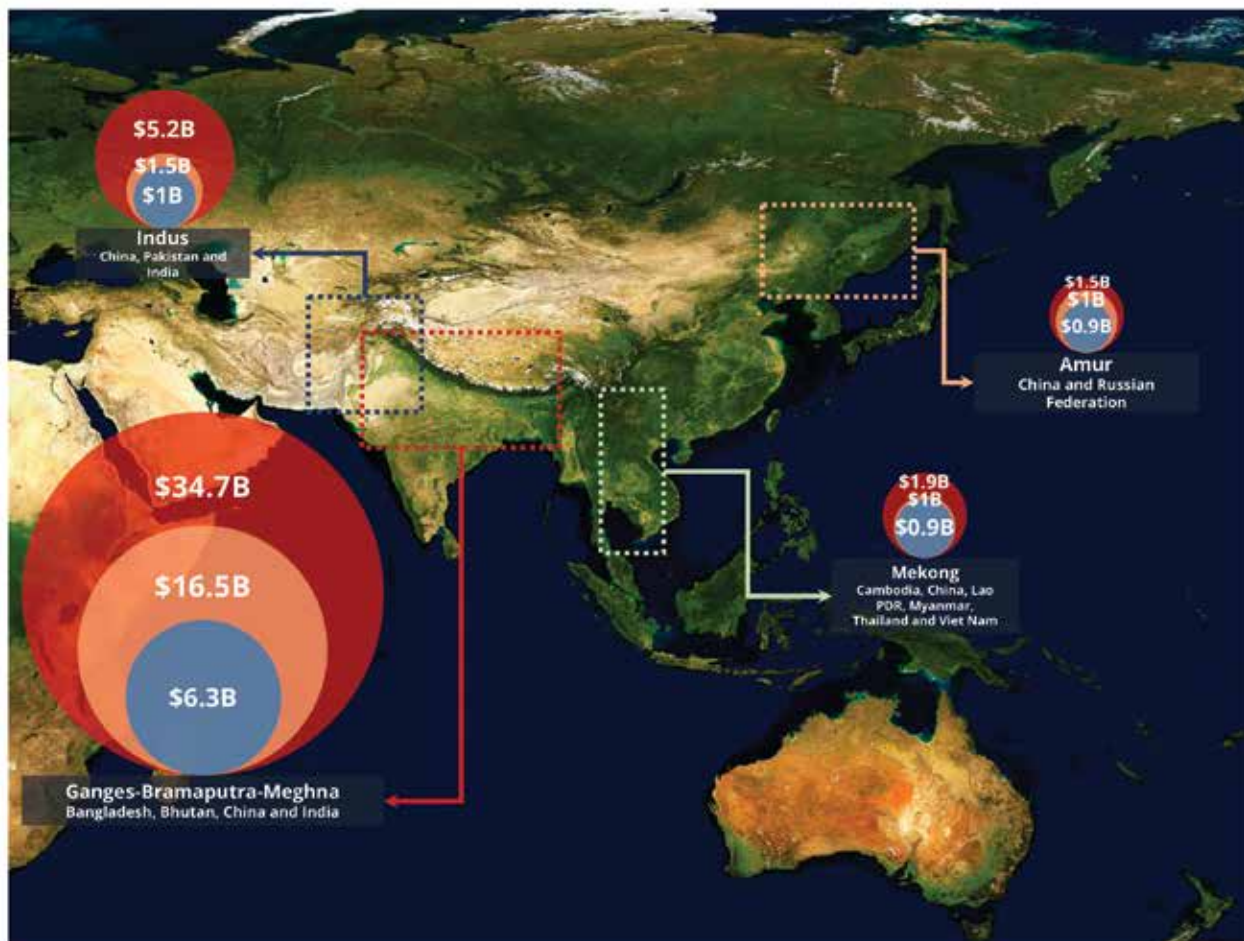
While flooding can be considered by country, in fact much of the excess water spreads across the region’s major river basins and over national frontiers. Under the moderate and severe climate change scenarios, the transboundary flood losses will be 2 to 6 times greater in the Ganga-Brahmaputra and Meghna basin; 1.5 to

5 times in the Indus basin; 1.1 to 2 times in the Mekong basin; and 1.1 to 1.6 times in the Amur basin (Figure 4-7).

Cyclone risk – The Global Assessment Report Atlas 2017 highlights the cyclone risk patterns in the Pacific and in the Indian Ocean basins (Figure 4-8). This is based on the probabilistic cyclonic wind and storm surge hazards analysis in conjunction with the historical frequency and intensity of tropical cyclones. While cyclones are more frequent and intense in the Pacific, vulnerability is higher in the Indian Ocean basin (the Bay of Bengal and Arabian Sea).

Figure 4-7

Transboundary flooding costs in major river basins, 2010 and 2030



[Grey circle] 2010, actual losses, [light red]; 2030, moderate scenario; [dark red] 2030 severe scenario.

Source: ESCAP, based on data from World Resources Institute, *Aqueduct Global Flood Analyzer*, (<http://floods.wri.org>).

Background image created by Reto Stokli, NASA, (<https://earthobservatory.nasa.gov/blogs/elegantfigures/2011/10/06/crafting-the-blue-marble/>).

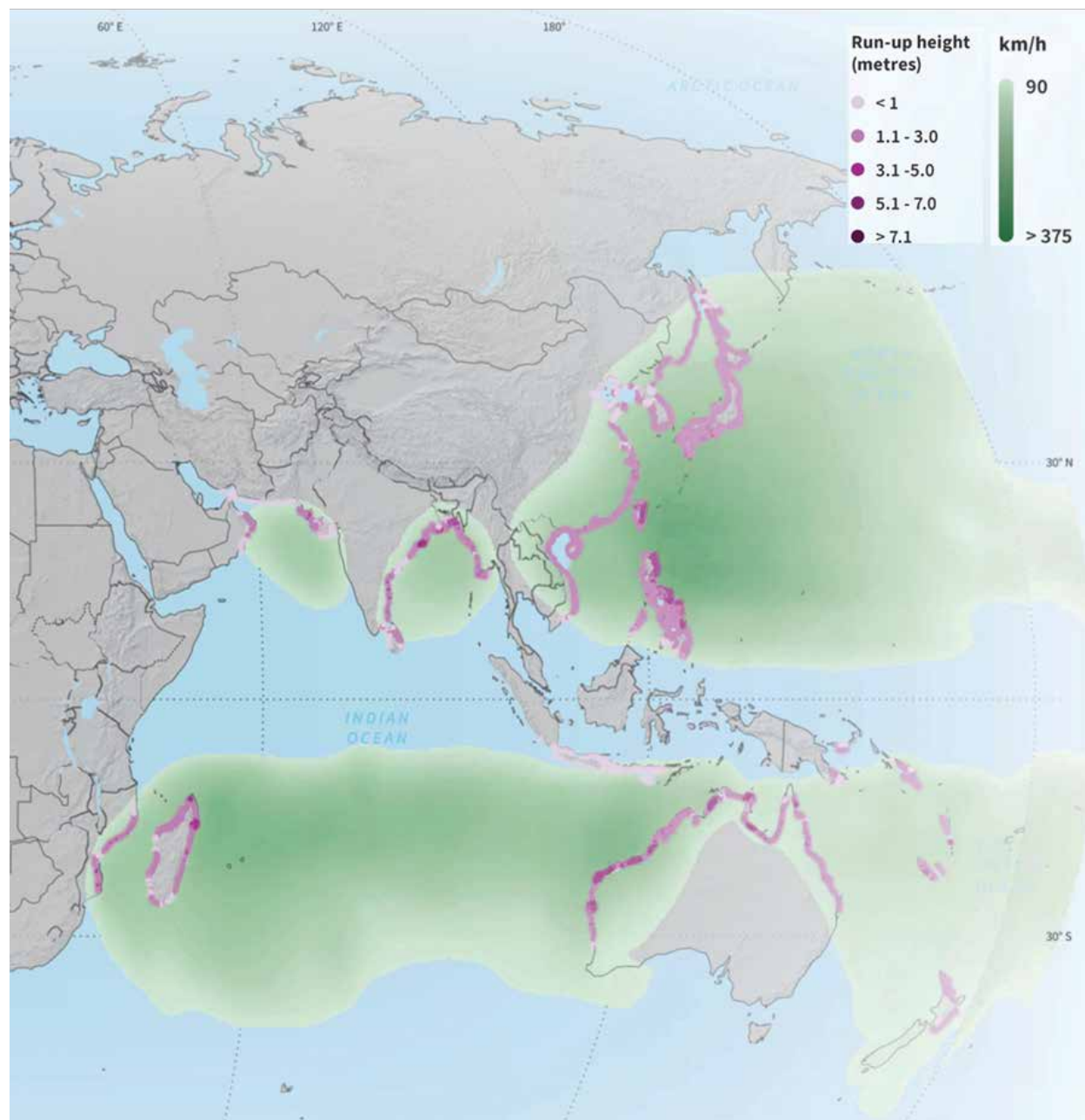
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Climate change is predicted to increase the frequency of high-intensity storms in selected ocean basins depending on the climate model. The ESCAP/WMO Typhoon Committee has estimated that the occurrence of tropical cyclones could shift eastward or northward

in the West and North Pacific basin, with the associated risk depending on changes in population density.¹⁷ Future climate scenarios also suggest that tropical cyclones will have shorter return periods and be increasingly destructive.¹⁸

Figure 4-8

Regional tropical cyclones, wind and storm surge hazards



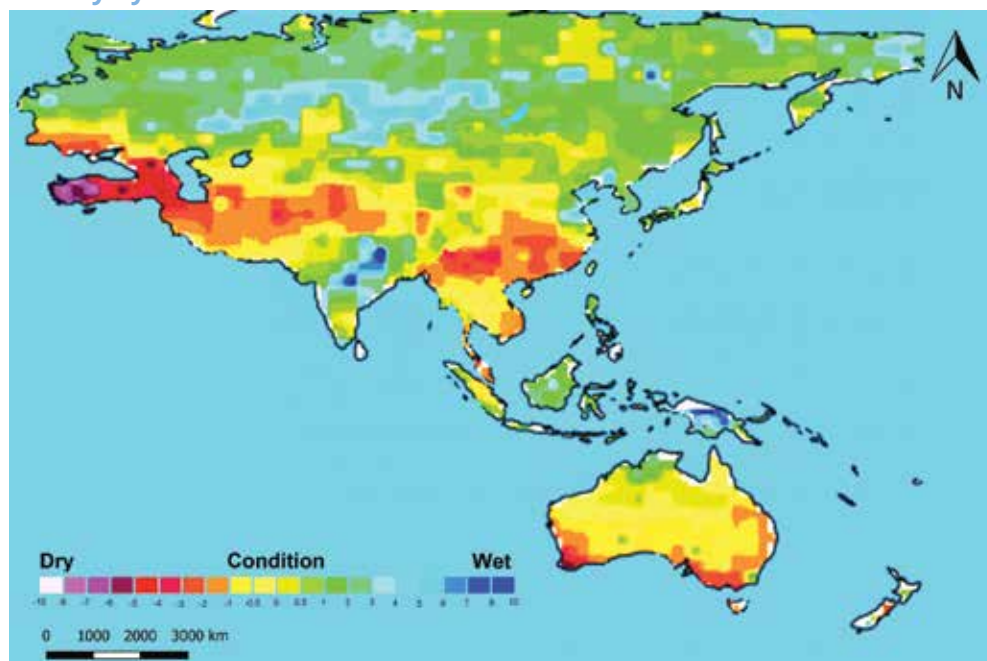
Source: ESCAP, based on UNISDR, *Global Assessment Report on Disaster Risk Reduction, Atlas*, March 2017.

Note: Wind hazard - wind speed 100 years return period. Storm surge hazard - run-up height 100 years return period

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 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.

Figure 4-9

Drought severity by 2030



Source: ESCAP based on Dai, A. (2011)

Note: This is based on the Palmer Drought Severity Index. Lower values indicate more severe drought risk.

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

Drought risk – Future drought risk scenarios are indicated in Figure 4-9.¹⁹ This uses the Palmer Drought Severity Index – a measure of dryness based on precipitation and temperature-related parameters.²⁰ By 2030, drought risk will have increased substantially. There will also be a shift in the geography of drought: in South Asia towards the west; in South-East Asia towards the east.

Climate risks are widespread across the region, but there are also ‘hotspots’ where greater likelihood of change coincides with high concentrations of vulnerable, poor or marginalized people.²¹ Generally, these cut across national boundaries (Figure 4-10).

River deltas – The Mekong and the Ganges–Brahmaputra–Meghna deltas will be affected by sea-level rise due to subsidence, decreases

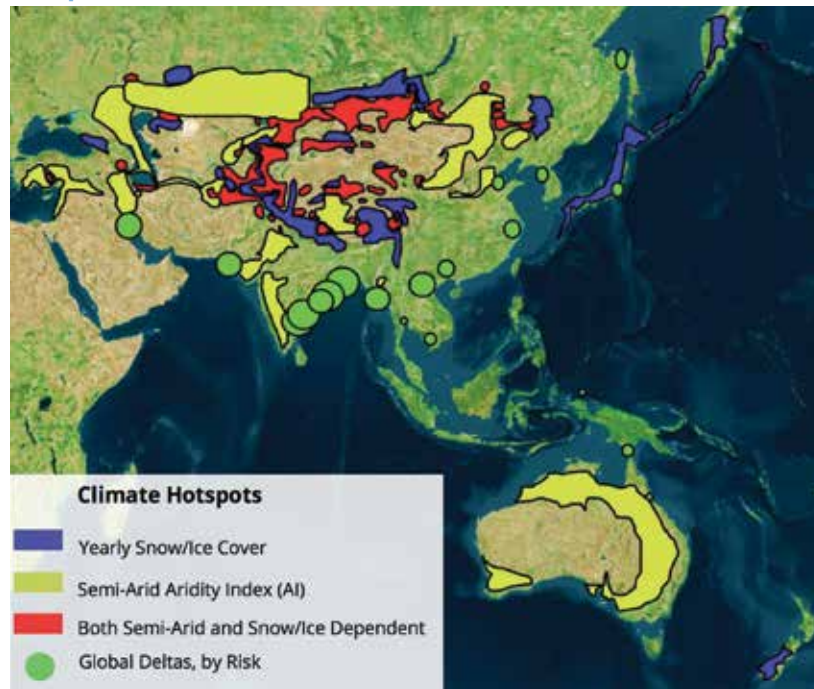
in sediment supply, increase in groundwater salinity, and deteriorating water quality. They will also suffer loss and erosion because of floods, storm surges, and extreme cyclonic events, exacerbated by the loss of protection from mangrove forests and sand dunes.²² All increase the risk of loss of life and economic losses and damages to economic activities such as fisheries,²³ along with reductions in biodiversity and species abundance.²⁴

Semi-arid regions – Around 60 per cent of the cultivated areas in semi-arid regions are rain fed, in South Asia by the annual monsoon.²⁵ These areas are likely to experience more frequent and intense droughts – and as a result will become more extensive.²⁶

Glacier- and snowpack-dependent river basins – More than 1.5 billion people living in

Figure 4-10

Climate change hotspots



Source: ESCAP, based on Szabo et al. (2016).

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

the floodplains of the Ganges, Indus, and Brahmaputra depend on the Himalayan water system.²⁷ Based on a projected estimate of glacier area in 2050, declining water availability could eventually threaten some 60 million people with food insecurity.²⁸

Adaptive capacity for climate resilience

A system’s adaptive capacity is the set of resources available for adaptation, as well as the ability of that system to use these resources effectively. The IPCC’s Fifth Assessment Report set out a range of interventions and policy responses:

Low-regrets measures – These provide large benefits but at low-cost – and thus cause low regrets should they prove unnecessary. They also have co-benefits in that they help

address other development goals, such as improving livelihoods, human well-being, and biodiversity, and help minimize the scope for maladaptation. Measures include: early warning systems; risk communication between decision makers and local citizens; and sustainable land management and ecosystem management and restoration. Other measures are: improvements to health surveillance, water supply, sanitation, and irrigation and drainage systems; climate-proofing of infrastructure; development and enforcement of building codes; and better education and awareness.

Integrated approaches – These involve a portfolio of actions that are most effective when customized to local circumstances. They could involve hard infrastructure combined with building individual and institutional capacity and improving ecosystems.

Multi-hazard risk management – Considering multiple types of hazards together lowers the likelihood that reducing the risk for one type will increase exposure and vulnerability to others.

Synergies with disaster risk management – Greater coordination is needed between technology transfer and cooperation on disaster risk reduction and climate change adaptation.

Community-based adaptation – Local populations can document their experiences with the changing climate, particularly extreme weather events. This will reveal existing community capacity as well as shortcomings. Community-based adaptation can be supported with human and financial capital and information that is customized for local stakeholders.

Effective risk communication – Perceptions of risk are driven by psychological and cultural factors, values, and beliefs. Appropriate and timely risk communication among all stakeholder groups should also clarify the degrees of uncertainty and complexity.

Iterative management – The complexity and uncertainties, and the length of the time frames associated with climate change, require iterative processes of monitoring, research, evaluation and learning.

Table 4-3 summarises key areas of climate risk and the potential for adaptation, with corresponding levels of confidence. This indicates critical gaps in adaptive capacity for all hazards, particularly for the near term – 2030–2040 – and for heat-related hazards and drought in semi-arid regions, as well as for water-related disasters in deltas and snow-pack-dependent river-basins.

Coherence between climate change adaptation and disaster risk reduction

The aim should be to build climate resilience while adapting to climate changes and treat these as complementary processes (Figure 4-11). At present, these activities diverge in many respects: they often, for example, have different institutional structures, with experts and functionaries who respond to different constituencies. There are also structural barriers at international and regional levels. In addition, policies, planning and programmes may be disconnected: DRR projects tend to be more ad hoc, with shorter timescales and narrower information bases that do not take full account of climate change risks. For some programmes however, there has been greater convergence, particularly at the regional level – in such areas as the management of coastal zones and river-basin floodplains, and watershed development, as well as in measures for land-use planning and drought mitigation.

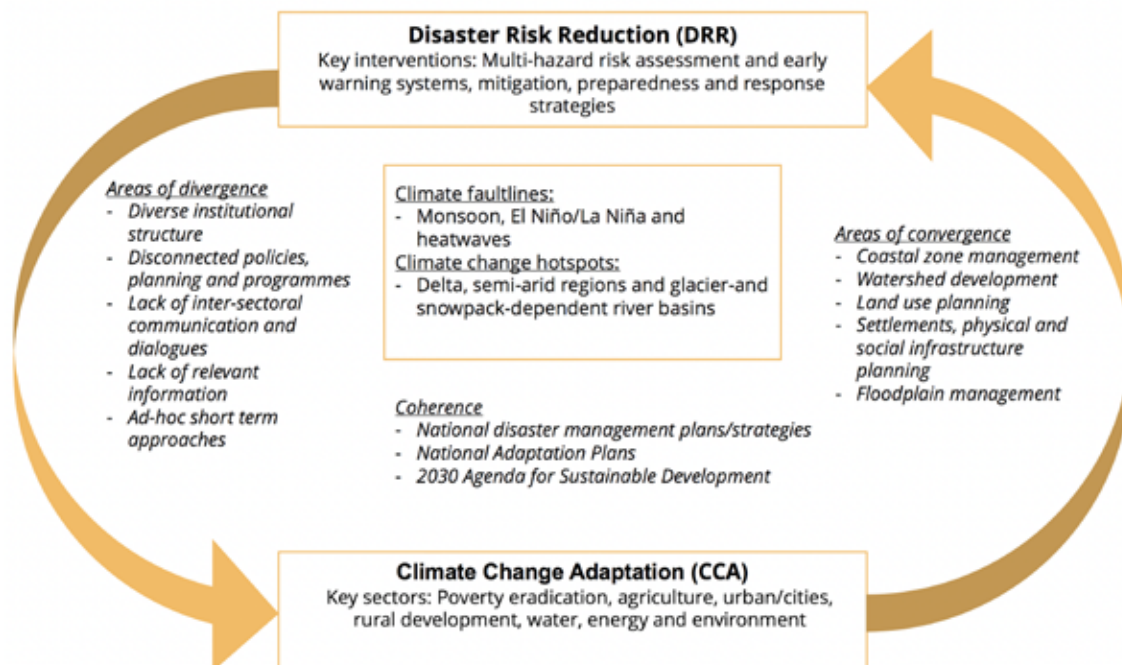
There are already well-established tools and techniques used for DRR such as multi-hazard early warning systems, hazard, risk and vulnerability analysis, risk assessment and monitoring, and risk mitigation, as well as response strategies. These can be integrated with climate change adaptation in sectors such as poverty eradication, agriculture, urban, rural, water and energy.

From ‘conceptual framework’ to ‘actionable strategies’, the following steps can help build regional climate resilience:

- *Step I: Managing climate fault-lines* – through better understanding of the climate risks associated with monsoon, El Niño/La Niña and heatwaves.

Figure 4-11

Coherence of climate change adaptation and disaster risk reduction



- *Step II: Forging resilient strategies for climate change hotspots* – including deltas, semi-arid regions, glacial and snow-pack-dependent river-basins with multi-hazard and transboundary approaches. Coastal zone management programmes and watershed development programmes in semi-arid regions, for example, address vulnerabilities through strategic planning for climate change adaptation.
- *Step III: Increasing coherence of climate change adaptation and DRR at global, regional, national and local levels* – to directly address climate change adaptation issues. Priority should be given to developing National Adaptation Plans of Action and integrating disaster risk reduction.

The gaps between adaptation and resilience can also be narrowed by improving meteorological, hydrological and climate information. The LDCs

often have weak national meteorological and hydrological services and agencies for disaster risk management. They need to significantly upgrade their observation networks and build the capacity of government professionals. The SIDS face many of the same issues, including the need to improve network equipment, information technology infrastructure, and professional staff capacity, as well as to prepare for hazards beyond tropical cyclones. National agencies should also link better with global and regional support centres. Two initiatives to increase the capacity in LDCs and SIDS are the Climate Risk and Early Warning Systems (CREWS) initiative (Box 4-1) and the Regional Integrated Multi-hazard Early Warning System for Asia and Africa (RIMES) (Box 4-2). Another key initiative for improving the accuracy of early warning systems and climate risk information is the Global Framework for Climate Services.²⁹

Box 4-1

Climate Risk and Early Warning Systems Initiative

The Climate Risk and Early Warning Systems initiative (CREWS) aims to mobilize \$100 million to increase the capacity for Multi-Hazard Early Warning Systems in more than 50 LDCs and SIDS. By 2020, all are expected to have weather stations, radar facilities, and at least moderate early warning system and risk information capacities.

The CREWS coalition is led by France, with support from Australia, Germany, Luxembourg, the Netherlands, Japan and Canada. It is being implemented by the World Meteorological Organization (WMO), the United Nations Office for Disaster Risk Reduction (UNISDR), the World Bank, and the Global Facility for Disaster Reduction and Recovery (GFDRR).

Source: Global Facility for Disaster Risk Reduction, the World Bank (<https://www.gfdr.org/crews-climate-risk-early-warning-systems>).

