DISASTERS WITHOUT BORDERS

Regional Resilience for Sustainable Development

Asia-Pacific Disaster Report 2015

UNITED NATIONS
ESCAP
Economic and Social Commission for Asia and the Pacific

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FOREWORD

As we approach the end of 2015, the member States of the United Nations have taken stock of the 15-year anti-poverty effort embodied in the Millennium Development Goals and endorsed the new 2030 Agenda for Sustainable Development, framed by the Sustainable Development Goals (SDGs). This new holistic and transformative agenda sets the strategic direction for building global resilience, among others by responding to concerns about