Box 4-2

Regional Integrated Multi-Hazard Early Warning System

The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) is an intergovernmental institution, owned and managed by its more than 30 Member States and collaborating countries. Established in 2009 with the support from ESCAP Multi-donor Trust Fund on Tsunami, Disaster and Climate Preparedness, RIMES allows Member States to gather information at much lower costs than individual early warning systems, particularly for high-impact, low frequency hazards.

RIMES services include localized and customized severe weather and short-term weather information that can be used for contingency planning. It also offers medium-term weather information for logistics planning, as well as longer-term climate outlooks for resource planning and management. In addition, it analyses risks of climate variability and change, identifies risk management and adaptation options, and develops new-generation risk information products. It also offers decision support tools including risk assessment, interpretation and translates early warning information into impact outlooks and response options.

For climate change adaptation, RIMES produces customized climate change information to inform national planning processes. To generate climate change scenarios for countries, RIMES uses a sub-set of eight Global Circulation Model (GCMs), downscaling the coarser resolution statistical models, analogue methods, and climate control correlations.

Source: Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), <http://www.rimes.int/cc/model-product>

Policy decisions and deep uncertainty

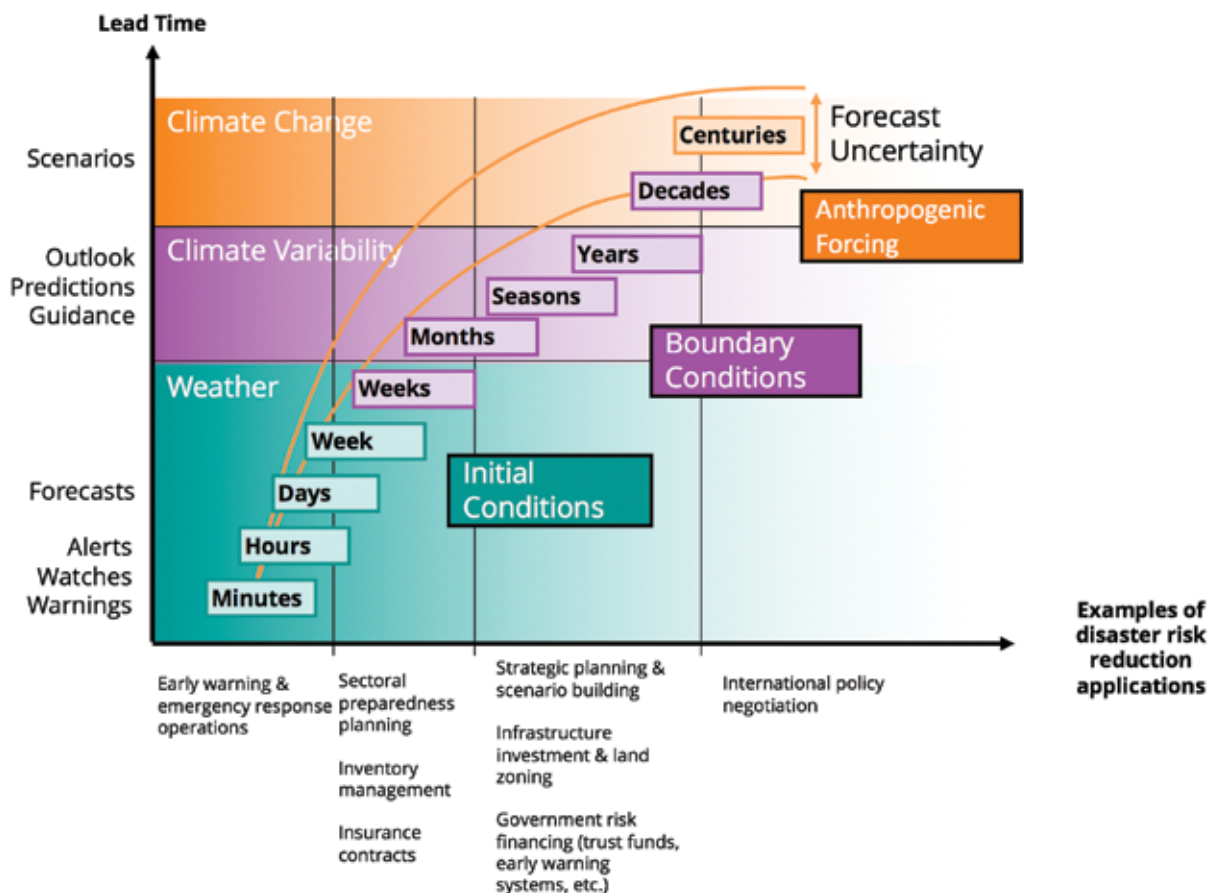
For DRR to be successful, it needs to take account of the shifting risks associated with climate change and ensure that measures do not increase vulnerability to climate change in the medium to long term.³⁰ Traditionally hazard analysis has been based on historical data, but this is no longer sufficient, because hazard characteristics are changing as a result of climate change. For instance, a 100-year flood or drought may become a 30-year flood or drought.³¹ Climate scenarios inevitably have

ranges of uncertainty which increase as they project further into the future (Figure 4-12 and Table 4-1).³² There are also issues of resolution, since the projections may be for areas broader than those required for local policy decisions.

Many buildings and critical infrastructure will have to cope in 2100 with conditions that, according to most climate models, will be radically different from current ones. Table 4-2 indicates the likely timeframes and degrees of exposure for different sectors. Many methodologies have been proposed for making decisions under deep uncertainty, often using a mix of methodologies.³³

Figure 4-12

Uncertainties associated with climate change scenarios, outlooks, and forecasts



Source: WMO (2011).

Table 4-1

State of science and models for different event types

H = high M = medium L = low	Capabilities of climate models to simulate event type	Quality/length of the observational record	Understand that lead to changes in extremes and result of climate change
Extreme cold events	H	H	H
Extreme heat events	H	H	H
Droughts	M	M	M
Extreme rainfall	M	M	M
Extreme snow and ice storms	M	L	M
Tropical cyclones	L	L	M
Extratropical cyclones	M	L	L
Wildfires	L	M	L
Severe convective storms	L	L	L

Source: National Academies of Sciences, Engineering, and Medicine. 2016.

Note: The assessments of the capabilities of climate models apply to those models with spatial resolutions (100km or coarser) that are representative of most models participating in the Coupled Model Inter-comparison Project Phase 5.

Table 4-2

Selected sectors that require long-term planning for climate change

Sector	Time scale	Exposure
Water infrastructures (e.g., dams, reservoirs)	30-200 yr.	+++
Land-use planning (e.g., in flood plain or coastal areas)	>100 yr.	+++
Coastline and flood defences (e.g., dikes, sea walls)	>50 yr.	+++
Building and housing (e.g., insulation, windows)	30-150 yr.	++
Transportation infrastructure (e.g., port, bridges)	30-200 yr.	+
Urbanism (e.g., urban density, parks)	>100 yr.	+
Energy production (e.g., nuclear plant cooling system)	20-70 yr.	+

Source: Illustrative list of sectors with high inertia and high exposure to climate conditions (from Hallegatte, 2009).

Figure 4-13

Seamless integration of climate scenarios, seasonal forecasts and medium/short term forecasts for a range



Climate risk exists in different time scales ranging from decades to weeks to days. As shown in Figure 4-13, risk-sensitive activities and decisions ranging from operational, strategic, to tactical – are being managed using different weather and climate information products.

Managing risks from long-term climate change should be viewed as part of a broader strategy for managing climate risks for all timescales. Since climate risks develop and accumulate over time, building plausible scenarios can be useful to help decision-makers identify adaptation measures against a range of climate change outcomes. Climate scenarios can be customized to support long-term policy decisions.

Opportunities for low-cost adaptation

Many adaptations can be implemented at low cost. It has been estimated that transitioning to a low-carbon pathway (under a 2°C scenario)

would cost the region 1.4 to 1.8 per cent of GDP by 2050 and 2 per cent of GDP by 2100. This is lower than the costs of inaction; without action, the region could see GDP decrease by as much as 3.3 per cent by 2050 and 10 per cent by 2100.

The costs are modest partly because of the steep drop in the cost of green technologies, but also because of the potential for large efficiency savings and significant co-benefits.³⁴ There are four priority areas to promote climate change adaptation and improve resilience: implement effective carbon pricing; phase out fossil fuel subsidies; encourage renewable energy and energy efficiency; and expand climate finance. All these efforts can take advantage of new tools that are becoming available. These are the subject of Chapter 6.

Table 4-3

Key areas of climate risk and potential for adaptation

Adaptation issues & prospects	Key risk	Climatic drivers	Risk Level	Region			
<ul style="list-style-type: none"> Exposure reduction via structural and non-structural measures, effective land-use planning, and selective relocation Reduction in the vulnerability of lifeline infrastructure and services (e.g., water, energy, waste management, food, biomass, mobility, local ecosystems, etc. communications) Construction of monitoring and early warning systems; Measures to identify exposed areas, assist vulnerable areas and households, and diversify livelihoods Economic diversification 	<p>Increased risk of heat-related mortality (high confidence)</p> <ul style="list-style-type: none"> Heat health warning systems Urban planning to reduce heat islands; Improvement of the built environment; Development of sustainable cities New work practices to avoid heat stress among outdoor workers 	<ul style="list-style-type: none"> Warming trend - heatwaves Extreme temperature 	<p>Risk level with high adaptation</p> <p>Risk level with current adaptation</p>	Asia			
					<p>Increased risk of drought-related water and food shortage (causing malnutrition) (high confidence)</p> <ul style="list-style-type: none"> Disaster preparedness including early warning systems and local coping strategies Adaptive/integrated water resource management Water infrastructure and reservoir development Diversification of water sources including water re-use More efficient use of water (e.g., improved agricultural practices, irrigation management, and resilient agriculture) 	<ul style="list-style-type: none"> Warming trend - drought Extreme temperature Drying trend 	
<p>The interaction of rising global mean sea level in the 21st century with high-water-level events will threaten low-lying coastal areas (high confidence)</p> <ul style="list-style-type: none"> Evolutionary adaptation potential of fish and invertebrate species to warming is limited as indicated by their changes in distribution to maintain temperatures. Human adaptation options: Large-scale translocation of industrial fishing activities following the regional decreases (low latitude) vs. possibly transient increases (high latitude) in catch potential; Flexible management that can react to variability and change; Improvement of fish resilience to thermal stress by reducing other stressors such as pollution and eutrophication; Expansion of sustainable aquaculture and the development of alternative livelihoods in some regions. 	<ul style="list-style-type: none"> Damaging cyclone Sea level 		Pacific Islands				

ENDNOTES

- 1 IPCC, 2012.
- 2 UNISDR, 2015a.
- 3 IPCC, 2014b
- 4 National Academies of Sciences, Engineering, and Medicine, 2016.
- 5 ESCAP, 2016b.
- 6 ADB, 2015.
- 7 ESCAP & RIMES, 2017.
- 8 IPCC, 2012.
- 9 Loo et al., 2015.
- 10 Sabeerali et al., 2017.
- 11 Cai et al., 2014.
- 12 Cho, 2016.
- 13 Campbell-Lendrum et al., 2005.
- 14 Reliefweb, 2015.
- 15 NOAA, 2015.
- 16 Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014. The RCPs are consistent with a wide range of possible changes in future anthropogenic greenhouse gas (GHG) emissions. RCP 4.5 assumes that global annual GHG emissions (measured in CO₂-equivalents) peak around 2040, then decline. In RCP 8.5, emissions continue to rise throughout the 21st century.
- 17 Ying et al., 2012.
- 18 Ibid.
- 19 Dai, 2011.
- 20 PDSI is a measurement of dryness based on recent precipitation and temperature. The index has proven most effective in determining long-term drought, a matter of several months.
- 21 Souza et al., 2015.
- 22 Gopal, 2013.
- 23 Raha et al., 2012.
- 24 Nicholls, 2011.
- 25 World Bank, 2009.
- 26 IPCC, 2014a.
- 27 IPCC, 2007.
- 28 Immerzeel et al., 2010.
- 29 WMO (n.d.).
- 30 Mitchell et al., 2008.
- 31 WMO, 2016.
- 32 Hallegatte et al. 2012.
- 33 Economics of Climate Adaptation, 2009.
- 34 ESCAP, 2016b.





5 PATHWAYS TO PREVENTION

PATHWAYS TO PREVENTION

There is often a close relationship between disasters and conflict. Conflicts undermine the capacity and commitment of states to prevent and respond to natural disasters and humanitarian crises. At the same time, disasters themselves can create unstable economic conditions, exacerbate social fault lines and heighten social exclusion – creating fertile ground for disputes. Reducing disaster-related risks can sometimes open paths for conflict prevention and more peaceful societies.

The United Nations Secretary-General has made the prevention of conflicts and crises a cross-pillar priority in the repositioning of the United Nations development system to deliver on the 2030 Agenda for Sustainable Development (Box 5-1). The focus is on areas of the world where there is a convergence between violent conflict, humanitarian crises and the impacts of disasters and climate change.

In recent years, most conflicts in Asia and the Pacific have been within states. The region has around 15 potential areas of inter-state conflict, but the conflicts that cost the most lives have been within states.¹ Figure 5-1 maps the occurrence of such conflicts for the period 1991–2015.

The extent of conflict risk can be gauged from the OECD States of Fragility Framework. Based on political, economic, social, environmental and security criteria, this framework identifies 56 fragile states, of which 11 are ESCAP members.² Of these countries, ESCAP designates eight as Countries with Special Needs (CSNs) that have priority for technical cooperation and capacity building support – Afghanistan, Myanmar, Papua New Guinea, Lao People's Democratic Republic, Timor-Leste, Cambodia and Tajikistan. Given the close interlinkages between sustainable development, disasters and conflict-prevention, the CSN category of countries should now be expanded to include other aspects of fragility such as environmental risk and conflict prevention to effectively address disaster resilience.³

Box 5-1

The vision of the United Nations Secretary General on prevention

“While the universal and comprehensive agenda for sustainable development and sustaining peace pledged to “leave no one behind,” the goals of peaceful coexistence and development are at risk in many countries. Millions flee in search of safer, better lives – even as doors are closing in many places. Brutal and violent conflicts continue to rage in many corners of the world, taking countless lives and displacing millions more. For many others, sustainable development seems distant. Terrorism and violent extremism are affecting all regions of the world. Climate-related disasters are becoming more frequent and their destructive powers more intense.

“By prevention, I mean doing everything that we can to help countries to avert the outbreak of crises that take a high toll on humanity, undermining institutions and capacities to achieve peace and development.

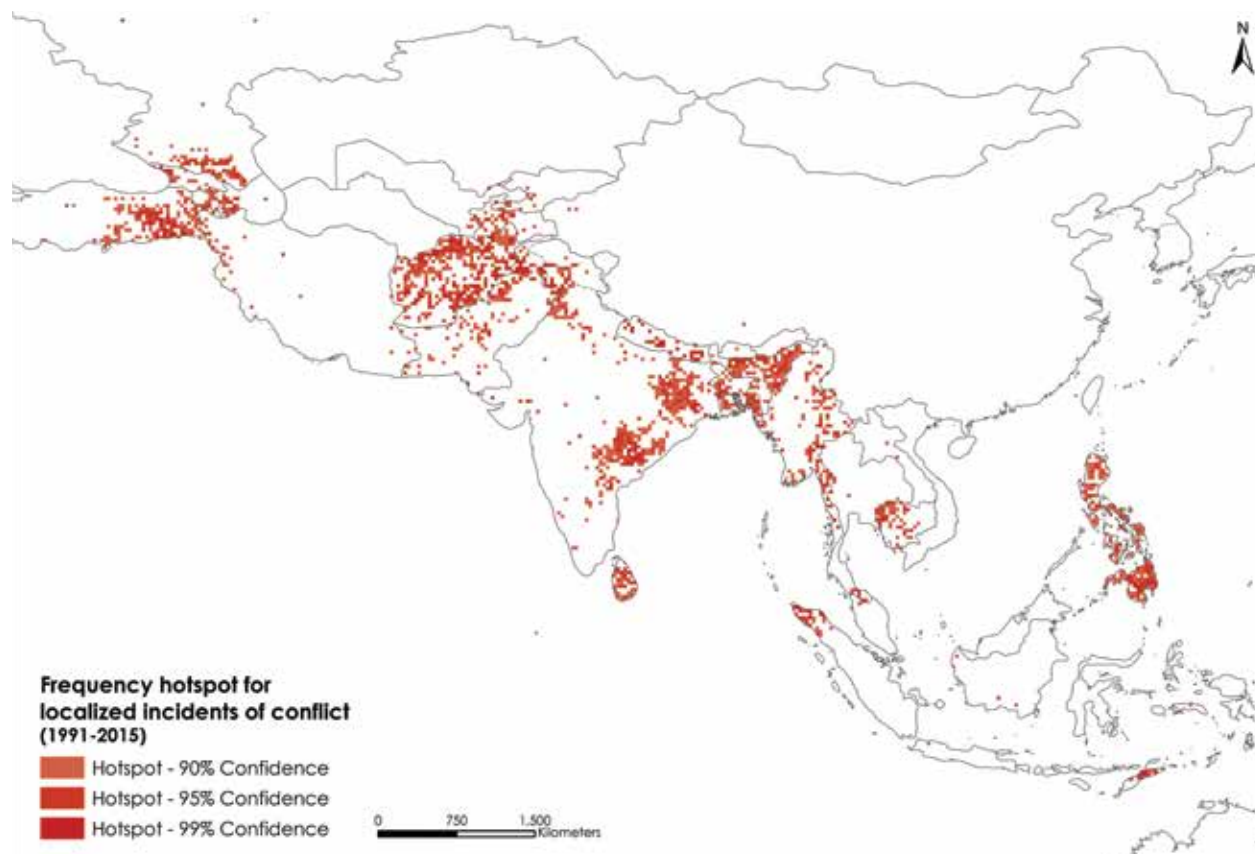
“The best way to prevent societies from descending into crisis is to ensure they are resilient through investment in inclusive and sustainable development, including concerted climate action and management of mass migration. Agenda 2030 and the Paris Agreement on Climate Change are an essential part of humanity’s universal blueprint for the future.

“For all countries, addressing inequalities, strengthening institutions and ensuring that development strategies are risk-informed are central to preventing the fraying of the social fabric that could erupt into crises. We need to invest more to help countries build strong and inclusive institutions and resilient communities. Development is the key to prevention. Far from diverting resources or attention away from development, an effective and broad focus on prevention will generate more investment and concerted efforts to achieve the SDGs.

“The SDGs and Sustaining Peace are complementary and mutually reinforcing. Sustainable development underpins peace, and sustained peace enables sustainable development. Implementation of both agendas will ensure that stable societies prosper and fragile societies become more resilient and can manage risks and shocks more effectively. Our prevention work seeks to shore up national and local institutions and capacities to detect and avert looming crises, sustain peace and achieve sustainable development.”

Source: Extracted from The Vision of the United Nations Secretary General on Prevention.

Figure 5-1

Localized conflict incidents, 1991-2015

Source: ESCAP analysis based on UCDP GED (2016).

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 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.

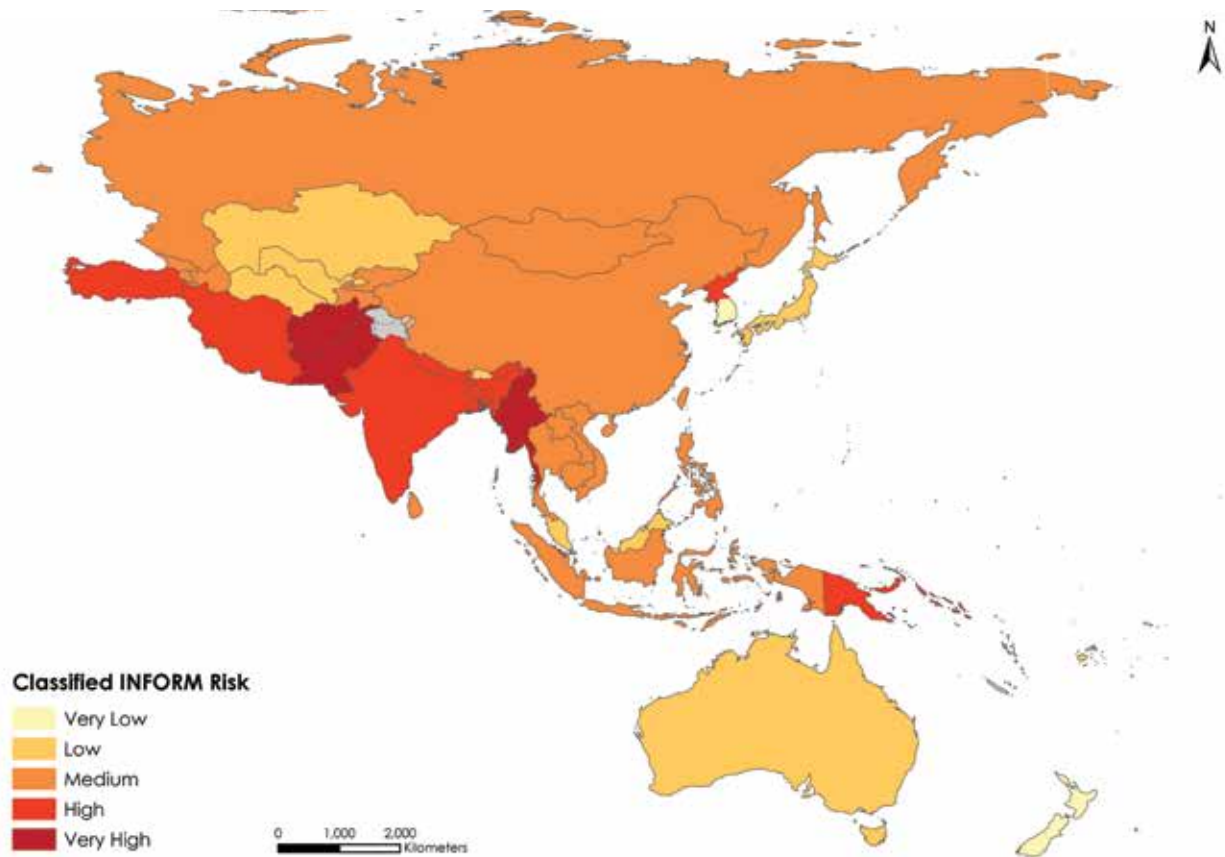
Compared with natural disasters, which are one-off, sometimes rapid, events, conflicts tend to last longer. Nevertheless, conflicts and disasters to the extent they exacerbate each other, compound risks to create complex and converging crises, so they can be considered together.⁴ The Inter-Agency Standing Committee Task Team for Preparedness and Resilience Capacities, has developed the INFORM index for risk management which identifies the Asia-Pacific

countries where conflict and disaster risk co-exist to create conditions of high or very high overall risk (Figure 5-2).⁵

As well as leading to loss of life, intra-state conflicts also displace many people within and between countries. Asia and the Pacific houses 15 per cent of the world's internally displaced people – 6 million people.

Figure 5-2

INFORM risk index for Asia and the Pacific



Source: Based on data from INFORM Index for Risk Management.

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 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.

The disaster-conflict interface

Fragile states affected by conflict find it more difficult to respond to disasters, as well as to protect communities from disaster, or to empower them for risk reduction or implement uninterrupted development agendas. At the same time, disasters can also exacerbate conflict fault lines and social exclusion.⁶ This is common where there is competition for natural resources, along with environmental stress, degradation and mismanagement.

Drought and desertification, for example, can exacerbate disputes where poor people

are competing for limited land and water.⁷ A severe drought threatens local food security, and livestock feeds, aggravates humanitarian conditions, and often triggers large-scale human displacement. It may also provide the breeding ground for sustained conflict.⁸ Environmental shock and violent conflict thus create vicious circles. One global study has concluded, that around one quarter of conflicts in ethnically fractionalized countries coincide with climatic calamities.⁹ Three examples in the region where the risk of disasters is compounded by conflict are Afghanistan, Myanmar and Papua New Guinea.

Afghanistan

In Afghanistan, there has been a close connection between conflict and drought. Nearly 85 per cent of agricultural production uses water from snowmelt that feeds rivers and streams and is then channelled through irrigation canals. The remaining water comes from groundwater.¹⁰

Years of conflict have either destroyed irrigation infrastructure, or restricted its maintenance resulting in siltation, bank damage and vegetation growth. The Government estimated in 2016 that during the previous 30 years of conflict, 4,850 irrigation networks had been destroyed and did not work at all.¹¹ In 1978, there were around 3.0 million hectares under irrigation; by 2002 this had fallen to 1.5 million hectares, but in 2014 rose again to 2.1 million hectares.¹²

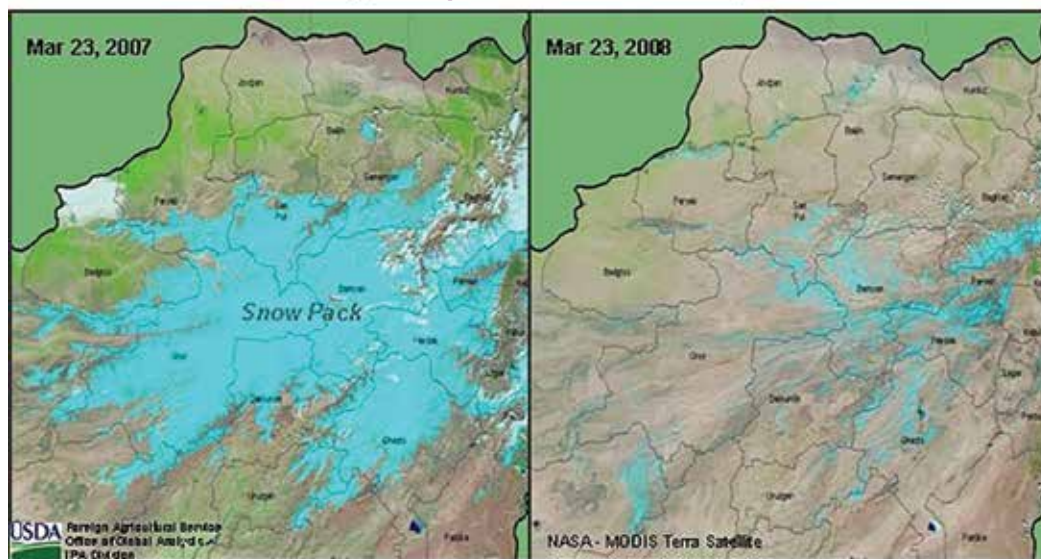
Afghanistan is vulnerable to fluctuating weather conditions and abnormal rainfall. During late-2007 and early 2008, across most of the country rainfall and winter snowfall were well below

normal and led to the worst drought in a decade (Figure 5-3). In 2008/09 wheat production was down 60 per cent.¹³ Food prices were rising in domestic food and feed grain markets – and globally – making it difficult for people to meet their basic food needs. Millions of people became food insecure and young men were more vulnerable to recruitment by militias who paid them for their services.

In 2008, the Government of Afghanistan and the United Nations issued an emergency appeal for donations of up to \$400 million to cover wheat imports and food aid for the 4.5 million people affected, and to prepare for the next winter cropping season.¹⁴ The problems were exacerbated by attacks on food aid convoys by both criminal groups and anti-government elements. Had government capacity not been constrained by conflicts, and the irrigation systems been maintained and fully functional, the advanced warning from the satellite imagery of snow pack would have enabled the Government and communities to better prepare for, and manage the drought.

Figure 5-3

Afghanistan, 2007 and 2008 winter snow packs



Source: Foreign Agricultural Bureau and NASA Modis terra satellite.

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

Myanmar

Standards of living have increased, with commensurable improvements in the quality of life in Myanmar. Despite this recent progress, Myanmar remains one of South-East Asia's poorest countries, with a per capita GDP of \$1,105. In 2010, around one-third of the population lived below the poverty line, most of them in rural areas with a high propensity for conflict.

Myanmar is also prone to a range of high-impact natural hazards, including cyclones, seasonal flooding, landslides, droughts, fires and earthquakes.

But widespread poverty and poor infrastructure mean that the country finds it difficult to prepare for, or recover from, such events. This capacity has also been eroded by conflict, notably in Kachin and Rakhine states.¹⁵ This interplay of natural hazards and human-induced risks has increased the vulnerability of the poor, especially women and children and reduced access to basic social services.

Rakhine state is especially exposed – people live in hard-to-reach areas predominantly in bamboo-constructed houses isolated from the rest of the country by inaccessible ranges of mountains and hills. There are few paved roads and in several areas transport links are limited to weather-dependent boat routes. Poverty is around 78 per cent, with limited access to health and education services.¹⁶

In July and August 2015, torrential rains and the onset of cyclone Komen triggered widespread floods and landslides across 12 of the 14 states and regions in Myanmar. Around 1.6 million individuals were temporarily displaced from their homes, and 132 lost their lives. Total losses and damages were equivalent

to 3.1 per cent of GDP. Rakhine residents sustained the second-highest value of damages and per capita losses. Younger and unmarried women were particularly vulnerable, due to cultural restrictions on movement without male accompaniment; and women felt more exposed and insecure during the evacuations.¹⁷

In July 2016, around 120,000 people were confined to IDP camps in low-lying coastal areas where there were few measures for disaster management or mitigation.¹⁸ IDPs have limited livelihood opportunities because their movements are restricted and their legal status is unclear, so most depend for food and shelter on external support provided by humanitarian organizations.

Papua New Guinea

In Papua New Guinea, 80 per cent of the population are semi-dependent on rain-fed subsistence farming. More than three-quarters of the food consumed in the country is locally grown, so weather changes that reduce household food production have immediate, severe and lasting impacts on food security.

The areas most vulnerable to weather extremes are the Highlands, where 2.2 million people live in thousands of isolated villages. The security situation in the Highlands remains volatile and was recently aggravated by El Niño related drought and weather anomalies.¹⁹

From April 2015, due to a strong El Niño, much of rural Papua New Guinea was hit by a major drought. By September, many areas experienced only 40 per cent of average rainfall. During the period November 2015–March 2016, some regions received only 30 per cent of normal rainfall. In the higher altitudes, these dry conditions reduced cloud cover and also produced damaging frosts.²⁰

This created a series of cumulative shocks to food security. Lack of water stunted the growth of staple root crops, and at higher altitudes frosts wiped out crops completely. At the peak of the drought, replanting was impossible. Following the increase in rains in November to December, communities resumed planting food gardens, but in some areas, including the Highlands, the sudden and heavy rains on dry ground resulted in flooding and landslides that destroyed properties, food gardens and agriculture infrastructure. Crop yields were also reduced by pest infestations and the excessive nitrogen content of the soil. By January 2016, having lost staple crops multiple times, reserve

stores of food, and other coping mechanisms, had been exhausted. During the period January to March 2016, around 1.3 million people were experiencing high food insecurity, and an additional 162,000 were classified as severely food insecure.²¹

While there is no evidence that the El Niño-induced disasters contributed directly to violent conflict in the Highlands, it is clear that the ongoing conflicts reduced community resilience to drought, and that the sustained drought heightened the risk of struggles over scarce resources (Box 5-2).

Box 5-2

El Niño and conflict in Papua New Guinea

A CARE monitoring mission in October 2015 made the following assessments:

There is a breakdown in social cohesion in some communities. Due to shortage of food, water and firewood, people do not want to share their resources with others. However, in other villages, there is strong community cohesion as it has been raining a lot and there is enough food to share.

ICRC works in conflict areas in the Southern Highlands and Hela provinces and also conducted their own assessments. The El Niño impact level is at category 3 but insecurities linked to conflict make people very vulnerable, and thus increase the level of impact. Communities are food stressed as they try to recover from the consequences of conflict. Assessments found that families cannot take care of themselves as prices of food crops also increased. Households are selling livestock just to buy food. If drought persists, the challenge will be migration. However, hostilities do not give much economic space for migration or manoeuvre.

Husbands are reportedly leaving their families in search of food from wantoks in town, making the women and children more vulnerable when left alone. Young men have also been moving in masses into Mendi town and participating in the informal sector – street vending. Increased street vending has since resulted in social chaos as vendors compete for buyers and the police try to exercise some control of these activities.

Source: CARE PNG El Niño Monitoring, October 2015.

Building disaster resilience can help reduce conflict

Communities in conflict-affected areas tend to have lower resilience to disasters. Similarly, community members affected by disasters can be more prone to engaging in conflict. In these circumstances, in addition to more conventional peacebuilding approaches, climate adaptation and disaster risk reduction offer further entry points for preventing conflict. The potential has been demonstrated by regional cooperation for transboundary river-basin flood risk management (Box 5-3).

In situations where conflict is based on competition for scarce resources, better management of natural resources, combined with climate change adaptation, can channel competing interests into non-violent resolutions.²² DRR interventions, such as climate risk information for drought, transboundary basin cooperation for floods, early warning for cyclones, and earthquake resistant building codes can reduce the disaster risk and build the resilience of households

and communities. In a volatile situation where conflict is either brewing or in full swing, these interventions can offset or soften the impact of a disaster. As illustrated in Figure 5-4 these interventions can be combined to tip the balance – as building disaster resilience and measures for conflict reduction are mutually reinforcing.

Disaster, climatic shocks and conflict risk can also be linked with declining rural incomes.²³ More resilient rural livelihoods can go a long way in preventing climate-related conflicts. In addition to more conventional peacebuilding, in places that are both vulnerable to disaster and climatic shocks and prone to social turmoil, climate adaptation and disaster risk reduction thus offer entry points for conflict prevention (Figure 5-5).

It is important to note that intense violence has much greater impact on environmental vulnerability than environmental shock has on conflict risk. Special attention must therefore be paid to disasters that strike zones of chronic conflict. Countries in Asia and the Pacific have demonstrated that disaster

Box 5-3

River basin cooperation to reduce international tensions

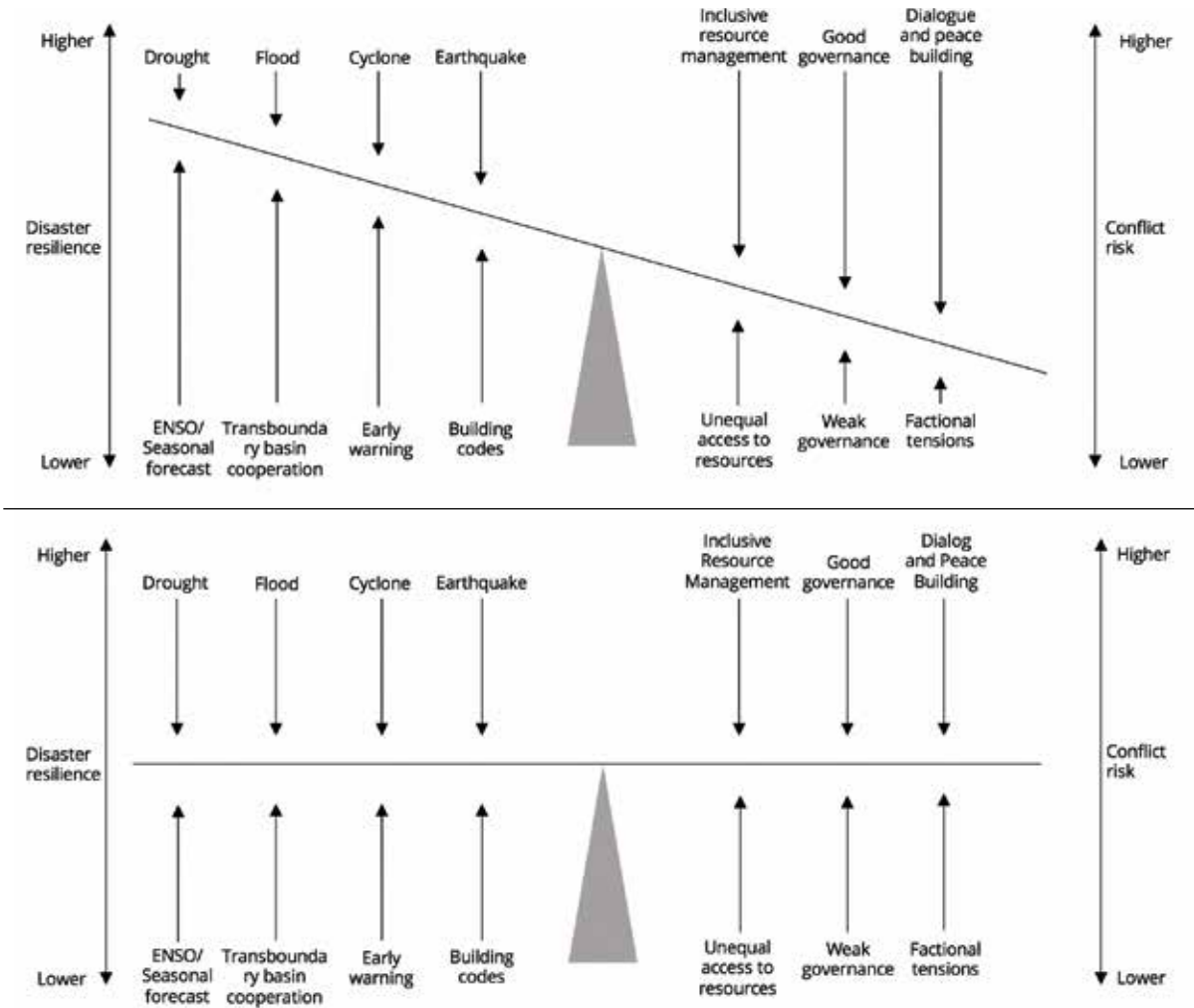
Research on bilateral and multilateral interactions between two or more states from 1948 to 2008 shows strong evidence of significant formal cooperation among river basin riparian states, and no cases of water causing two states to engage in war. Transboundary water cooperation, particularly joint management, flood control, and technical cooperation, can form a basis for longer-term cooperation on a range of contentious issues.

Efforts at basin-wide institutional development tend to help move relations on, from the assertion of conflicting rights to water, to addressing the multiple values of water, and ultimately to sharing benefits across national boundaries.

Source: Adger, W.N., et al, 2014. Human Security

Figure 5-4

Tipping the balance: higher disaster resilience for lower conflict risk



Source: ESCAP

management interventions can stimulate dialogue and collaboration between social groups since community cooperation and capacity development are less contentious than direct attempts at conflict reduction. The most dramatic windows of opportunity can be opened by large-scale, generally rapid-onset, disasters.

In Indonesia for example, the 2004 tsunami destroyed some coastal areas of the province of Aceh which had long been subject to a conflict.

Here the response to the disaster helped bring peace talks to fruition. The post-tsunami recovery was seen as an historic opportunity to ‘build back better’ – addressing both tsunami recovery and post-conflict reconstruction in a more unified way. In 2005, after 29 years of war, the separatist movement signed a peace agreement with the Indonesian Government.

Aid, however, is not always so supportive, and in some cases, post-disaster responses can

exacerbate conflict. Assistance programmes involve transferring resources of some kind – be they seeds, tools, housing, water and sanitation, financial services, food, health care or technical skills. If these infusions appear to favour some sections of society over others aid may increase social tensions. In conflict areas, such resources are likely to already be scarce, so those who gain control over them increase their power and wealth, and the resources themselves become part of the conflict.

Sri Lanka’s experience of post-tsunami relief, for example, was different from that of Indonesia. Here there was a long-running conflict between the North and the South. On 22 February 2002, the Government and the separatist group signed a Memorandum of Understanding and agreed on an indefinite cease-fire agreement.

But ongoing tensions were exacerbated after the tsunami.

Disaster management should therefore be conflict-sensitive to guard against unintended harm, while peace-building should be hazard proof. Even though organizations working in DRR may not possess specialist conflict resolution or peace-building skills, they should be conflict-sensitive, seeking to avoid contributing to social tensions. Over the past 15 years or so, many agencies have increasingly adopted the ‘Do No Harm’ approach in emergency programmes.

ESCAP can support these efforts at the conflict-disaster prevention nexus by serving as a hub for bridging development gaps and providing integrated policy analysis and advice – helping

Figure 5-5

Climate adaptation and DRR are entry points to help reduce conflicts



Source: Detges, 2017.

to build peace in conflict affected areas while also helping to prevent fragile situations from becoming full-blown crises (Box 5-4).

Environmental management, conflict prevention, DRR and peace-building thus should not be seen as separate activities but as linked to each other, as well as to programmes for

poverty reduction and improving livelihoods. Interventions to reduce disaster risk cannot prevent conflict on their own, particularly if these are related to political power struggles or ethnic conflict, but they can be part of a larger, more integrated approach to conflict prevention and peace building. Some of the new tools available for this purpose are the subject of the next chapter.

Box 5-4

ESCAP's contribution to DRR and conflict resolution

In cooperation with Member States, ESCAP engages in efforts at DRR that can contribute to conflict resolution. These include:

Risk scenarios – ESCAP's analytical work on the 2015/2016 El Niño impact outlook presented a methodology to understand the complex risk scenarios of slow-onset disasters in countries with critical disaster-conflict interfaces.

Monsoon forums – ESCAP, through its Trust Fund and partners, established monsoon forum risk communication platforms in Myanmar, Pakistan, Papua New Guinea and Timor-Leste to reduce vulnerability and strengthen disaster preparedness. ESCAP plans to expand these forums with context-specific risk assessment and early warning products.

Regional Drought Mechanism – This mechanism takes advantage of data and imagery from the region's space-faring countries – China, India, Japan, Republic of Korea, Russian Federation and Thailand – and shares it with other countries, especially those prone to drought.

Analytical work – Most of the analytical research in disaster prevention and peace building is from Africa and the Middle-East. There has been less work in Asia and the Pacific. ESCAP's flagship biennial publication, the Asia-Pacific Disaster Report, has therefore undertaken a diagnosis of the disaster-conflict-nexus. Further, the INFORM Index for Risk Management for natural and man-made disasters will be used to monitor the progress of disaster prevention and peace building in the region.

Capacity development – ESCAP plans to scale up its work on building resilience to drought and improving the capacity of countries to produce early warning on major weather events such as El Niño and related slow-onset disasters. This will contribute to building the overall resilience of fragile countries and conflict-impacted communities.

Box 5-4 cont'd

ESCAP's contribution to DRR and conflict resolution

Regional cooperation – The Regional Economic Cooperation and Integration high-level meeting has recommended establishing a specific platform for LDCs and fragile states on shared vulnerabilities and risks. In this regard, the ESCAP Committee on Disaster Risk Reduction at its 5th session in October 2017 will initiate discussions on how to establish a platform that builds disaster resilience in a cohesive way.

ENDNOTES

- | | | | |
|---|--|----|--|
| 1 | The United Nations Central Emergency Response Fund (CERF) uses the dataset from the Uppsala Conflict Data Program (UCDP) as one of a handful of inputs in developing its CERF Index for Risk and Vulnerability which provides a comprehensive picture of current and likely future humanitarian needs. | 8 | von Uexkul et al., 2016. |
| 2 | OECD, 2016. | 9 | Schleussner et al. 2016. |
| 3 | Peace-Building and Conflict Prevention in the Asia Pacific Region: Role of ESCAP. Draft Concept Note. 20 June 2017. | 10 | Qureshi, 2002. |
| 4 | GFDRR & GTZ, 2016. | 11 | UNAMA, 2016. |
| 5 | INFORM is the first global, objective and transparent tool for understanding the risk of humanitarian crises, developed by the Inter-Agency Standing Committee (IASC). http://www.inform-index.org/ | 12 | FAOSTAT, n.d. |
| 6 | GFDRR & GTZ, 2016. | 13 | United States Department of Agriculture, Foreign Agricultural Service, 2008. |
| 7 | UNDP, 2011. | 14 | USDA, n.d. |
| | | 15 | Government of the Union of Myanmar, 2015. |
| | | 16 | UNOCHA, 2016. |
| | | 17 | Ibid. |
| | | 18 | Advisory Commission on Rakhine State, 2017. |
| | | 19 | IFRC, 2015. |
| | | 20 | United Nations Country Team in Papua New Guinea, 2016. |
| | | 21 | Ibid. |
| | | 22 | Detges, 2017. |
| | | 23 | Catani, 2008. |



Photo: Alexandru Lande



6

LEAVE
NO ONE
BEHIND
POLICIES, ACTIONS
AND TOOLS

LEAVE NO ONE BEHIND

POLICIES, ACTIONS AND TOOLS

The 2030 Agenda for Sustainable Development established a mandate to ‘leave no one behind’. This framework now needs to be translated into resilience-building programmes and actions. An important part of this will be regional cooperation which will enable countries to harness economies of scale, address shared vulnerabilities, and extend the strongest possible support to high-risk, low-capacity countries and communities.

Over the past three decades, the international community has resolved to build greater resilience to disasters. In 1987, the World Commission on Environment and Development highlighted this priority in its report *Our Common Future*.¹ The United Nations General Assembly responded in the same year by designating the 1990s as the International Decade of Natural Disaster Reduction – calling upon governments to “formulate national disaster-mitigation programs, as well as economic, land use and insurance policies for disaster prevention and, particularly in developing countries, to integrate them fully into their national development programs.”²

In 1994, this commitment was reiterated at the First World Conference on Disaster Reduction which resulted in the Yokohama Strategy and Action Plan for a Safer World, which said that “disaster prevention and preparedness should be considered integral aspects of development policy and planning”.³ In 2005, the World Disaster Reduction Conference concluded that the world was still falling short on this objective.⁴ This resulted in the Hyogo Framework of Action 2005–2015 (HFA) whose key goal was ‘effective integration of disaster risk reductions into sustainable development policies, planning and programs at all levels.’⁵

Even after the HFA, however, many developing and least developed countries were still making slow progress.⁶ In four subsequent biennial assessments, 58 Asia-Pacific countries scored less than three out of five for addressing underlying risk factors.⁷ Most countries were preparing for and responding to disasters, but paying less attention to reducing disaster risk. And while many countries had introduced new disaster management institutions these generally operated as distinct units rather than pervading other government activities and all development sectors. Meanwhile, countries have been acquiring additional risks through unplanned urbanization, for example. Generally, there is still a relatively low appreciation how modest public investment for prevention would yield long-term social and financial benefits.

The international community clearly needed a deliberate and coherent approach that placed disaster risk reduction at the heart of sustainable development. Over the period 2015–2016, governments responded with a comprehensive global framework (Figure 6-1). This comprised six separate but interrelated agreements:

- Sendai Framework for Disaster Risk Reduction 2015-2030

Figure 6-1

Global development frameworks embracing disaster risk reduction



- 2030 Agenda for Sustainable Development
- Paris Agreement under the United Nations Framework Convention on Climate Change
- Agenda for Humanity
- New Urban Agenda
- Addis Ababa Action Agenda under the Third International Conference on Financing for Development

The thread of resilience

At the heart of the sustainable development agenda is disaster resilience.⁸ The paradigm shift from prevention to resilience that began with the Hyogo Framework for Action (2005-2015) has been reiterated and strengthened in the global development frameworks adopted in 2015 and 2016.

The frameworks were spearheaded by different United Nations agencies and national governments and each has different institutional and financial mechanisms at national and local levels. While resilience has been a common theme through all these global frameworks and agreements, the terminology has not been consistent, prompting the United Nations Secretary-General to call for a 'shared understanding of sustainability, vulnerability and resilience'.⁹

The Sendai Framework – This draws from the UNISDR definition of resilience as 'the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to 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'.¹⁰ It comprises seven targets and four priority actions (Figure 6-2).

Figure 6-2

The Sendai Framework: seven targets and four priority actions



The 2030 Agenda for Sustainable Development – This does not define resilience but uses the term in the preamble, vision, goals and targets as a quality to be ‘built’, ‘developed’ and ‘strengthened’ to reduced people’s exposure as a foundation for inclusive economic growth and prosperity. The term is also used in relation to inclusive and safe cities, and high-quality and reliable infrastructure.

The Paris Agreement – The agreement includes resilience, particularly for building adaptive capacity and reducing vulnerabilities to the adverse effects of climate change. Resilience has to be ‘strengthened’, ‘built’ or ‘fostered’. Resilience is also emphasized for communities and livelihoods, as well as for socioeconomic and ecological systems and is considered a global mechanism for reducing the loss and damage associated with the impacts of climate change.

New Urban Agenda – This combines elements of risk management, adaptive capacity and inclusive development.

Agenda for Humanity – This focuses clearly on building resilience of communities for preparing for disasters.

Addis Ababa Action Agenda – Resilience is seen both as economic resilience of countries for absorbing the shocks of disasters, and as financial resilience for mobilizing resources for sustainable and resilient development.

All the global development frameworks and commitments are based on an understanding that sustainable development ‘meets the needs of the present without compromising the ability of future generations to meet their own needs’. They therefore aim to balance the economic, social and environmental dimensions of sustainable development. They also pay attention to the needs of vulnerable people – the poor, the excluded and those who are discriminated against. They share many common understandings:

- *Hazards are inevitable but disasters are not* – Disasters are endemic in nature and in the process of social and economic development. Such risks cannot be prevented or preempted, but they can be assessed, anticipated, mitigated and adapted to.
- *Risk reduction is crosscutting* – Resilience

concerns multiple disciplines and sectors, including: natural resource management, food security, health, education, social safety nets, insurance, infrastructure, urban planning, housing, building codes and standards, the private sector, supply chain management, tourism, and livestock. No single sector or agency of the government at any level can handle all the issues.

- *Work in concert* – Coordination is needed within and across sectors, with the full engagement of all State institutions, executive and legislative, at national and local levels.
- *Science can help* – Advances in science and technology in areas such as earth observation systems, spatial planning, big data analysis, and ICT can help countries in understanding risks, and in forecasting and communications.
- *Finance needs to be mobilized* – All frameworks highlight the need to tap into a variety of financing sources, including domestic public resources, private business and finance, international development cooperation and international trade.
- *Learning to do how* – Capacity needs to be developed across all sectors and at all levels.
- *International opportunities* – The SIDS, the LDCs and the developing countries will need international cooperation to develop capacities, and acquire technologies and financial assistance.
- *Measure progress* – Each of the global development agendas adopted in 2015 and 2016 has specific goals and targets, that need to be consistently monitored.

National level – action points for building resilience

Governments aiming to build resilience for the 2030 Agenda, in line with Sendai Framework, need to continually relearn and retool disaster risk reduction to meet new challenges, such as climate change, as well as new mandates, such as the SDG requirement to ‘leave no one behind’. For this purpose, they already have a wealth of experience to build on. Decades of implementing DRR and adaptation have established institutions, processes and lessons that can help deliver the SDGs, though these need to be re-evaluated and fortified.

There is an abundance of tools and approaches for building resilience. Some are already proven; others are emerging. Many are driven by technological advances in risk assessment, communication, and financing. But these science-based approaches need to be customized to national and local needs and needs to be sensitive to the differing circumstances of poor communities.

Make SDG implementation plans risk informed

During the period of the Millennium Development Goals, the dominant approach was to protect development gains from disasters. The SDGs, on the other hand, allow for incorporating disaster risk reduction into other policy agendas such as poverty eradication, food security, infrastructure, and urban development – while also responding to climate change.¹¹ Disaster risk reduction and resilience is not one of these goals, but it is embedded in the SDGs and explicitly so in at least four (1, 2, 11, and 13), with the aim of anticipating the potential creation of risks (Box 6-1).

Box 6-1

Disaster risk reduction in the SDG targets

Target		Indicators	
1.5	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	1.5.1	Number of deaths, missing persons and persons affected by disaster per 100,000 people
		1.5.2	Direct disaster economic loss in relation to global gross domestic product (GDP)
		1.5.3	Number of countries with national and local disaster risk reduction strategies
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	2.4.1	Proportion of agricultural area under productive and sustainable agriculture
3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	3.9.1	Mortality rate attributed to household and ambient air pollution
		3.9.2	Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)
4A	Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all	4A.1	Proportion of schools with access to: (a) electricity; (b) the Internet for pedagogical purposes; (c) computers for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; and (g) basic handwashing facilities (as per the WASH indicator definitions)
6.5	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	6.5.1	Degree of integrated water resources management implementation (0-100)
		6.5.2	Proportion of transboundary basin area with an operational arrangement for water cooperation
7B	By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, least developed countries, small island developing States, and landlocked developing countries, in accordance with their respective programmes of support	7B.1	Investments in energy efficiency as a percentage of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services
8.1	Sustain per capita economic growth in accordance with national circumstances and, at least 7 per cent gross domestic product growth per annum in the least developed countries		n/a

Box 6-1 cont'd

Disaster risk reduction in the SDG targets

Target		Indicators	
9A	Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States	9A.1	Total official international support (official development assistance plus other official flows) to infrastructure
10.1	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average	10.1.1	Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population
11.5	By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	11.5.1	Number of deaths, missing persons and persons affected by disaster per 100,000 people
		11.5.2	Direct disaster economic loss in relation to global GDP, including disaster damage to critical infrastructure and disruption of basic services
13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	13.1.1	Number of countries with national and local disaster risk reduction strategies
		13.1.2	Number of deaths, missing persons and persons affected by disaster per 100,000 people
13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	13.3.2	Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions
14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	14.1.1	Index of coastal eutrophication and floating plastic debris density
15.3	By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	15.3.1	Proportion of land that is degraded over total land area
16.1	Significantly reduce all forms of violence and related death rates everywhere	16.1.2	Conflict-related deaths per 100,000 population, by sex, age and cause
17.6	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism	17.6.1	Number of science and/or technology cooperation agreements and programmes between countries, by type of cooperation

For this purpose, governments will need to assess current risks, and the gaps in disaster risk reduction, along with future climate risks – and do so at all timescales, sub-seasonal, seasonal and long-term – up to 2030, to see how these will affect the SDGs. The SDGs require that no one should be left behind, so these data need to be disaggregated by gender, age, and income as well as by other social groups. Then, in consultation with stakeholders, governments can identify – and cost – the necessary measures.

Some countries were already taking steps in this direction long before the SDGs were adopted. Japan, for example, has an official annual report to the parliament on the status of disasters and on budgetary allocations for DRR programmes.¹² The Philippines integrates disaster risk reduction and climate change adaptation into national, sectoral, regional and local development policies, plans and budgets. China prepares a comprehensive Atlas of Natural Disasters that is used for developing disaster prevention and reduction plans.¹³

Similarly, government plans, policies, and programmes have been taking climate change into account. All Asian LDCs, for example, have prepared National Adaptation Programmes of Action. Almost all countries have also prepared National Communications and National Capacity Self-Assessments.¹⁴ More recently, many countries have started preparing their National Adaptation Plans; the first country in the region to submit such a plan to the UNFCCC was Sri Lanka. As part of these processes, countries have set up technical and institutional capacities, data infrastructure, and coordination mechanisms. Nepal, for example, building on its institutional arrangements for climate change adaptation, has integrated its strategies for the 2030 Agenda, the Sendai Framework and the New Urban Agenda.

Scientific and technological advances have improved the understanding of natural hazards and provided sophisticated tools for weaving disaster risk reduction into all activities for achieving the Sustainable Development Goals (Box 6-2). However, less is known about the ways in which natural hazards interact with layers of physical, social, economic and environmental vulnerabilities in changing conditions. Knowledge of historical risk is important for all hazards, and even so for seismic hazards. Due to the low frequency of such events, the range of all probable events may be beyond the collective memory and experiences of societies (Box 6-3).

Risk mapping needs to capture the dynamic processes of risk generation and risk accumulation over time. Systemic improvement of risk assessment will require collection, analysis, management of data on hazard, vulnerability, exposure and capacity at all levels; real time access to reliable data; strengthening baselines; strengthening technical and scientific capacity; and investments in innovation and technology development.

Another essential requirement of making SDG plans risk-informed is the establishment of multi-stakeholder platforms to gather and synthesize risk information on an ongoing basis and to translate this into risk reduction measures. A useful model has been demonstrated by national climate outlook forums – a generic term which encompasses the various multi-stakeholder forums around seasonal climate, such as the monsoon forums, winter, and spring forums. These are regular dialogues where producers and users of data can discuss seasonal forecasts and how these will affect climate-sensitive sectors, such as water management, energy generation, agriculture, and health. These dialogues also encourage countries to adopt a more pro-active approach to climate change.

Box 6-2

Science-based tools for improving understanding of disaster risks

Space-based and aerial technologies

Disaster risk reduction has become increasingly enhanced by space technologies. Current satellite images are used for real-time monitoring of hazards, while historical satellite data can also be useful for long-term planning for land-use assessment, for example, and infrastructure construction.⁵¹

In Bangladesh, flood forecasting benefits from a radar altimeter on a NASA satellite, Jason-2. This tracks the levels of the Ganges and Brahmaputra rivers in the neighbouring upstream countries revealing almost immediately the river's height at the point of the satellite's crossing, so downstream flood risks can be assessed realistically. The Bangladesh Flood and Forecast Warning Center uses this data to produce daily eight-day flood forecasts and alert the public.⁵²

Remote sensing

Data collected from remote sensing methods can also provide high-resolution data for topographic maps that can be used for flood management and coastal vulnerability analysis. Nowadays these take the form of digital elevation models created with light and radar detection and ranging (LiDAR) technology which produce models with a vertical accuracy of 10 to 20 centimetres. In the Philippines, for example, previous hazard maps indicated that almost 90 per cent of the country's land was disaster-prone but provided no further detailed information. LiDAR is now being used to create high-resolution hazard maps that feed into a flood advisory system to enable decision makers to update flood risk reduction strategies. The resolution is accurate up to 20 centimetres, which is better than the images produced by most satellites. The processed information is accurate around 85 per cent of the time.⁵³

Drone-used geospatial data management

Unmanned aerial vehicle (UAV) or drone, is fast emerging as an alternative and/or complement to traditional satellite-based and remote sensing method for producing high-resolution base topographic maps for pre-disaster risk assessment, as well as risk monitoring. The application of data gathered by drones can enhance the capacity of developing countries to collect and analyse remote sensing and geospatial data for disaster preparedness, response, and long-term risk reduction. Compared to traditional sources of remote sensing data, UAV can provide faster and easier access to quality data.

Box 6-2 cont'd

Science-based tools for improving understanding of disaster risks cont'd

This has particular relevance for the high-risk, low-capacity Pacific countries that have sparse populations scattered across wide distances. Normally these countries receive geospatial data from space-faring countries but during emergency and disaster situations, they have to wait until these data are provided. ESCAP through a technical cooperation project funded by Japan on strengthening multi-hazard risk assessment and early warning systems helped in testing a series of UAV experimental flights in Tonga. Some 70 to 80 hectares were covered per flight within a maximum 30-minute flying time. Automatically geocoded aerial images were collected and used to generate 3-D models and processed geospatial data for cyclone risk assessment in 5 to 10 centimetre resolution.

Downscaled climate change projections

Accounting for future risks, including those from climate risks, is critical in making the SDGs resilient to disasters. Therefore, policymakers need climate change information that is reliable and matches their policy horizons and areas of interest. The most advanced tools currently available for simulating the response of the global climate system to increasing greenhouse gas concentrations are general circulation models (GCMs) which represent physical processes in the atmosphere, ocean, cryosphere and land surfaces. Although their horizontal resolution has been increased by more powerful computing capacity, these projections are nevertheless still too coarse (~300 to 150 kilometres) for use in routine development work – including infrastructure design and agricultural and urban planning.

This information can, however, be downscaled using dynamical and statistical techniques. These do not make the information more reliable, but do at least allow spatial refinement to 50 to 25 kilometres resolution. Planning and implementation can therefore be carried out in a much more targeted way. Users in South Asia, for example, can access this information through web-based interfaces such as the Climate Data Access and Analysis System (CDAAS), which was developed by RIMES with initial funding from the ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness.⁵⁴ CDAAS also provides access to high-resolution NASA Earth Exchange global datasets (25 x 25 km). CDAAS and other tools enable national meteorological and hydrological services to prepare national climate projections and help users interpret and apply these for risk analysis. There are also dynamically downscaled scenarios from the Coordinated Regional Downscaling Experiment (CORDEX) South Asia domain, an undertaking by the World Climate Research Programme.

Box 6-3

Historical risk knowledge - a global assessment of tsunami hazards over the last 400 years

Knowledge on where tsunamis are likely to occur can save lives and include the possibility of achieving zero casualties with appropriate preparation. A landmark study carried out by Tohoku University in Japan shows the importance of assessing or recognizing the hazards based on historical events beyond recent experiences. Based on a 400-year database, the study shows that memories of tsunami events can be limited and, as a result, there is a gap between societies' experiences and historical tsunamis. The study provides insights into future tsunamis, including in low-risk areas where the greatest casualties could occur because of the lack of awareness and preparedness. It recommends accounting for potential events such as those that may occur in a seismic gap, that is, a section of a fault that has produced earthquakes in the past but is now quiet, as well as other types of tsunami sources in assessments of future hazards. The work being carried out under ESCAP's Multi-Donor Trust Fund in the Makran Subduction region in the north-eastern Indian Ocean, where a deadly tsunami last occurred more than 70 years ago is driven by this consideration.

Source: Fumihiko Imamura Anawat Suppasri Panon Latcharote Takuro Otake. A global assessment of tsunami hazards over the last 400 years. International Research Institute of Disaster Science. Tohoku University, October 2016.

There are climate outlook forums in 14 Asia-Pacific countries (Figure 6-3). Some are biannual, around the onset of monsoon seasons; others convene more frequently. Most operate at the national level, but some countries, such as India, Myanmar, and the Philippines, have also started convening sub-national monsoon forums. The ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness is supporting WMO and RIMES to establish national climate outlook forums in Fiji, Papua New Guinea and Samoa.

Climate outlook forums have created networks of technical experts from various sectors and are nurturing a culture of anticipatory management. The Philippines, for example, as of 2017 had convened around 90 forums which had resulted in user-initiated projects based on seasonal climate forecasts.¹⁵ In Sri Lanka, the

cyclical and regular monsoon forums encourage preparedness (Box 6-4).¹⁶ In Myanmar, the Department of Hydrology and Meteorology has been convening forums at the national and local levels since 2008 for mitigating risks in climate-sensitive sectors.¹⁷

Climate outlook forums generally only disseminate seasonal climate forecasts three to six months ahead. However, they can also accommodate second-generation products, such as downscaled climate change information, and serve as platforms for understanding climate risks and opportunities.¹⁸

These national climate forums also receive information from the Regional Climate Outlook Forums (RCOFs) where experts from climatologically similar regions convene to provide consensus-based predictions and

information. The RCOFs are important sources of support for countries that do not have the technology or capacity to create their own climate outlooks. Many RCOFs in the region also feature capacity building training sessions on generating national-level seasonal predictions. They are regional components of the Global Framework for Climate Services, an initiative led by WMO.

Address the risks faced by different poor populations

Leave no one behind, as called for by the 2030 Agenda, requires governments to identify the specific vulnerabilities of poor countries and communities. It also means addressing issues of

governance, poverty, marginalization, and access to resources, which in the past have exacerbated the vulnerability of poor and marginalized populations to disasters.

Several countries in the region, including China and Japan, are moving towards ‘impact-based’ forecasting. An impact-based forecast combines hazard forecasts with data on risk to highlight how people in hazard-exposed and marginal areas could be affected. The inclusion of vulnerability information will identify groups that are commonly left behind, perhaps because they are not reached by weather and climate warning services or, due to disability, they have limited mobility to respond to warnings.

Box 6-4

Averting disaster through weather and climate forecasting in Sri Lanka

In 2015, the South Asian Regional Climate Outlook Forum predicted normal to above-normal rainfall for the second inter-monsoon 2015 (October-November) and the north-east monsoon seasons (December-January). The Sri Lankan Department of Meteorology downscaled this general forecast to produce a forecast for Sri Lanka. This was then shared at the monsoon forum in October 2015 which was attended by various sectoral agencies, the Department of Irrigation and the Department of Agriculture.

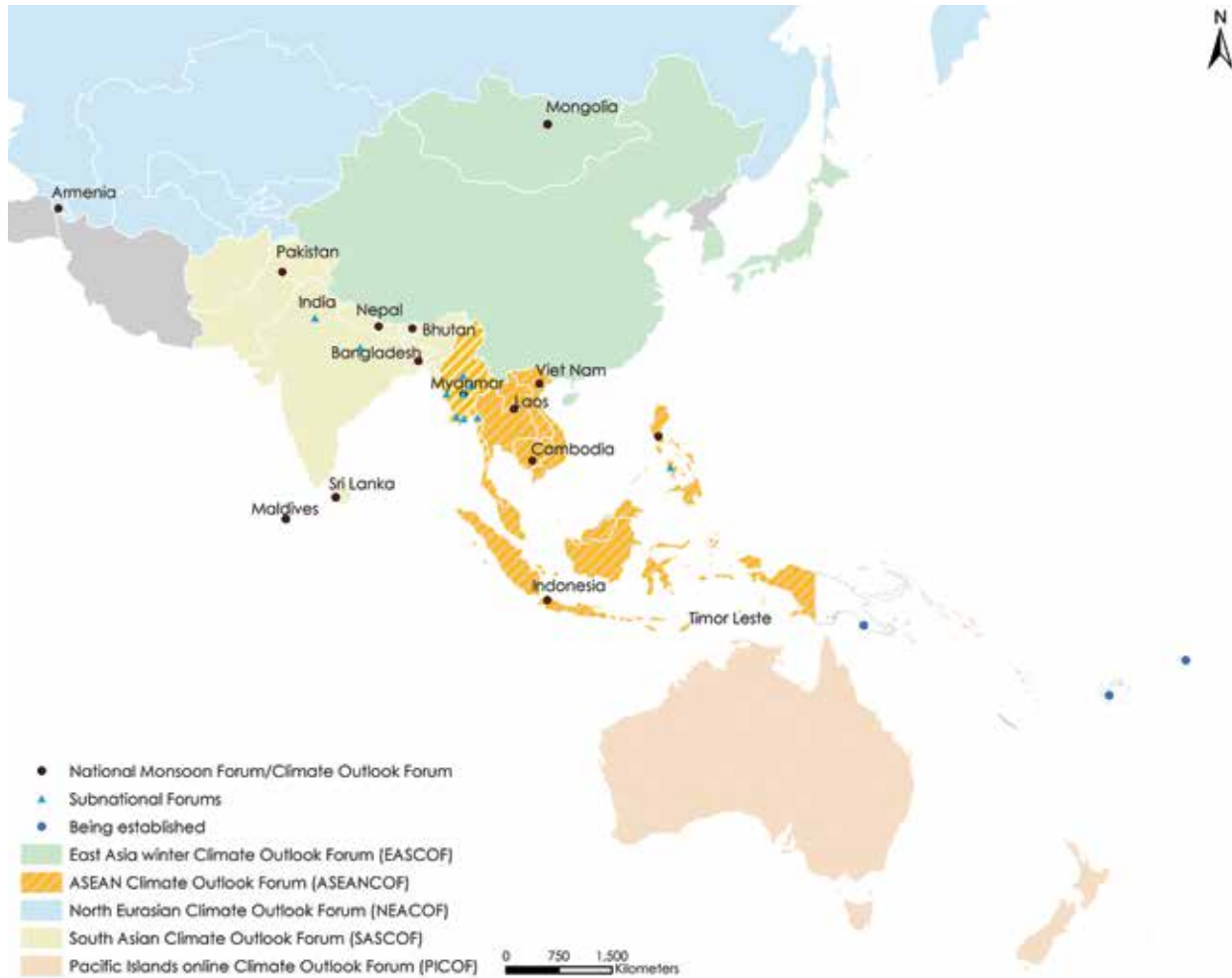
After careful assessment of current water levels in the reservoirs, the Irrigation Department issued special instructions to the engineers responsible for reservoir operations, to maintain reservoir water levels one metre below the full capacity, allowing for flood retention and also for smooth operation of radial gates in the spillways. The forecast for above-normal rainfall was borne out, and these actions minimized flood damage and also avoided flooding that would have resulted from rapid release of water.

By using the seasonal forecast, the Department of Irrigation saved resources equivalent to about \$40 billion, by regulating water in dams and reservoirs in various areas in the country, preventing a potential flood disaster. Nevertheless, there remain gaps in translating early warning information into preparedness. In May 2017, flooding in Sri Lanka caused the deaths of over 100 people and displaced over half a million.

Source: Minutes of the Forty-third session of the Tropical Cyclone Panel; RIMES presentation at the Regional Learning Platform, March 2017.

Figure 6-3

Regional and national climate outlook forums



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 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.

Figure 6-4

The climate outlook forum process



Impact-based forecasting shows how natural hazards interact with socio-economic conditions of potentially affected areas. However, while it is useful to have early warning of a probable event, it is even more valuable to have an indication of the impact on specific areas, communities, and assets that are at risk and likely to be affected. For example, national disaster management agencies need to know not just the storm track and intensity but also the areas of maximum winds, coastal inundation zones, inland flooding areas, and the evacuation zones that will be safe (Box 6-5).

Even if potential impacts to affected populations are known, this knowledge will not necessarily result in early action to protect families, livelihoods and property. More than two decades of experience has shown that such information is of little use if it is not in the right form or if people lack the resources and capacity to respond.

In the case of agriculture, there can be weaknesses at all levels – from the generation of climate information down to the translation of this information into usable advice for farmers. Often the information is not at a sufficient resolution to be useful – for example, not assessing at a local level the risk of a wet or dry spell during a season, or the risks of late or early onset of rains.¹⁹ Governments can provide such information as part of agriculture extension systems – delivering weather and information along with a bundle of other advisory, financial, market, and rural extension services. For this purpose, however, they will need to invest in climate observation and monitoring systems and convert scientific understanding into information and tools that farmers can use. A project by the APEC Climate Center in Tonga, for example, seeks to address these problems by tailoring agro-climate services to local users. The services include a web-based and mobile

phone-compatible decision support system for commercial farmers and extension workers.

If farmers are to act upon climate information, however, they too will need other resources – in the form of seeds, fertilizers, water and credit. Experience from West Java, Indonesia, for example, has shown that to respond to climate information farmers require a broad range of support from agricultural ministries, local agricultural services, and cooperatives.²⁰

Strengthen risk governance at all levels

Resilience is a cross-cutting issue that concerns multiple disciplines and sectors. The 2030 Agenda, as well as the other agendas, cut across all sectors. The Hyogo Framework first underscored three key sectors for building resilience: ecosystem management, social and economic development practices, and land-use planning. The Sendai Framework then broadened this to include the private sector. However, these issues cannot be handled in isolation by a single sector or agency of the government; what is needed is a collective ‘whole of government’ approach. Some countries have demonstrated significant political commitment and almost all have created legal and institutional frameworks. Most Asia-Pacific countries have strategic plans of action for disaster risk management, though these need to be revised and aligned with the Sendai and other global frameworks. However, many do not have the legal and institutional framework for developing such plans at the local level. The experiences of Indonesia, India and Pakistan are useful in this regard.

A major concern is that the new legal and institutional systems for disaster management have typically been high-level committees that take policy decisions but leave implementation to institutions that are still oriented to post-

Box 6-5

Impact-based forecasting

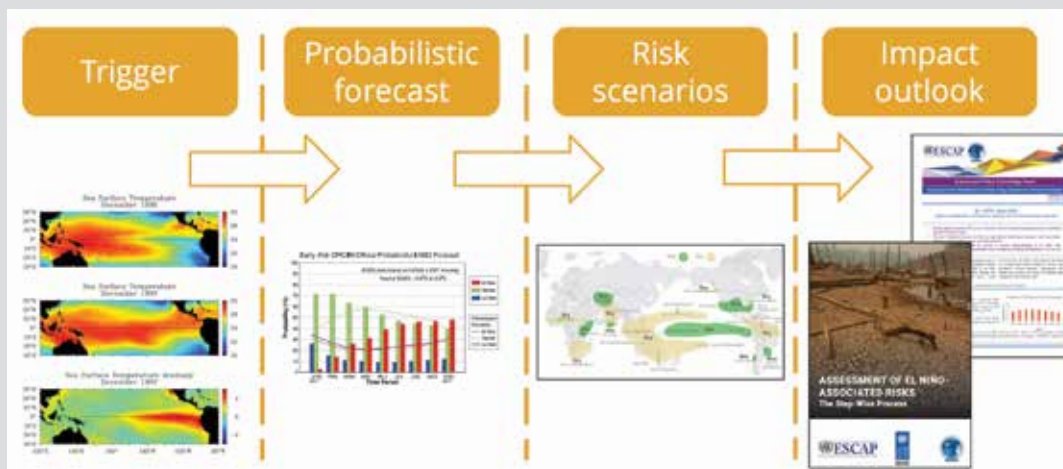
Impact-based forecasting requires a coordinated, multi-disciplinary effort amongst various government agencies. Early warning providers, such as the national hydrological and meteorological services, seismological early warning, and geospatial agencies, need to coordinate closely with disaster management authorities and sectoral ministries, such as agriculture, water management, public works and infrastructure.⁵⁵

Impact-based forecasting also requires new investments in data collection. Data and information – on hazards, vulnerability and exposure – will need to be integrated from a much wider range of sources, including from models, satellite measurements, ground observation, crowd sourcing, cloud computing, census, and damage and loss databases.

Impact-based forecasting also requires inputs from ensemble-based numerical weather prediction systems. These systems require significant computing facilities, so WMO has helped countries develop sharing and partnership arrangements whereby large-scale computing is undertaken only by a few centres and these data are then shared with others and sometimes customized to their areas and requirements. In the Asia-Pacific region, countries that do not have the capacity to establish their own computing systems can have access to model outputs from the European Centre for Medium Range Weather Forecast through a facility maintained by RIMES which customizes these data for application to specific locations in the region.

The figure below shows how information that is a departure from sea surface temperature averages ('trigger'), is translated into usable information for risk managers. The process starts by characterizing the probability of an El Niño happening during the year, followed by an assessment of how it might impact the seasons in different locations, and finally by an assessment of the potential biophysical and socio-economic impacts.⁵⁶

Process for producing impact based forecasts for slow-onset disasters



Sources: National Oceanic and Atmospheric Administration, International Research Institute for Climate and Society, Food and Agricultural Organization of the United Nations, ESCAP

Box 6-5 cont'd

Impact-based forecasting

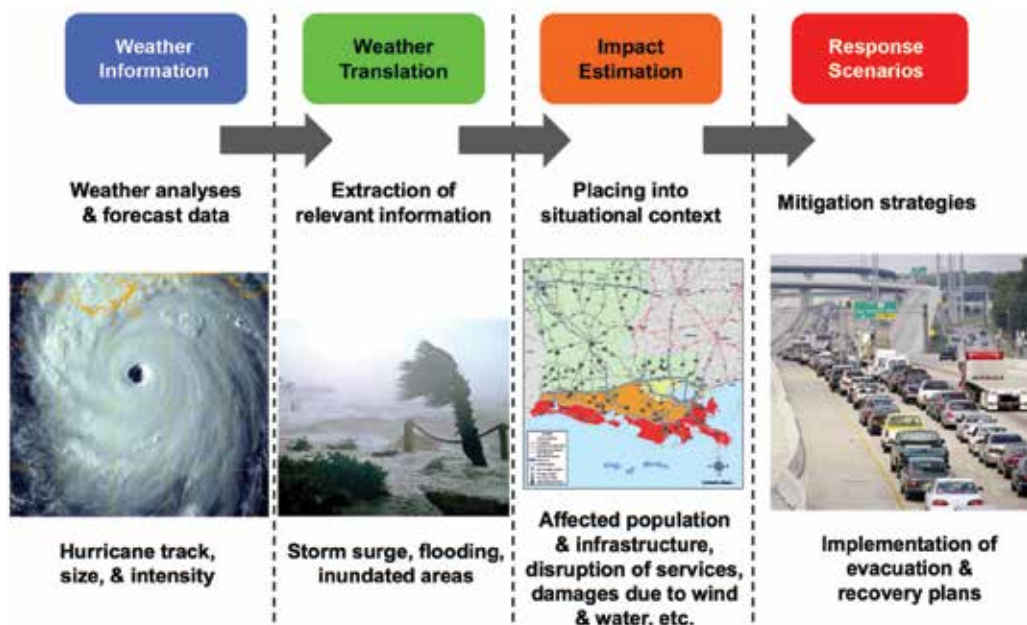
Assessing likely socio-economic impacts are based on vulnerability information captured by national and local socio-economic data which will demand national investment. Socio-economic databases, including those on the impacts of past disasters, could also be strengthened as part of monitoring the progress of the Sendai Framework and the data revolution called for in the 2030 Agenda.

disaster relief and rehabilitation. Even where there are new institutions these too have largely focused on disaster response and preparedness. Instead of becoming a common concern for all sectors, disaster risk management has become compartmentalized into a sector of its own.²¹

These problems can be overcome by stronger political commitment. Building resilience

depends on effective coordination mechanisms within and across sectors, requiring the full engagement of State institutions – executive and legislative – at national and local levels. This is stated as a guiding principle of the Sendai Framework, and is highlighted in the Paris Agreement and the Agenda for Humanity. To assist in this, ESCAP has supported efforts by priority countries to sensitize key officials of

Figure 6-5

Process of producing impact-based forecasts for extreme weather events

Source: ESCAP (2016); WMO/GFDRR Shanghai workshop report; Baode and Xu Tang (2014). Translating weather forecast into impact-relevant information; WMO Status of EWS.

planning and finance departments. A regional guide book has also been developed on the subject and regional training programmes have been organized.²²

There are now technical standards and codes for risk-resistant construction and land-use planning. And countries have established early warning systems for hydro-meteorological hazards and emergency management systems for responding to disasters.

These and other initiatives have helped save human lives in low-to-medium scale disasters, particularly hydro-meteorological disasters, such as cyclones, for which early warnings are available. However, some of these gains are being offset by the damage from high-intensity low-frequency disasters such as mega-earthquakes, or complex disasters that combine natural and technological hazards, notably the 2011 Tohoku earthquake and tsunami that caused meltdown of nuclear reactors.

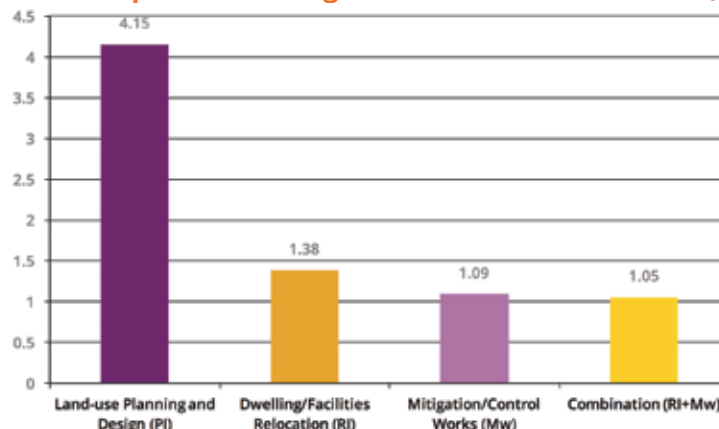
Invest in disaster risk reduction

Due to pressing priorities, many countries find it difficult to allocate human or financial resources for disaster risk reduction. This is partly because in most developing countries policymakers, particularly in planning and finance departments, fail to appreciate the economic value of investing in disaster risk reduction and building resilience. They could, for example, make cost-benefit calculations for risk-proofing roads, and making schools and hospitals earthquake-proof, and improving meteorological forecasting and communications, and satellite imagery. These can all provide positive returns.

In the case of reducing risks from seismic hazards in urban areas, an analysis of various policies and interventions shows that the largest ratio of benefits to costs are from land-use planning and improved building standards (approximately 1 to 4) (Figure 6-6).²³ The argument for these measures is even more compelling when taking into account the political and economic benefits from avoiding loss of life and injury, decreasing poverty and increasing human development.

Figure 6-6

Benefit-cost ratios of earthquake risk mitigation measures in Colombia, Mexico and Nepal



Source: ESCAP based on ERN-AL. 2011. *Probabilistic modelling of disaster risk at global level: development of a methodology and implementation of case studies, Phase 1A: Colombia, Mexico, Nepal. Background paper for the 2011 Global Assessment Report on Disaster Risk Reduction.* Geneva, Switzerland: UNISDR.

Investments in prospective and corrective risk management can lead to significant reductions in mortality. It may not be feasible to do so through demolition and reconstruction, either because of the cost or because buildings have cultural, social and historical importance. There are, however, affordable forms of retrofitting that can improve the seismic performance of buildings or reduce the risks to acceptable levels. The experience of Nepal during the 2015 earthquake demonstrates the benefits of retrofitting (Box 6-6).

It is also useful to estimate a broader benefit-cost ratio for the region as a whole.²⁴ Developed countries and the multilateral funding agencies are now working with new tools and techniques of cost-benefit analysis for risk mitigation projects. These suggest that, globally, disaster risk reduction interventions have a rate of return of between four and seven times, depending on the context.²⁵ Assuming these rates can be applied consistently across all interventions and countries, then to reduce the average annual loss for Asia and the Pacific of \$160 billion by 10 per cent by 2030, the average annual investment required would be between \$2.3 billion and \$4.0 billion.

Just as important, other new investments should avoid creating new sources of risk. All new projects can be disaster resistant not only in their structural components, but also in their impacts on society, livelihoods and the environment. Some countries in the region are adopting innovative tools like disaster impact analysis, marginal cost analysis, and disaster check lists.²⁶ Moreover, with 10 to 15 per cent of additional investment it is possible to retrofit development projects. Careful consideration can be given to identifying suitable and secure locations when planning infrastructure. This will require regulations and guidelines on

zoning and land-use planning. Measures to enhance infrastructure resilience include avoiding construction in vulnerable locations, realigning coastal roads or shifting them to higher locations, providing warning signs, and designating emergency rescue routes.

Adopt innovative ways of managing the fiscal burden of disasters

Many countries, especially Countries with Special Needs, face huge financing gaps; they may have ability to access domestic and external savings for financing reconstruction and relief.

A study assessing fiscal vulnerability from floods, windstorm, tsunami and earthquake hazards show that many Asia-Pacific countries have financing gaps and hold insufficient resources to recover from these hazards. In particular, Bangladesh, the Philippines, Pakistan and the Pacific SIDS are expected to face fiscal challenges due to natural disasters that occur less than every 10 years.²⁷ Many countries also encounter delays in accessing financing which further slows the recovery process and increases the severity of disaster impacts. Reducing disaster impacts requires immediate access to liquidity.

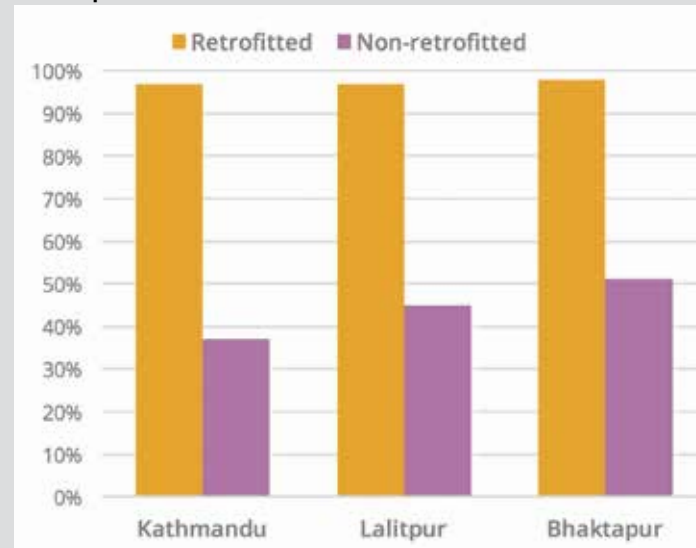
Asia-Pacific developing economies have very limited insurance penetration which has not kept pace with economic growth – widening the gap between insured and actual losses (Figure 6-7). Inadequate government funds and the lack of insurance can be offset to a certain extent by international aid. From 2006 to 2015, countries in Asia and the Pacific received approximately \$5 billion in international humanitarian assistance though this was only around 10 per cent of the average damage per year from natural disasters.²⁸

Box 6-6

Retrofitted school buildings survived the 2015 Nepal earthquake

On 25 April 2015 an earthquake struck the historic district of Gorkha, about 76 km northwest of Kathmandu. Most of the school buildings in the affected areas in Gorkha, Sindhupalchowk, Adlakha, Nakao and part of Kathmandu valley, suffered significant damage that would have killed and injured students, had they been at school during the earthquake. However, 160 school buildings that had been retrofitted withstood the massive 7.8 magnitude tremor and over 100 aftershocks. Some of these buildings were retrofitted as part of the joint effort by the Ministry of Education and the National Society for Earthquake Technology co-financed by the Asian Development Bank and the Government of Australia.

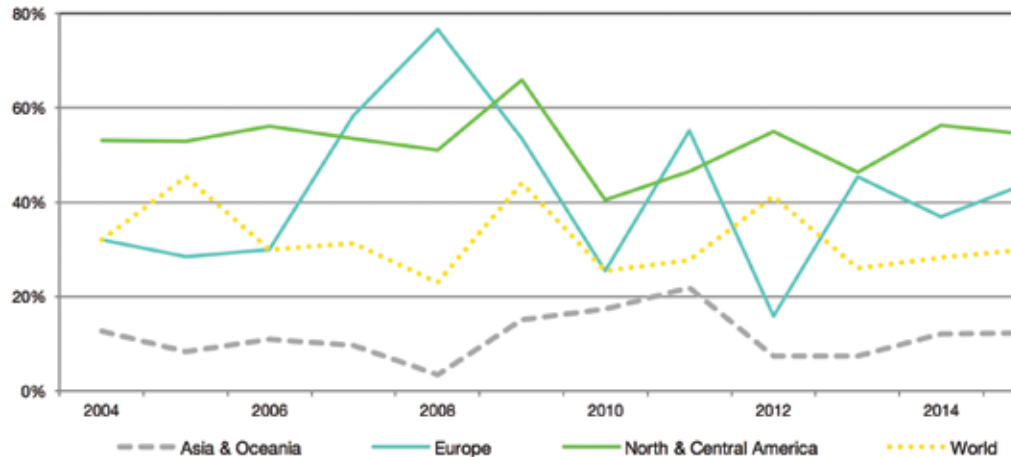
Buildings that could be used immediately after the earthquake: retrofitted and non-retrofitted



Source: Naveed Anwar, Sandip Adhikari, Maria Shahid, Shankar Shrestha, "Making schools safer for earthquakes effectiveness of retrofitting: case studies from Nepal", AIT Solution, November 2016.

Figure 6-7

Percentage of disaster losses insured, 2004–2015



Source: Based on non-life insurance premium data from SwissRe, Sigma annual report on world insurance. Insured loss data from MunichRe, NatCatSERVICE.

Note: The "Asia & Oceania" regional grouping used by the source slightly differs from the composition of "Asia-Pacific" used throughout this report.

Countries in the region are trying innovative solutions to improve access to post-disaster liquidity. One option is forecast-based financing. When a disaster has been forecast beyond an agreed threshold of probability, funds are released for disaster preparedness and response as well as for building resilience.²⁹ This approach has been rolled out by the United Nations World Food Programme (WFP) and the International Federation of Red Cross and Red Crescent Societies, together with the German Red Cross. In 2015, in the light of predictions of El Niño and extreme weather, the Red Cross successfully activated the mechanism in Guatemala, Uganda, and Zimbabwe. Forecast-based financing lowers the cost of the humanitarian response by as much as 50 per cent. In Asia, WFP and Red Cross Societies have put this mechanism in place in Bangladesh, Nepal, and the Philippines.³⁰

Similarly, the World Bank and Columbia University have an initiative on financial instruments for rapid release of funds for disaster relief and response. Research is underway on the use of satellite remote sensing data, in tandem

with ground-based information, for assessing the economic implications of catastrophic flooding at a country level. The initial focus countries are Bangladesh, Malaysia and Thailand. If such an assessment is feasible instruments could be designed for use by finance ministries to buffer the country from the burden of disasters.³¹

Governments and other actors have also considered ways of sharing risks – both within and between countries. The key risk-transfer instruments include: financial insurance, micro-insurance, and micro-financing, investment in social capital, government disaster reserve funds, and intergovernmental risk sharing.³²

For individual farmers, for example, a useful option is parametric weather-index insurance. In this case, the payout is tied not to the actual damage but to agreed thresholds of such parameters as local wind speeds and rainfall. This has several advantages over traditional forms of insurance, since there is less administration, payouts can be much quicker. Payouts can also facilitate anticipatory action that reduce the

risk of a physical phenomenon, such as drought, evolving into a disaster – so payouts can be lower than those required afterwards.

In the past, weather-index based insurance has been hampered by a lack of historical data and inadequate weather observation and monitoring facilities. In Panay Island in the Philippines, for example, a private sector scheme was hampered by a lack of historical rainfall data and the insurance company could only insure farms within 20 kilometres of the weather observation and monitoring station.

Moreover, some disasters, such as floods, do not depend on a single parameter, and insurance markets have struggled to provide affordable insurance in high-risk areas. Even in many developed markets, flood is an ‘uninsurable’ risk in coastal areas or on floodplains where the extent of potential losses renders insurance financially unviable. For flood insurance, it is common, therefore, for part of the risk to be underwritten by the state.

One index-based flood insurance product was being piloted for smallholder farmers in the districts of Muzzafarpur in Bihar, India, and Sirajganj in Bangladesh, during the summer monsoon in 2017. It was developed by the International Water Management Institute (IWMI), the Indian Council for Agricultural Research, the Disaster Management Department, the Institute of Water Modelling, the insurance company SwissRe, and NGOs. The IWMI conducted a survey to ascertain the willingness of farmers to pay; most wished to be part of the pilot scheme, while expressing their need for affordable premiums in line with their incomes. In Bihar, more than 200 farming households have already enrolled in the scheme with the total sum insured estimated to be equivalent to \$78,000.³³

IWMI will use satellite data to verify claims and assist in calculating payouts. The payout index is tied to a 35-year record of floods and associated losses in paddy rice crops. The index combines hydrological and hydraulic modelling and newly available 10 metre-resolution satellite images from the European Space Agency. If a trigger water level is reached the satellite images are used to verify the depth and duration of the flood and identify the farmers who are eligible for compensation, who will be notified via SMS.³⁴

Given the flurry of interest in parametric insurance, the diversity of products being tested on the ground, and the tools and services being exchanged regionally through ESCAP’s Regional Cooperation on Space Applications, some ESCAP member States have expressed the need for a platform for peer learning on this topic.

Monitor progress in resilience-building

The global development agendas have clear goals and targets, so it is important to monitor bottlenecks and progress in building resilience. The Sendai Framework consists of seven global targets, while the Sustainable Development Goals number 17 in total, and include 169 targets. In early 2017, to ensure coherence the indicators for both the Sendai Framework and the SDGs were aligned, i.e. the Sendai Framework indicators contribute to measuring four of the SDG targets (Figure 6-8).

The Paris Agreement aims to keep the increase in global average temperature to well below 2 °C above pre-industrial levels and the Conference of the Parties is entrusted with periodically taking stock and assessing progress at the global and national levels. The New Urban Agenda encourages “voluntary, country-led,

open, inclusive, multi-level, participatory and transparent follow-up and review”.

One of the main problems is that many countries have yet to develop national systems for collecting disaster-related statistics. In February 2017, at the request of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction, UNISDR started the Sendai Framework Data Readiness Review. This covers two time periods: current availability; and 2005–2015 which was the implementation period of the Hyogo Framework for Action from which the baseline for the Sendai Framework for Disaster Risk Reduction was developed. As of 20 April 2017, there were inputs from 87 countries, 27 coming from Asia and the Pacific.³⁵

To fill the critical data gap the International Research Institute of Disaster Science at

Tohoku University and UNDP launched a joint initiative, the Global Centre for Disaster Statistics. The centre will establish a global database to collect and archive disaster loss and damage data and other relevant data from various sources. It will also build the capacity of national disaster management agencies to provide and use official data, which includes monitoring country progress under Sendai Framework.

Traditional statistics can be complemented with earth observation data and geospatial information which can be used to monitor and visualize progress on disaster risk reduction and resilience. The drivers of risk accumulation over time can be monitored by data on land use, land cover, elevation, and topography. However, taking advantage of these new data sources and technologies needs investments in systems, and staff training for integrating geospatial, and earth observation data and ensuring interoperability.

Figure 6-8

Alignment between the Sendai Framework and SDG indicators



More data do not necessarily result in usable information or better decisions. Advances in technology or technical human capabilities will only deliver their potential as part of integrated systems that align the flow of information with the shifting needs and demands of users.³⁶ Ensuring that countries with limited capacity benefit from these tools and technologies is discussed in the next section.

Action for regional cooperation

Resilience can be facilitated and strengthened through international and regional cooperation. The six global development frameworks emphasized such cooperation through the established mechanisms of the United Nations, multilateral financial institutions and North-South and South-South triangular cooperation. The Sendai Framework says that “each State has the primary responsibility to prevent and reduce disaster risk including through international, regional, subregional, transboundary and bilateral cooperation”. Consequently, there is a global target to substantially enhance international cooperation for developing countries.

Many of the Sustainable Development Goals also contain targets on cooperation. In addition, there is a dedicated target (SDG 17) on revitalizing the global partnership for sustainable development. The Addis Ababa Action Agenda is firmly based on international cooperation. The New Urban Agenda also requires “enhanced international cooperation and partnerships among governments at all levels”. The Agenda for Humanity, calls for an international order, based on “solidarity and collaboration - with people at its centre”.

In Asia and the Pacific, there have been a number of initiatives to translate these global

commitments into regional implementation plans:

- *Regional road map for implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific* – ESCAP member States adopted the regional road map in March 2017 at the Asia-Pacific Forum on Sustainable Development. This includes: strengthening regional cooperation; efficient and coordinated support to member States; and sharing knowledge and good practices more effectively. Disaster risk reduction and resilience is identified as one priority area for regional cooperation.
- *Regional action plan* – The Asian Ministerial Conference for Disaster Risk Reduction has adopted the Regional Action Plan and Road Map for implementation of the Sendai Framework. The regional plan provides broad policy direction, a 15-year road map, and a two-year action plan.
- *Pacific Framework* – The Pacific Community has adopted the Pacific Framework for Resilient Development in the Pacific which provides an integrated approach to address climate change and disaster risk management for the Pacific island countries.³⁷
- *ASEAN Declaration* – ASEAN countries have adopted a Declaration on Institutionalizing the Resilience of ASEAN and its Communities and Peoples to Disasters and Climate Change. The declaration underlines the importance of coherence, consistency and alignment across all relevant sectors by integrating disaster risk management and climate change adaptation in sectoral policies, strategies, plans, programmes, and projects.³⁸

Box 6-7

Cross-border tracking improves typhoon monitoring and forecasting

For nearly 50 years, the ESCAP/WMO Typhoon Committee has enabled the use of the latest innovative technologies to ensure well-coordinated regional responses to typhoons and cyclones. When a storm passes a certain threshold, the Typhoon Committee's standard operating procedure is activated, and countries exchange data to minimize blind spots when tracking the typhoon. Typhoon Meranti, which hit Philippines, eastern China and Taiwan, Province of China in September 2016, was the strongest tropical cyclone in the world that year. Its estimated peak intensity was 165 knots (305 kilometres per hour). Nevertheless, the damage was minimal due in part to precise tracking of its speed, intensity and movement. Such precision was made possible by the joint monitoring operations of Typhoon Committee members.

There can also be considerable inequalities between countries – which may differ greatly in their access to technologies and information, and their ability to use them. Some resources can be delivered as regional public goods, such as early warning for transboundary hazards. ESCAP member countries can take a number of measures to ensure that populations and countries with low capacity can make use of technologies through partnerships and regional cooperation.

Maximize the efficiency of regional early warning systems

Joint action is needed to improve warning systems for shared hazards that cut across national borders. ESCAP and WMO have jointly established two regional bodies to minimize and mitigate the impacts of tropical cyclone-related disasters: the Typhoon Committee covers the western Pacific; and the Panel on Tropical Cyclones covers cyclones emanating from the Bay of Bengal and the Arabian Sea. These bodies coordinate country operations, focusing on meteorology, hydrology, disaster risk reduction, training and research (Box 6-7). They also collaborate as, for example,

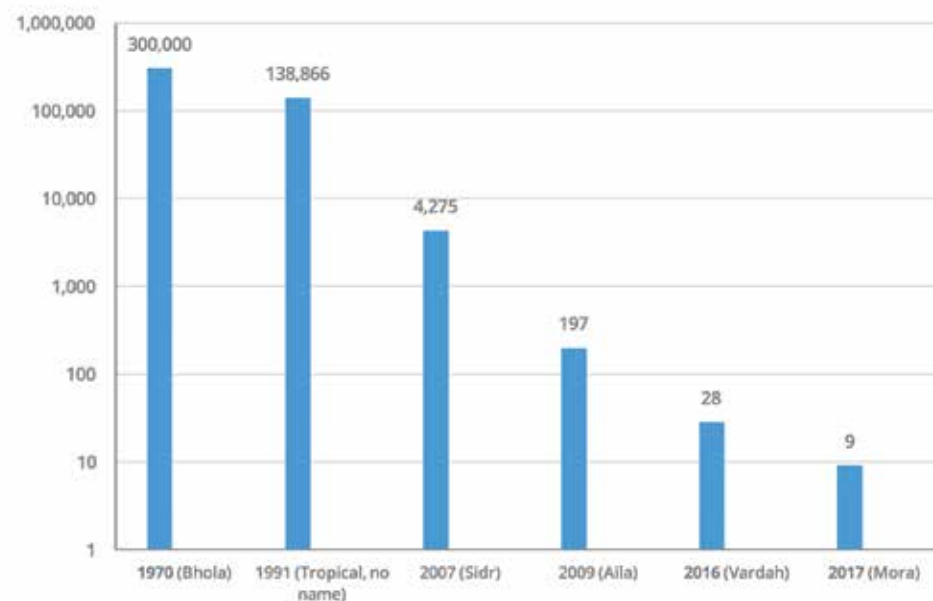
in the production of a manual on standard operating procedures for coastal multi-hazard early warning systems.³⁹

Regional learning platforms can also facilitate peer learning to share lessons from successful efforts such as early warning systems. Many Asia-Pacific countries have improved their early warning systems for typhoons and cyclones – notably India, Bangladesh, Myanmar, the Philippines, and Viet Nam.⁴⁰ Early warnings work best in conjunction with other interventions. In the Philippines, for example, Albay province is frequently hit by some of the strongest typhoons but has a zero casualty policy – based on early warnings, combined with engineering interventions, and social preparation and capacity building, along with preemptive evacuation.⁴¹

The WMO/ESCAP Panel on Tropical Cyclone and the ESCAP/WMO Typhoon Committee helped enhance regional cooperation by sharing of dynamic risk data, monitoring cyclone/typhoon from its origin to the landfall at the coast, and building institutional capacity of member States.

Figure 6-9

Deaths from tropical cyclones hitting Bangladesh (1970-2017)



Under these regional cooperation mechanisms, Bangladesh for example, has had great success in combining early warnings and cyclone shelters. Armed with information on cyclone tracks, wind speed, and expected rainfall quantities, millions of people have been taken out of harm's way due to timely evacuation and pre-positioning of relief goods. Over a 40-year period, fatalities related to housing damaged by cyclones have been cut dramatically: in May 2017, for example, cyclone Mora, hit southern coastal areas with wind speeds of up to 150 kilometres per hour but there were fewer than ten deaths.⁴²

Another successful example is Hong Kong, China where the reduction in deaths from typhoons has been attributed to early warning systems combined with better compliance with building codes (Figure 6-10).

There are also options for other hazards such as transboundary river-basin floods, flash floods and landslides. At the request of

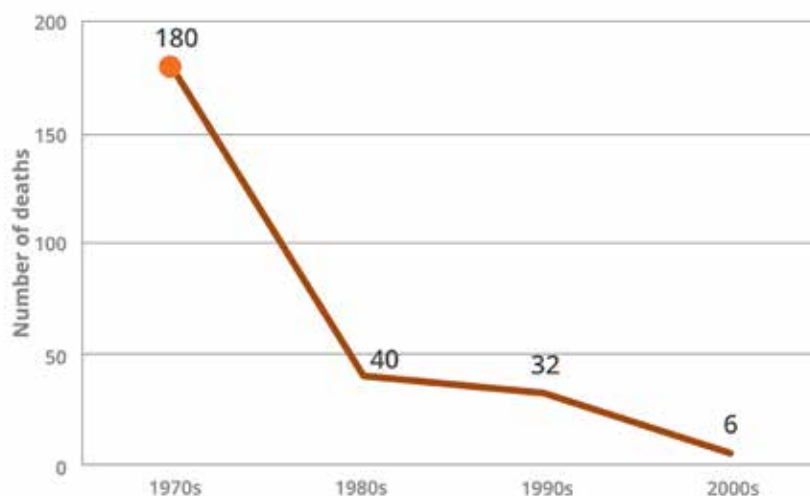
member States in 2015, ESCAP, with funding from GIZ, is conducting feasibility studies to review challenges, opportunities and the status of regional cooperation for early warning of transboundary hazards.⁴³

The costs of warning systems vary greatly among countries, so it is important to identify affordable and practical solutions that lend themselves to replication across the region. Countries can then strengthen cooperation, knowledge sharing, joint learning and innovation – taking advantage of each stakeholder's expertise to scale up successful initiatives into effective and sustainable mechanisms.

Regional cooperation is indispensable for financing early warning of tsunamis. The initial investment for establishing the IOTWMS, after the 2004 tsunami, was \$300 million, mostly borne by the governments of Australia, India and Indonesia and their partners. As of 2014, the total annual cost of operating and maintaining the system was \$90 million.

Figure 6-10

Deaths due to typhoons in Hong Kong, China, 1970s to 2000s



Source: UNEP, 2014.

Around half of this is likely to be for maintenance of water surface-level buoys which are susceptible to outages and malfunctioning due to harsh conditions and vandalism.⁴⁴

A major concern therefore is sustainability. Governments have many competing priorities and over time can question the value of expensive systems to protect against events that are very infrequent. The IOTWMS which provides 24 countries around the Indian Ocean with access to tsunami warning services can be considered as a regional 'public good'. A study for ESCAP estimated that on average, over the next century the IOTWMS will save the equivalent of at least 1,000 lives per year.

The weakest link in the IOTWMS is reaching the 'last mile'. ESCAP's support to the IOTWMS focuses therefore on strengthening community preparedness with well-established plans for quick evacuation that are understood by residents. With support from the ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness, RIMES has developed the Evaluation System

for Computing Accessibility and Planning Evacuation (ESCAPE).

ESCAP is now also intensifying its work in the north-western Indian Ocean. Since 2009, ESCAP has been raising awareness on the tsunami risk posed by the Makran Subduction Zone and the importance of close cooperation on tsunami monitoring.

Tsunami early warning is ultimately the responsibility of national governments, but there are also other opportunities for regional cooperation. Working together, countries can engage in joint learning and exchange of experience or technical assistance – improving inundation maps and warning chains, for example, and developing evacuation plans. This is particularly important for poorer countries that lack the capacity to conduct such processes by themselves.

Share data and knowledge

Leveraging the advances in science and technology to improve DRR depends on

access to data, information and knowledge. The information needs to be specific and ‘actionable’ to the end-user down the line. For example, achieving target G of Sendai Framework which aims to substantially increase the availability and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030, need various layers of processed data to produce actionable early warning information, namely hazard characteristics, vulnerability, exposure, and potential impacts. While hazard data are widely available, vulnerability and exposure data are limited. Improving the availability of these data

and information will not only help countries achieve this Sendai target but also serves as inputs to monitoring the progress on Sendai and SDG indicators (Figure 6-11).

At the global level, space applications have been recognized as an important means of implementation for development frameworks. If countries are to take advantage of space applications, they will need better access to information and knowledge. To achieve this, ESCAP’s Regional Space Applications Programme for Sustainable Development in Asia and the Pacific (RESAP) support low-capacity, high-risk countries.

Figure 6-11

Outcome (SDG 1.5) to input indicators (Sendai target G)

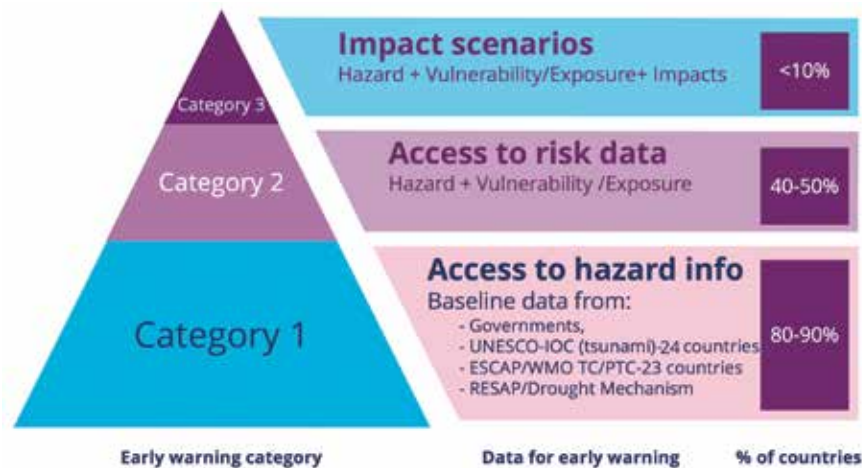


Figure 6-12

Pillars of the RESAP Plan of Action for Space Applications, 2018-2030



RESAP adopted a Plan of Action that started in 2012 and will end in 2017. This work will be taken forward by a new Plan of Action for Space Applications, 2018-2030, which is aligned with the SDGs, the Sendai Framework and the Paris Agreement, along with the Regional road map for implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific. For this purpose, in 2016, the twentieth Intergovernmental Consultative Committee of RESAP recommended three pillars (Figure 6-12).

Under these thematic areas, four main modalities of delivery were suggested:

- Timely provision of near real-time satellite imagery
- Programmes on thematic areas
- Skills and capacity to address existing gaps and emerging challenges
- Institutional development through emerging technology, knowledge products, standards and procedures

One of the flagship programmes under RESAP is the Regional Drought Mechanism. The aim is to build partnerships that enable countries experienced in using space applications to assist other low-capacity, high-risk countries. The mechanism builds tailored drought monitoring systems, linked with seasonal and climate forecasts, catchment water balance tools, and institutional capacity building. Linking space, hydrometeorological, census and ground-level data with policies and strategies provides a cross-sectoral system to address the complex issue of drought, whilst building the capacity of national governments in using space applications and other science and technological tools.

The programme uses various practical tools and components which are developed or

supported by other government agencies and partners. These include the National Remote Sensing Centre of India, the Chinese Academy of Sciences, eWater Australia, and the Geo-Informatics and Space Technology Development Agency of Thailand.

Another regional programme for enhancing access to space-based data is SERVIR. This is a joint venture through which USAID and the National Aeronautics and Space Administration provide satellite-based earth observation data to the International Centre for Integrated Mountain Development and the Asian Disaster Preparedness Center.

Build regional capacity

In recent years, there have been substantial improvements in understanding weather and climate systems. Coupled with more sophisticated modelling and greater computing power, this has resulted in more accurate forecasts with longer lead times. In general, depending on location and season, it is now possible to provide a climate forecast three to six months in advance. Integrating such weather and climate forecasting into early warning systems has helped reduce exposure to extreme climate events and improve planning and management in business, food security, and health.⁴⁵

Implementing the 2030 Agenda for resilience-building is often hampered by a lack of capacity. For example, many countries have found it difficult to make full use of risk information, including that related to climate change, and have not made their overall development plans fully sensitive to disaster risks. A number of countries have therefore established national institutions to develop capacity for disaster risk management.

Countries can also take advantage of United Nations initiatives. The United Nations Global Education and Training Institute for Disaster Risk Reduction in Incheon, for example, has training programmes on disaster risks and resilience. ESCAP has also organized training programmes for key government functionaries and other stakeholders. ESCAP has also recently established the Asian and Pacific Centre for the Development of Disaster Information Management (APDIM) to provide member countries with advisory services and technical cooperation on building codes, seismic micro-zonation and retrofitting. This will draw on the expertise and resources offered by centres of excellence in the host country, the Islamic Republic of Iran, such as the Building and Housing Research Centre and the National Cartographic Centre.

Such activities may be stepped up in collaboration with national and sub-regional and other centres to address capacity gaps in other key areas, such as developing national statistical systems, assessing emerging risks, post-disaster need assessment, end-to-end early warning systems, and integrated disaster risk reduction in nation development.

One important area for sharing regional experience and building capacity is for addressing the El Niño Southern Oscillation (ENSO) cycle.⁴⁶ El Niño brings considerable risks, as a harbinger of extreme weather and slow-onset disasters, but it also offers opportunities to manage these risks because during an El Niño year the seasonal climate becomes more predictable depending on the location and season, El Niño can be predicted from three to six months in advance.⁴⁷ Many countries in the region – notably Australia, India, Indonesia, the Philippines, and Viet Nam – have considerable experience managing major El Niño events. For example, during the El Niño drought of 2002, the Government of India developed a cell

under a cabinet secretary to monitor drought and advise on agricultural strategies and water management. This cell was subsequently used to tackle the droughts of 2009, 2014 and 2015.⁴⁸

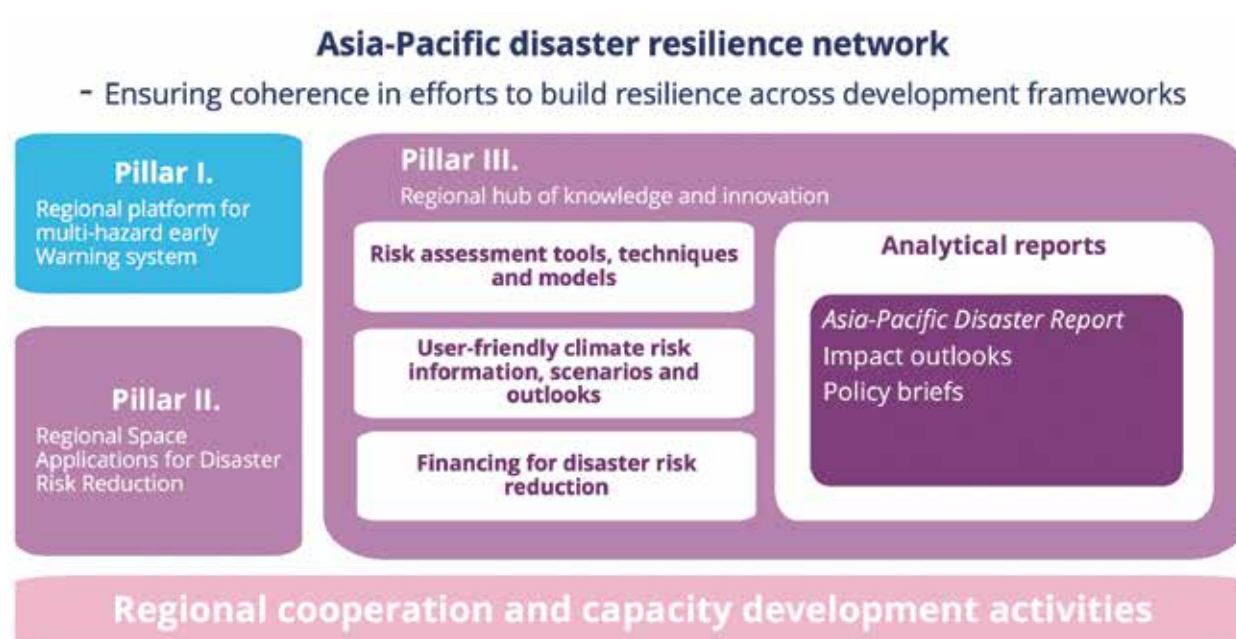
Overall, countries now have greater capacities to generate and interpret forecasts. Since the powerful El Niño in 1997-1998 there has been a significant increase in interactions among the international community, regional and national centres, and local communities.⁴⁹ Nevertheless, many developing countries still lack the resources and expertise to benefit fully from climate services.⁵⁰ Countries in the region therefore need to intensify cooperation to improve their capacities to reduce El Niño risks as part of broader strategies to manage the impacts of climate variability.

Considering the limited availability of indicators and data to monitor progress on Sendai targets and the disaster risk reduction related targets of the SDGs, capacity development for geo-spatial monitoring is important. A joint monitoring of emerging transboundary disaster ‘hotspots’ due to the changing geography of risks, changes in demography, development context or a combination of all, is an important component of SDG implementation which can be supported by regional cooperation.

Countries are at different stages of developing strategies to build resilience to disasters across sectors. The development and implementation of these plans require guidelines across all relevant sectors of development along with the means of implementation, such as enabling technologies, finance and capacity development opportunities. In this regard, there is a need to establish the Asia-Pacific Disaster Resilience Network (APDRN) in ESCAP to support the ongoing efforts of member countries to ensure coherence across the global development frameworks for disaster risk reduction and resilience (Figure 6-13).

Figure 6-13

Schematic diagram of Asia-Pacific Disaster Resilience Network



The APDRN could forge existing knowledge and capacities through inter-related pillars, including the regional platform for multi-hazard early warning systems and the regional space applications for disaster risk reduction. A regional hub of knowledge and innovation could be organized to serve as an infrastructure for analytical research and norm setting. The APDRN could align the analytical research and norm setting work of ESCAP with regional cooperation and it could initiate new analysis on disaster prevention and peace building in countries where disasters and conflicts co-exist.

Reinforcing the future

Disasters may not be completely predictable, but they can be anticipated. Governments across Asia and the Pacific now have a greater

understanding of how natural disasters unfold – exposing weaknesses in physical and social infrastructure and striking hardest at the poorest.

In response, governments have established the necessary policy frameworks. And scientific advances have enhanced tools for more effective action. But building resilience is not a job for the public sector alone, it must involve multiple stakeholders, from the private sector and civil society, to regional and international organizations. This requires ‘whole-of-government’ and ‘all-of-society’ engagements – to build more resilient structures and societies for current and future generations. This will be an essential basis for achieving the Sustainable Development Goals – for extending the benefits of human progress to everyone, with a resolute determination to leave no one behind.

ENDNOTES

- 1 United Nations, 1987.
- 2 United Nations General Assembly, 1989.
- 3 Yokohama Strategy and Action Plan for a Safer World, 23-27 May 1994.
- 4 United Nations WCDRR, 2004.
- 5 UNISDR, 2005.
- 6 United Nations, 2011, 2013, 2015.
- 7 UNISDR, 2014.
- 8 ESCAP, 2015a.
- 9 United Nations, 2016.
- 10 The Framework quotes this definition from UNISDR, 2009.
- 11 ESCAP, 2017b provides a list of indicative activities for the implementation of SDGs that also implements the Sendai Framework.
- 12 Davis et al. (eds), 2015.
- 13 UNIDR, 2013b.
- 14 ESCAP, ADB & UNDP, 2017.
- 15 De Guzman, 2017.
- 16 Policarpio, 2017.
- 17 Khin Cho Cho, 2017.
- 18 The ESCAP Tsunami and Climate Resilience Trust Fund supported the introduction of long-term climate projections to the Monsoon Forums in Pakistan, Cambodia and Myanmar.
- 19 Srinivasan, et al., 2011.
- 20 ADPC, 2009.
- 21 UNISDR, 2015b.
- 22 ESCAP, 2017b.
- 23 UNISDR, 2011b.
- 24 Note that we are only focusing on mitigating economic damages, not reducing fatalities or numbers of affected persons, though the latter number would presumably be reduced if economic damages are reduced.
- 25 Venton, 2004; ODI et al., 2011; Wilenbockel, 2011 & IFRC, 2012.
- 26 ESCAP, 2017b.
- 27 Williges et al., 2015.
- 28 OECD, 2016.
- 29 Coughlan et al., 2015.
- 30 IFRC, n.d.
- 31 Columbia Water Center, 2017.
- 32 The latter two help to provide much needed relief and immediate liquidity after a disaster in regions where individual countries, because of their size and lack of diversity, cannot have viable risk insurance schemes. See IPCC, 2012.
- 33 Amarnath, 2017a.
- 34 Amarnath, 2017b.
- 35 Afghanistan, Australia, Bangladesh, Bhutan, Cambodia, China, Cook Islands, Democratic People's Republic of Korea, Federated States of Micronesia, Georgia, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nauru, New Zealand, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand, Tonga, Turkey, Tuvalu.
- 36 Georgia Institute of Technology, 2013.
- 37 The Pacific Community, 2016.
- 38 ASEAN, 2017.
- 39 ESCAP/WMO Typhoon Committee et al., 2015.
- 40 CRED & UNISDR, 2016.
- 41 Salceda, 2013.
- 42 IFRC, 2016.; Haque et al., 2012.
- 43 ESCAP, 2015c.
- 44 Lauterjung, et al. (eds.), 2017.
- 45 IPCC, 2012.
- 46 ESCAP, UNDP & RIMES, 2016.
- 47 Goddard, 2015.

- 48 Gadgil, 2015.
- 49 Dilley, 2015.
- 50 WMO, 2015.
- 51 ESCAP, 2016d.
- 52 Danao-Schroeder, et al., 2015.
- 53 Arkin, 2016.
- 54 Namely, from AR5 CMIP 5 genre used in the
IPCC Fifth Assessment Report, 2013.
- 55 CMA et al., 2016.
- 56 ESCAP, UNDP & RIMES 2016.

APPENDIX

Determining the relationship between disaster occurrences and Gini coefficient – results

Table 1 Basic statistics for variables used in the estimation (N=379)

Variable	Mean	Standard Deviation	Source
Imputed Gini	36.94	4.69	World Development Indicators, World Bank (Accessed, August 2017)
Number of disasters	4.28	4.09	EM-DAT: The international Disaster Database (Accessed March 2017)
Agriculture, value added (% of GDP)	17.47	4.00	World Development Indicators, World Bank
GDP per capita growth	10177.77	9727.16	World Development Indicators, World Bank
Unemployment (% of total labour force)	6.88	3.95	World Development Indicators, World Bank

Table 2 Stepwise Estimates (1990-2016): Dependent variable is Imputed Gini

	Standardized Beta	t-statistic	Significance	Model R-square
Final Model				0.230
Constant	35.953	43.070	0.000	
Number of disasters	0.13**	2.597	0.000	
Agriculture, value added (% of GDP)	-0.34**	-4.730	0.000	
GDP per capita growth	-0.25**	-3.580	0.000	

Note: **p<0.01

The autocorrelation test was performed using the Durbin-Watson test for the panel data (DW=1.983). Since no significant autocorrelation was found, the panel data observations were used independently.

The regression estimates were determined from panel data from 1990 to 2016 for 19 countries as follows: Armenia, Australia, Azerbaijan, Bangladesh, Cambodia, Georgia, Iran (Islamic Republic of), Kazakhstan, Kyrgyzstan, Lao People’s Democratic Republic, Malaysia, Mongolia, Pakistan, the Philippines, Russian Federation, Sri Lanka, Tajikistan, Thailand, Turkey, and Viet Nam (Table 1).

Gini coefficients were not available for all time points and were therefore imputed. The imputations were performed on countries with 5 or more data points for the Gini coefficient and were based on 5 simulations using Markov chain and Monte Carlo analysis which were pooled to incorporate the variance of the missing values. Covariates in the model (GDP growth, agriculture value added, and unemployment

rate) were determined from the literature. Stepwise regression was performed with three control variables (GDP per capita growth, agriculture value added, and unemployment). The final model with the best fit is given in Table 2.

An important point to note in the analysis is that, the panel nature of the data as well as the imputation methods can lead to an underestimation of bias. In addition, while disasters have a significant relationship, it should be noted that other macro variables such as agriculture value added and GDP per capita growth are more significantly related to the Gini coefficient. Thus, the results of the analysis related to impacts of disasters on inequality should be interpreted with caution.

REFERENCES

- Advisory Commission on Rakhine State (2017). Towards a peaceful, fair and prosperous future for the people of Rakhine. Available from http://www.rakhinecommission.org/app/uploads/2017/08/FinalReport_Eng.pdf
- Alliance Development Works & United Nations University Institute for Environment and Human Security (UNU-EHS) (2014). *World Risk Report 2014*. Bonn: UNU-EHS.
- Amarnath, Giriraj (2017a). Farmers successfully enrolled in flood insurance program. Consultative Group on International Agricultural Research website. Available from <https://wle.cgiar.org/farmers-successfully-enrolled-flood-insurance-program>. Accessed 23 July 2017.
- _____ (2017b). Satellite-based insurance protects farmers from destructive floods. *Geospatial World*. Available from <https://www.geospatialworld.net/article/satellite-based-insurance-protects-farmers-from-floods>. Accessed 22 June 2017.
- Angel, Shlomo, Alejandro M. Blei, Jason Parent, Patrick Lamson-Hall, & Nicolás Galarza Sánchez, with Daniel L. Civco, Rachel Qian Lei & Kevin Thom (2016). *Atlas of Urban Expansion—2016 Edition, Volume 1: Areas and Densities*. Co-published by the NYU Urban Expansion Program at New York University, UN-Habitat, and the Lincoln Institute of Land Policy.
- Arkin, Fatima (2016). Monitoring hazards from the sky. Available from <http://www.scidev.net/global/disasters/multimedia/monitoring-hazards-from-the-sky-1.html>
- Asian Cities Climate Change Resilience Network (n.d.). Urban, Peri-Urban and Ecosystems Working Group. Available from <https://www.acccrn.net/wg/urban-peri-urban-and-ecosystems-working-group>. Accessed 20 June 2017
- Asian Development Bank (2015). Climate change losses for South East Asia well above previous estimate – ADB, News Release, 7 December 2015. Available from <https://www.adb.org/news/climate-change-losses-southeast-asia-well-above-previous-estimate-adb>. Accessed 21 September 2017.
- Asian Disaster Preparedness Center (2009). Climate Forecast Application for Disaster Mitigation in Southeast Asia Program (2003-2009). Final Program Implementation Report.
- Asian Disaster Reduction Center (2017). Information on disaster risk reduction of the member countries. Available from <http://www.adrc.asia/nationinformation.php?NationCode=608>. Accessed 14 April 2017.
- Association of Southeast Asian Nations (2016). Declaration on Institutionalizing the Resilience to Disasters and Climate Change.
- Barron, Patrick, Erman Rahmant & Kharisma Nugroho (2013). The Contested Corners of Asia – Subnational Conflict and International Development Assistance: The Case of Aceh, Indonesia. The Asia Foundation. Available from <http://asiafoundation.org/resources/pdfs/AcehCaseStudyFullReport.pdf>. Accessed 21 September 2017.
- Bird, Kate (2011). How is poverty transmitted intergenerationally and what might be done to stop it in its tracks? Working paper. Chronic Poverty Research Center.
- Brouwer, R., Akter, S., Brander, L. & Haque, E. (2007). Socioeconomic vulnerability and adaptation to environmental risk: a case study of climate change and flooding in Bangladesh. *Risk Analysis*, 27(2): pp.313-16.
- Cai, Wenju, Simon Borlace, Matthieu Lengaigne, Peter van Rensch, Mat Collins, Gabriel Vecchi, Axel Timmermann, Agus Santoso, Michael J. McPhaden, Lixin Wu, Matthew H. England, Guojian Wang, Eric Guilyardi & Fei-Fei Jin. (2014). Increasing frequency of extreme El Niño events due to greenhouse warming, *Nature Climate Change* Vol. 4, pp.111-116.

- Cambodia Ministry of Agriculture, Forestry and Fisheries (2015). Statistics on Raining Season Rice Plant Affected and Damaged in Year 2015.
- Campbell-Lendrum, D., Holloway, T. & Foley, J. A. (2005). Impact of regional climate change on human health. *Nature* 438, pp.310–317. DOI: 10.1038/nature04188
- Catani, Claudia, Nadja Jacob, Elisabeth Schauer, Mahendran Kohila & Frank Neuner (2008). Family violence, war, and natural disasters: A study of the effect of extreme stress on children's mental health in Sri Lanka. *BMC Psychiatry*. DOI: <https://doi.org/10.1186/1471-244X-8-33>
- Centre for Research on the Epidemiology of Disasters & United Nations Office for Disaster Risk Reduction (2016). *Poverty and Death: Disaster and Mortality: 1996-2015*. Available from http://www.unisdr.org/files/50589_credisastermortalityallfinalpdf.pdf. Accessed 21 September 2017.
- China Meteorological Administration (CMA), Meteo Shanghai, World Meteorological Organization & Global Facility for Disaster Risk Reduction (2016). Implementing Multi-Hazard Impact-based Forecast and Warning Services.
- Cho, Renee (2016). El Niño and Global Warming – What's the connection? State of the Planet, Earth Institute, Colombia University. Available from <http://blogs.ei.columbia.edu/2016/02/02/el-nino-and-global-warming-whats-the-connection/>. Accessed 21 September 2017.
- CITYNET (2017). Disaster Cluster. Available from <http://citynet-ap.org/category/about/clusters/disaster/>. Accessed 20 June 2017.
- Columbia Water Center (2017). Project Uses Satellites for Rapid Assessment of Flood Response Costs. State of the Planet, Earth Institute, Colombia University. Available from <http://blogs.ei.columbia.edu/2017/05/22/project-uses-satellites-for-rapid-assessment-of-flood-response-costs/>
- Coughlan de Perez, E., van den Hurk, B., van Aalst, M. K., Jongman, B., Klose, T. & Suarez, P. (2015). Forecast-based financing: an approach for catalyzing humanitarian action based on extreme weather and climate forecasts, *Natural Hazards and Earth System Sciences, Vol. 15*: pp.895-904. DOI: <https://doi.org/10.5194/nhess-15-895-2015>
- Dai, Aiguo (2011). Drought under global warming: a review. *WIREs Climate Change, Vol. 2, Issue 1*. pp.45-65.
- Danao-Schroeder, Noemi & Coulter, Dauna (2015). Satellite Data Is Saving Lives with Flood Forecasting in Bangladesh. *Frontlines*, September/October 2015. United States Agency for International Development. Available from <https://www.usaid.gov/news-information/frontlines/climate-change-2015/satellite-data-saving-lives-flood-forecasting>. Accessed 22 September 2017.
- Dankelman, Irene (2017). *Action not words: Confronting Words-Confronting Gender Inequality through Climate Change Action and Disaster Risk Reduction in Asia*. UN Women Publication.
- Davis, Ian, Kae Yanagisawa & Kristalina Georgieva (Eds.) (2015). *Disaster risk reduction for economic growth and livelihood - investing in resilience and development*. London and New York: Routledge.
- De Guzman, Rosalina (2017). Philippine Climate Outlook Forum. Presentation at Regional Learning Platform: Mainstreaming Disaster Risk Reduction and Resilience into Sustainable Development with focus on poverty reduction. Bangkok, pp.29-31 March 2017.
- Detges, Adrien (2017). *Climate and Conflict: Reviewing the Statistical Evidence. A summary for policy-makers*. Berlin: adephi.
- Dilley, Maxx (2015). Concluding Remarks at El Niño 2015 Conference, November 2015, New York.
- Dinar, A., Dinar, S., McCaffrey, S., & McKinney, D. (2007). *Bridges over water: understanding transboundary water conflict, negotiation and cooperation, Case Study 2: The Ganges basin (with focus on India and Bangladesh)*. World Scientific. Available from http://www.caee.utexas.edu/prof/mckinney/ce397/Readings/case-study2_Ganges.pdf. Accessed 3 July 2017.

Economic and Social Commission for Asia and the Pacific. (2014). Pro-poor urban climate resilience in Asia and the Pacific.

_____ (2015a). *Asia-Pacific Disaster Report 2015: Disasters without Borders – Regional Resilience for Sustainable Development*. Bangkok: United Nations.

_____ (2015b). *Economic and Social Survey of Asia and the Pacific 2015 – Part I: Making Growth More Inclusive for Sustainable Development*. Bangkok: United Nations.

_____ (2015c). Resolution 71/12 Strengthening regional mechanisms for the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030 in Asia and the Pacific.

_____ (2015d). *Statistical Year Book for Asia and the Pacific 2015: Facts and Trends at the Outset of the 2030 Agenda for Sustainable Development*. Bangkok: United Nations

_____ (2016a). Report of the Capacity Building Workshop: Building Climate Resilient Agriculture in Pacific SIDS. Nadi, Fiji, pp.9-11. Available from <http://www.unescap.org/sites/default/files/Final%20Summary%20Report%20Nadi%20Workshop.pdf>

_____ (2016b). *The Economics of Climate Change in Asia-Pacific region*. Bangkok: United Nations

_____ (2016c). *Statistical Yearbook for Asia and the Pacific: SDG Baseline Report*. Bangkok: United Nations.

_____ (2016d). Towards a new Asia-Pacific strategy for using space applications to support the 2030 Agenda for Sustainable Development: an opportunity for the space community to shape a sustainable future. Working paper prepared for the 20th Session of the Intergovernmental Consultative Committee on the Regional Space Applications Programme for Sustainable Development and the Asia-Pacific Leaders Forum, held from 31 October to 2 November 2016, in New Delhi, India. Available from http://www.unescap.org/sites/default/files/ESAP%20forward%20looking%20paper_0.pdf

_____ (2017a). ESCAP Online Statistical Database. Available from <http://www.unescap.org/stat/data>.

_____ (2017b). Mainstreaming Disaster Risk Reduction for Sustainable Development: a guidebook for Asia-Pacific. Available from http://www.unescap.org/sites/default/files/publication_WEBdrr02_Mainstreaming.pdf

_____ (2017c). Working paper on sand and dust storm, unpublished.

Economic and Social Commission for Asia and the Pacific, Asian Development Bank, & United Nations Development Programme (2017). *Asia-Pacific Sustainable Development Goals Outlook*. Bangkok: United Nations. DOI: <http://dx.doi.org/10.22617/TCS178699-2>

Economic and Social Commission for Asia and the Pacific & Regional Integrated Multi-Hazard Early Warning System (2014). *El Nino 2014/2015 Policy Implications for Asia and Pacific*

_____ (2015b). El-Niño 2015/2016 – Impact Outlook and Policy Implications. Available from <http://www.unescap.org/resources/el-nino-20152016-impact-outlook-and-policy-implications>

_____ (2016). *Flood Forecasting and Early Warning in Transboundary River Basins: A Toolkit*. Available from <http://www.unescap.org/resources/flood-forecasting-and-early-warning-transboundary-river-basins-toolkit>

_____ (2017). Joint Research Study of Climate Risk Assessment for 2030, Unpublished Report.

Economic and Social Commission for Asia and the Pacific, United Nations Development Programme & Regional Integrated Multi-Hazard Early Warning System (2016). *Assessment of El Niño-Associated Risks: The Step-Wise Process*. Available from <http://www.unescap.org/resources/assessment-el-ni%C3%B1o-associated-risks-step-wise-process>

- Economic and Social Commission for Asia and the Pacific & United Nations Office for Disaster Risk Reduction (2012). *Asia-Pacific Disaster Report 2012: Reducing Vulnerability and Exposure to Disasters*. Bangkok: United Nations.
- Economics of Climate Adaptation (2009). *Shaping Climate-Resilient Development: a framework for decision-making*. Climate Works Foundation, Global Environment Facility, European Commission, McKinsey & Company, The Rockefeller Foundation, Standard Chartered Bank & Swiss Re.
- ESCAP/WMO Typhoon Committee, WMO/ESCAP Panel on Tropical Cyclones, Economic and Social Commission for Asia and the Pacific & World Meteorological Organization (2015). *Quick reference guide on synergized standard operating procedures (SSOPs) for coastal multi-hazards early warning system*. Available from http://typhooncommittee.org/SSOP/QUICK_FINAL.pdf.
- Farr, Malcolm & Charis Chang (2015). NASA warns of worst ever forest fires, environmental disaster, as smoke blankets six countries. Available from <http://www.news.com.au/technology/environment/nasa-warns-of-worst-ever-forest-fires-environmental-disaster-as-smoke-blankets-six-countries/news-story/7dda690a4223f194b2bd5c037cc96221>. Accessed 22 September 2017
- Food and Agriculture Organization (2008). *Climate Change and Food Security: A Framework Document*. Available from <http://www.fao.org/forestry/15538-079b31d45081fe9c3dbc6ff34de4807e4.pdf>
- _____ (2015a). 2015-2016 El Niño: Early action and response for agriculture, food security and nutrition.
- _____ (2015b). *The impact of disasters on agriculture and food security*. Available from <http://www.fao.org/resilience/resources/resources-detail/en/c/346258/>
- _____ (2015c). *The Impacts of Natural Hazards and Disasters on Agriculture and Food Security and Nutrition: A call for action to build resilient livelihoods*. Updated May 2015. Rome: FAO.
- _____ (2016a). *Characterization of the agricultural drought prone areas on a global scale*. Available from <http://www.fao.org/3/a-i5764e.pdf>
- _____ (2017). Global Information and Early Warning System Country Briefs – Mongolia. Available from <http://www.fao.org/gIEWS/countrybrief/country.jsp?code=MNG>. Accessed 22 September 2017.
- _____ (n.d.). FAOSTAT. Available from <http://www.fao.org/faostat/en/?#data>. Accessed 27 May 2017.
- Gadgil, Sulochana (2015). Case Study: El Niño of 2015 and the Indian summer monsoon. Presented at the El Niño of 2015 Conference, New York, 17 November 2015. Available from <http://iri.columbia.edu/wp-content/uploads/2015/11/17nov15IRIgadgil.pdf>. Accessed 22 September 2017.
- Gaire, Surya, Tefera, D. D., Srijana, P. & Guha-Sapir, D. (2016). Impact of disasters on child stunting in Nepal. *Risk Management and Healthcare Policy, Vol.2016, Issue 9*, pp. 113-127.
- Gassert, F., Luck, M., Landis, M., Reig, P., & Shiao, T. (2014). Aqueduct global maps 2.1: Constructing decision-relevant global water risk indicators. World Resources Institute. Available from <http://www.wri.org/publication/aqueduct-global-maps-21>
- Georgia Institute of Technology, CERCS (2013). Big Data and Disaster Management: A report from the JST/NSF Joint Workshop. Technical Report No. GIT-CERCS-13-09.
- Global Facility for Disaster Reduction and Recovery & Deutsche Gesellschaft für Internationale Zusammenarbeit (2016). Disasters, Conflict and Fragility: A Joint Agenda. GFDRR Consultative Group Discussion Paper.
- Goddard, Lisa (2015). The Evolution and Outstanding Challenges for El Niño Modeling and Prediction. Presentation at El Niño 2015 Conference, November 2015, New York. Available from http://iri.columbia.edu/wp-content/uploads/2015/11/Goddard_talk.pdf

- Gopal, Brij (2013). Future of wetlands in tropical and subtropical Asia, especially in the face of climate change. *Aquatic Sciences Vol.75. Issue 1*. pp. 39–61. DOI: 10.1007/s00027-011-0247-y
- Government of Fiji (2016). *Fiji Post-Disaster Needs Assessment: Tropical Cyclone Winston, February 20, 2016*.
- Government of Nepal, National Planning Commission (2015a). *Nepal Earthquake 2015: Post-Disaster Needs Assessment, Vol A: Key Findings*.
- _____ (2015b). *Nepal Earthquake 2015: Post-Disaster Needs Assessment, Vol B: Sector Reports*.
- Government of Pakistan, Asian Development Bank & World Bank (2011). *2011 Pakistan Floods: Preliminary Damage and Needs Assessment*.
- Government of Solomon Islands (2014). *Solomon Islands: Rapid Assessment of the Macro and Sectoral Impacts of Flash Floods in the Solomon Islands, April 2014*. Washington DC: World Bank.
- Government of Sri Lanka (2016). *Sri Lanka Post Disaster Needs Assessment: Floods and Landslides – May 2016*.
- Government of Sri Lanka & World Food Programme (2017). *Joint Assessment of Drought Impact on Food Security and Livelihoods March 2017*.
- Government of the Union of Myanmar (2015). *Myanmar Post-Disaster Needs Assessment of Floods and Landslides, July – September 2015*.
- Government of Vanuatu (2015). *Vanuatu Post-Disaster Needs Assessment, Tropical Cyclone Pam, March 2015*.
- Guha-Sapir, D., R. Below, Ph. Hoyois - EM-DAT: The CRED/OFDA International Disaster Database – www.emdat.be – Université Catholique de Louvain – Brussels – Belgium.
- Hallegatte, S., Shah, A., Brown, C., Lempert, R., & Gill, S. (2012). *Investment Decision Making under Deep Uncertainty: application to climate change*. Sustainable Development Network. Washington DC: World Bank.
- Hallegatte, S., Vogt-Schilb, A., Bangalore, M., & Rozenberg, J. (2016). *Unbreakable: building the resilience of the poor in the face of natural disasters*. Washington DC: World Bank.
- Haque, Ubydul, Masahiro Hashizume, Korine N. Kolivras, Hans J. Overgaard, Bivash Das & Taro Yamamoto (2012). Reduced death rates from cyclones in Bangladesh: what more needs to be done? *Bulletin of the World Health Organization*, Vol. 90. pp. 150-156. Available from <http://www.who.int/bulletin/volumes/90/2/11-088302/en/>. Accessed 22 September 2017.
- Immerzeel, W. W., Van Beek, L. P., & Bierkens, M. F. (2010). Climate change will affect the Asian water towers. *Science*, Vol. 328, Issue. 5984. pp. 1382-1385. DOI: 10.1126/science.1183188
- Indoitu, R., Kozhoridze, G., Batyrbaeva, M., Vitkovskaya, I., Orlovskaya, N., Blumberg, D. & Orlovsky, L. (2015). Dust emission and environmental changes in the dried bottom of the Aral Sea. *Aeolian Research*, Vol. 17: pp.101-115
- Intergovernmental Panel on Climate Change (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.
- _____ (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change* [Field, C. B., V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G. K. Plattner, S. K. Allen, M. Tignor, & P. M. Midgley (Eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA. 582pp.

- _____ (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.
- _____ (2014a). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.
- _____ (2014b). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
- International Federation of Red Cross and Red Crescent Societies (2012). *The long road to resilience: Impact and cost-benefit analysis of community-based disaster risk reduction in Bangladesh*. Geneva: IFRC.
- _____ (2015). Emergency Plan of Action (EPoA) Papua New Guinea: Drought. Available from: <http://adore.ifrc.org/Download.aspx?FileId=97904>. Accessed 22 September 2017.
- _____ (2016). *World Disaster Report 2016: Resilience: saving lives today, investing for tomorrow*. Available from http://www.ifrc.org/Global/Documents/Secretariat/201610/WDR%202016-FINAL_web.pdf
- _____ (n.d.). Pilot projects. Available from <http://www.ifrc.org/en/what-we-do/disaster-management/preparing-for-disaster/risk-reduction/forecast-based-financing/pilot-projects/>. Accessed 22 September 2017.
- International Federation of Red Cross and Red Crescent Societies & World Bank (2011). *Natural Hazard, Unnatural Disasters: Economics of Effective Prevention*. Washington DC: World Bank.
- International Tsunami Information Center. (n.d.). Indian Ocean Tsunami 2004. Available from http://itic.ioc-unesco.org/index.php?option=com_content&view=category&id=1136&Itemid=1373. Accessed 28 April 2017.
- Jung, Woosuk. (2016). Environmental Challenges and Cooperation in Northeast Asia. *Focus Asia: Perspective & Analysis*, No. 16 March 2016. Institute for Security & Development Policy.
- Kabeer, N. & Mahmud, S. (2009). Imagining the Future: Children, Education and Intergenerational Transmission of Poverty in Urban Bangladesh. *IDS Bulletin* Vol. 40, Issue 1. pp.10-21. DOI: 10.1111/j.1759-5436.2009.00003.x
- Karna, S. K. (2017). Gorkha Earthquake 2015 and its Impact on Poverty Alleviation in Nepal. Prepared on behalf of ESCAP.
- Koppel, Andrea (1995). Floods force North Korea to ask for international help. 18 December 1995, CNN World News. Available from http://edition.cnn.com/WORLD/9512/north_korea/. Accessed 22 September 2017.
- Lauterjung, J. & Letz, H. (Eds.) (2017). *10 Years Indonesian Tsunami Early Warning System: Experiences, Lessons Learned and Outlook*. Potsdam: GFZ German Research Centre for Geosciences. DOI: <http://doi.org/10.2312/GFZ.7.1.2017.001>
- Loo, Yen Yi, Lawal Billa & Ajit Singh (2015). Effect of climate change on seasonal monsoon in Asia and its impact on the variability of monsoon rainfall in Southeast Asia. *Geoscience Frontiers* Vol. 6, pp.817-823. DOI: <https://doi.org/10.1016/j.gsf.2014.02.009>
- Massachusetts Institute of Technology, Urban Risk Lab (2017). News and events. Available from <http://urbanrisklab.org/News-and-Events>. Accessed 3 July 2017
- May, Quynh (2016). Stemming the rising tide: Flooding and local lives in HCMC. 13 March 2016, Mekong Commons. Available from <http://www.mekongcommons.org/stemming-rising-tide-flooding-local-lives-hcmc/>. Accessed 23 August 2017.

- Mitchell, Tom & Maarten van Aalst (2008). Convergence of Disaster Risk Reduction and Climate Change Adaptation. A review for DFID, 31 October 2008. Available from http://www.pacificdisaster.net/pdnadmin/data/original/ConvergenceofDRRandCCA1_2008.pdf. Accessed 22 September 2017.
- Moore, K. (2004). Chronic, life-course and intergenerational poverty, and South-East Asian youth. In UN Workshop on Youth Poverty in South-East Asia, held from 2-4 August 2004, Yogyakarta, Indonesia.
- Munich Re. (2010). MR Touch Natural hazards – Event report: heat wave, drought, wildfires in Russia (Summer 2010). Available from https://www.munichre.com/site/touch-naturalhazards/get/documents_E-132629599/mr/assetpool.shared/Documents/5_Touch/_NatCatService/Catastrophe_portraits/event-report-hw-dr-wf-russia-touch-en-update.pdf. Accessed 4 August 2017.
- National Academies of Sciences, Engineering, and Medicine (2016). *Attribution of Extreme Weather Events in the Context of Climate Change*. Washington DC: The National Academies Press. <https://doi.org/10.17226/21852>.
- National Disaster Management Authority of Pakistan, Provincial Disaster Management Authority of Sindh, Pakistan & European Union, with Food and Agriculture Organization & World Food Program (2016). *Sindh Drought Needs Assessment: The State of Agriculture, Livelihood, Food Security, Nutrition, Water and Sanitation in Drought Affected Communities in Sindh*.
- National Oceanic and Atmospheric Administration (2015). India heat wave kills thousands. Available from <https://www.climate.gov/news-features/event-tracker/india-heat-wave-kills-thousands>
- Nicholls, R. J. (2011). Planning for the impacts of sea level rise. *Oceanography*, Vol. 24, Issue: 2: pp.144–157. DOI: 10.5670/oceanog.2011.34
- Organization for Economic Co-operation and Development (2016). *States of Fragility 2016: Understanding Violence*, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264267213-en>
- _____ (2017). Creditor Reporting System. Available from <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>. Accessed 22 March 2017.
- Pacific Community. (2016). *Framework for Resilient Development in the Pacific: An Integrated Approach to Address Climate Change and Disaster Risk Management (FRDP) 2017-2030*. Available from <http://www.forumsec.org/resources/uploads/embeds/file/Annex%201%20-%20Framework%20for%20Resilient%20Development%20in%20the%20Pacific.pdf>
- Parpart, Erich (2015). Government seeks solutions to torrid drought. 25 June 2015, The Nation. Available from <http://www.nationmultimedia.com/national/Govt-seeks-solutions-to-torrid-drought-30263053.html>. Accessed 10 January 2017.
- Patankar, A. & Patwardhan, A. (2016). Estimating the uninsured losses due to extreme weather events and implications for informal sector vulnerability: a case study of Mumbai, India. *Natural Hazards*, Vol. 80, Issue 1. pp.285-310. DOI: <https://doi.org/10.1007/s11069-015-1968-3>
- Paul, S. K. (2010). Flood proneness and coping strategies: the experiences of two villages in Bangladesh. *Disasters*, Vol. 34, Issue 2, pp.480-508. DOI: 10.1111/j.1467-7717.2009.01139.x
- Phuong, D. Dao & Yuei-An, Liou (2015). Object-Based Flood Mapping and Affected Rice Field Estimation with Landsat 8 OLI and MODIS Data. *Remote Sensing*, Vol.7, Issue 5, pp. 5077-5097. DOI: 10.3390/rs70505077
- Policarpio, Ruby Rose (2017). Seasonal Climate Forums in Asia and the Pacific: Impacts, Innovations and Emerging Trends. Presentation at Regional Learning Platform: Mainstreaming Disaster Risk Reduction and Resilience into Sustainable Development with focus on poverty reduction. Bangkok, 29-31 March 2017.
- Qureshi, Asad Sarwar (2002). *Water Resources Management in Afghanistan: the Issues and Options*. Working Paper 49, Pakistan Country Series No. 14. International Water Management Institute and FutureHarvest. Available from <https://cropwatch.unl.edu/documents/Water%20Resource%20Issues%20In%20Afghanistan.pdf>

- Raha, A., Das, S., Banerjee, K. & Mitra, A. (2012). Climate change impacts on Indian Sundarbans: a time series analysis (1924–2008). *Biodiversity and Conservation* Vol. 21, Issue 5, pp.1289–1307. DOI: 10.1007/s10531-012-0260-z
- Relief Web (2015). Pakistan heatwave death toll reaches 800. Available from <http://reliefweb.int/report/pakistan/pakistan-heatwave-death-toll-reaches-800>
- _____ (2016a). Pacific El Niño Overview (as on 18 April 2016). Available from <http://reliefweb.int/report/marshall-islands/pacific-el-ni-o-overview-18-april-2016>. Accessed 17 April 2017.
- _____ (2016b). South-East Asia: Drought – 2015-2017. Available from <http://reliefweb.int/disaster/dr-2015-000180-vnm>. Accessed 12 April 2017.
- _____ (2016c). Sri Lanka: Drought – Sep 2016. Available from <http://reliefweb.int/disaster/dr-2016-000139-lka>. Accessed 13 July 2017.
- _____ (2016d). Viet Nam: Drought and Saltwater Intrusion Situation Update No. 6 (as of 16 September 2016). Available from <http://reliefweb.int/report/viet-nam/viet-nam-drought-and-saltwater-intrusion-situation-update-no-6-16-september-2016>. Accessed 17 April 2017.
- _____ (2017a). Afghanistan: Avalanches and Floods – Jan 2017. Available from <http://reliefweb.int/disaster/av-2017-000013-afg>. Accessed 28 April 2017.
- _____ (2017b). Mongolia Severe Winter: Humanitarian Report (as of 15 Feb 2017). Available from <http://reliefweb.int/report/mongolia/mongolia-severe-winter-humanitarian-report-15-feb-2017>. Accessed 2 May 2017.
- _____ (2017c). Mongolia: Dzud – Dec 2016. Available from <http://reliefweb.int/disaster/cw-2017-000001-mng>. Accessed 13 July 2017.
- _____ (2017d). Philippines: Earthquakes – Feb 2017. Available from <http://reliefweb.int/disaster/eq-2017-000016-phl>. Accessed 28 April 2017.
- _____ (2017e). South Asia: Flooding – Humanitarian Snapshot (as of 24 August 2017). Available from <http://reliefweb.int/report/india/south-asia-flooding-humanitarian-snapshot-24-august-2017>. Accessed 30 August 2017.
- _____ (2017f). South-East Asia: Drought – 2015-2017. Available from <http://reliefweb.int/disaster/dr-2015-000180-vnm>. Accessed 28 April 2017.
- Rodriguez-Llanes, J. M. (2016). Flood exposure is associated with higher prevalence of child undernutrition in rural eastern India. *International Journal of Environmental Research and Public Health*, Vol. 13, pp.210-220.
- Sabeerali, C.T. & Ajayamohan, R.S. (2017). On the shortening of Indian summer monsoon season in a warming scenario. *Climate Dynamics* pp.1-16. DOI: <https://doi.org/10.1007/s00382-017-3709-7>
- Salceda, Joey Sarte (2013). Zero Casualty: DRRM in Albay. Presentation at the Global Innovations Conference, held on 3 October 2013, in Albay, Philippines. Available from [http://www.galingpook.org/Websites/GalingPook/images/GPIC/Day1_PM_Panel2_1Philippines_\(Albay\)_Salceda.pdf](http://www.galingpook.org/Websites/GalingPook/images/GPIC/Day1_PM_Panel2_1Philippines_(Albay)_Salceda.pdf)
- Sastry, D. V. S., Singh, B., Bhattacharya, K., & Unnikrishnan, N. K. (2003). Sectoral linkages and growth prospects: reflections on the Indian economy. *Economic and Political Weekly*, Vol. 38, No. 24, pp.2390-2397.
- Schleussner, C. F., Donges, J. F., Donner, R. V., & Schellnhuber, H. J. (2016). Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries. *Proceedings of the National Academy of Sciences*, Vol. 113, Issue 33, pp.9216-9221.
- Shein, Khin Cho Cho (2017). Myanmar Monsoon Forum. Presentation at Regional Learning Platform: Mainstreaming Disaster Risk Reduction and Resilience into Sustainable Development with focus on poverty reduction. Bangkok, 29-31 March 2017.

- Shepherd, Andrew, Mitchell, T., Lewis, K., Lenhardt, A., Jones, L., Scott, L. & Muir-Wood, R. (2013). *The geography of poverty, disasters and climate extremes in 2030*. Available from <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8633.pdf>
- Sirimanne, Shamika, Sanjay Srivastava, Sung Eun Kim, Ho Miu David Li, Axel Firer & Shweta Sinha. (2015). United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Building Resilience to Water-Related Disasters in the Asia-Pacific Region 7th World Water Forum 12–17 April 2015, Daegu and Gyeongbuk, Republic of Korea. Available from http://lib.icimod.org/record/30291/files/CaseStudy_4WWF.pdf
- Souza, Ken De, Evans Kituyi, Blane Harvey, Michele Leone, Kallur Subramanyam Murali & James D. Ford (2015). Vulnerability to climate change in three hot spots in Africa and Asia: key issues for policy-relevant adaptation and resilience-building research. *Regional Environment Change* Vol. 15, pp. 747–753. DOI: 10.1007/s10113-015-0755-8
- Srinivasan, G., Rafisura, K. & Subbiah, A. R. (2011). Climate information requirements for community-level risk management and adaptation. *Climate Research*, Vol. 47, pp. 5–12.
- Szabo, S., Nicholls, R. J., Neumann, B., Renaud, F. G., Matthews, Z., Sebesvari, Z., AghaKouchak, A., Bales, R., Ruktanonchai, C.W., Kloos, J., Fofoula-Georgiou, E., Wester, P., New, M., Rhyner, J., & Hutton, C. (2016). Making SDGs work for climate change hotspots. *Environment: Science and Policy for Sustainable Development*, Vol. 58, Issues 6, pp. 24-33.
- Thaiwater (n.d.). Thaiwater website: <http://www.thaiwater.net/web/>. Accessed July 2017.
- United Nations (1987). Report of the World Commission on Environment and Development: Our Common Future. Available from <http://www.un-documents.net/our-common-future.pdf>. Accessed 22 September 2017.
- _____ (1994). Yokohama Strategy and Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation. In World Conference on Natural Disaster Reduction, Yokohama, 23-24 May, Yokohama, Japan.
- _____ (2016). One Humanity: Shared Responsibility. Report of the UN Secretary General for the World Humanitarian Summit 2016.
- United Nations (2017). *New Urban Agenda*. Available from <http://habitat3.org/the-new-urban-agenda>. Accessed 22 September 2017.
- United Nations Assistance Mission in Afghanistan (2016). *Water Rights: An Assessment of Afghanistan's Legal Framework Governing Water for Agriculture*. Available from https://unama.unmissions.org/sites/default/files/2016_19_10_water_rights_final_v2.pdf
- United Nations Country Team in Papua New Guinea (2016). Papua New Guinea: El-Niño Response Plan, 18 April. Available from <https://reliefweb.int/report/papua-new-guinea/papua-new-guinea-el-ni-o-response-plan>. Accessed 22 September 2017.
- United Nations Development Programme (2011). *Disaster-Conflict Interface Comparative experiences*. New York: United Nations Development Programme.
- United Nations Environment Programme (2010). *Green economy: Developing Countries Success Stories*. Geneva: United Nations Environmental Programme.
- United Nations Environment Programme, World Meteorological Organization & United Nations Convention to Combat Desertification (2016). *Global Assessment Report of Sand and Dust Storms*. Nairobi: United Nations Environmental Programme.
- United Nations General Assembly (1989). *International decade for natural disaster reduction. United Nations General Assembly Resolution 236 session 44 of 22 December 1989. A-RES-44-236*.

- _____ (2011). *High-level meeting on addressing desertification, land degradation and drought in the context of sustainable development and poverty eradication, Note by the Secretary-General, 11 June 2011*. A-65-861.
- United Nations International Children's Emergency Fund (2014). Real time evaluation of UNICEF's humanitarian response to Typhoon Haiyan in the Philippines. UNICEF Evaluation Brief, No. 2014/4, September 2014.
- _____ (2015). *Myanmar Child-Centered Risk Assessment*. First Edition - 2015. Available from [https://www.unicef.org/myanmar/Myanmar_Child-Centered_Risk_Assessment_\(ENG\).pdf](https://www.unicef.org/myanmar/Myanmar_Child-Centered_Risk_Assessment_(ENG).pdf)
- United Nations International Strategy for Disaster Reduction. (2005). *Hyogo Framework for Action 2005-2015: Building Resilience of Nations and Communities to Disasters*.
- _____ (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva: United Nations.
- United Nations Office for Disaster Risk Reduction (2011a). *Global Assessment Report on Disaster Risk Reduction 2011*. Geneva: UNISDR.
- _____ (2011b). Probabilistic modelling of disaster risk at global level: Development of a methodology and implementation of case studies, Phase 1A: Colombia, Mexico, Nepal. Background Paper for the 2011 Global Assessment Report on Disaster Risk Reduction.
- _____ (2013a). *Global Assessment Report on Disaster Risk Reduction 2013*. Geneva: UNISDR.
- _____ (2013b). Using science for disaster risk management. UNISDR Scientific and Technical Advisory Group Report 2013. Available from http://www.unisdr.org/files/32609_stagreport2013assembled.pdf
- _____ (2014). Reducing Underlying Risk Factors in the Asia-Pacific.
- _____ (2015a). Disaster Risk Reduction and Resilience in 2030 Agenda for Sustainable Development – A reflection paper prepared by the UN Office for Disaster Risk Reduction, October 2015.
- _____ (2015b). *Global Assessment Report on Disaster Risk Reduction 2015: Making Development Sustainable*. Geneva: UNISDR.
- _____ (2015c). Poorly planned and managed urban development. Available from <http://www.preventionweb.net/risk/poorly-planned-managed-urban-development>
- _____ (2017). Disaster Resilience Scorecard for Cities: Preliminary level assessment. Available from http://www.unisdr.org/campaign/resilientcities/assets/documents/guidelines/03%20Preliminary%20Assessment_Disaster%20resilience%20scorecard%20for%20cities_UNISDR.pdf. Accessed 20 June 2017.
- United Nations Office for Disaster Risk Reduction, Alliance for Disaster Resilient Societies (2017). Introducing ARISE Network Japan: How we work towards resilience. Available from http://www.preventionweb.net/files/53166_53166introducingarisenetworkjapanho.pdf. Accessed 20 June 2017.
- United Nations Office for the Coordination of Humanitarian Affairs (2016). HCT Myanmar – Inter-Agency Emergency Response Preparedness (ERP) Plan (June 2016). Available from http://reliefweb.int/sites/reliefweb.int/files/resources/hct_myanmar_emergency_response_preparedness_plan_june_2016.pdf. Accessed 22 September 2017.
- United Nations World Conference on Disaster Reduction (2004). Review of the Yokohama Strategy and Plan of Action for a Safer World. 20 December. A/CONF.206/L.1.
- United States Department of Agriculture, Foreign Agricultural Service (2008). Commodity Intelligence Report – Central Asia. Available from https://www.pecad.fas.usda.gov/cropexplorer/pecad_stories.aspx?regionid=stans&ftype=topstories. Accessed 22 September 2017.

- Vanuatu Daily Post (2015). Vt 7 billion income lost due to Cyclone Pam: Labour. 22 April. Available from http://dailypost.vu/news/vt-billion-income-lost-due-to-cyclone-pam-labour/article_f06d1b11-2eac-5f82-a474-b78705a2773f.html. Accessed 22 September 2017.
- Venton, C. & Venton, P. (2004). *Disaster preparedness programmes in India: A cost benefit analysis*. Network Paper No. 49, November 2004, Humanitarian Practice Network, London: Overseas Development Institute.
- von Uexkull, N., Croicu, M., Fjelde, H., & Buhaug, H. (2016). Civil conflict sensitivity to growing-season drought. *Proceedings of the National Academy of Sciences*, Vol. 113, Issue 44, pp. 12391-12396. DOI: 10.1073/pnas.1607542113
- Wiltenbockel, Dirk (2011). *A Cost-Benefit Analysis of Practical Action's Livelihood Based Disaster Risk Reduction Project in Nepal*. Brighton: IDS.
- Williges, K., Hochrainer-Stigler, S., Mochizuki, J. & Mechler, R. (2015). Modeling the indirect and fiscal risks from natural disasters: emphasizing resilience and "building back better". Background paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction.
- Win, Lei (2017). Mongolian herders need aid to weather second big freeze: Red Cross. 16 February 2017, Thomson Reuters Foundation News. Available from <http://news.trust.org/item/20170216053542-ma3r3/>. Accessed 22 September 2017.
- World Bank (2009). *Economics of adaptation to climate change— synthesis report*. Washington DC: World Bank.
- _____ (2015). *South Asia Water Initiative: Annual Report from the World Bank to Trust Fund Donors*. Available from <http://documents.worldbank.org/curated/en/442761468197632182/pdf/103878-AR-SAWI-Progress-Report-2015-PUBLIC.pdf>. Accessed 8 August 2017.
- _____ (2016a). *Bangladesh: Building Resilience to Climate Change*, 9 October 2016. Available from <http://www.worldbank.org/en/results/2016/10/07/bangladesh-building-resilience-to-climate-change>. Accessed 22 September 2017.
- _____ (2016b). *Disaster Risk Profile - Afghanistan*. Available from <http://documents.worldbank.org/curated/en/284301491559464423/pdf/114097-WP-P155025-PUBLIC-afghanistan-low.pdf>. Accessed 22 September 2017.
- _____ (2017). *Land area data from online database*. Available from <http://data.worldbank.org/indicator/AG.LND.TOTL.K2>. Accessed 2 August 2017.
- World Food Programme (2016). *How Disasters Affect Hunger*. Available from <https://www.wfp.org/disaster-risk-reduction/how-disasters-affect-hunger>. Accessed 22 September 2017.
- World Meteorological Organization (2011). *WMO Strategic Plan 2012-2015*. Available from https://library.wmo.int/pmb_ged/wmo_1069_en.pdf
- _____ (2015). *Synthesis of the status and trends with the development of early warning systems*. Background paper prepared for the Global Assessment Report 2015.
- _____ (2016). *Climate Services on for Disaster Risk Reduction - Experiences from the GFCS Adaptation Program in Africa*. Global Framework for Climate Services. Available from <http://www.wmo.int/gfcs/2017-ic-mhews-climate-services-for-DRR>. Accessed 22 September 2017.
- _____ (n.d.). *What are Weather/Climate Services?* Global Framework for Climate Services. Available from https://www.wmo.int/gfcs/what_are_climate_weather_services. Accessed 22 September 2017.

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Asia and the Pacific is the region most affected by natural disasters which hit hardest at the poorest countries and communities. And on present trends, as more migrants crowd into slums and shanty towns in Asia-Pacific cities, whole communities are likely to see their homes and livelihoods shattered or washed away by the wilder forces of nature.

This edition of the **Asia-Pacific Disaster Report**, looks at the extent and impact of natural disasters across the region and how these intersect with poverty, inequality and the effects of violent conflict. But it also shows how scientific and other advances have increased the potential for building disaster resilience and ensuring that even in the most extreme circumstances people can survive disaster impacts and rebuild their communities and livelihoods.

Disaster resilience is a key element of the 2030 Agenda for Sustainable Development. The Sustainable Development Goals are based on the premise of reaching absolutely everyone. When the drought is assessed, when the flood warnings are broadcast, when the tsunami siren sounds, the aim is to 'leave no one behind'. If governments are to fulfil this ambition, and protect their most vulnerable people, they will need to ground national development strategies firmly in disaster resilience.

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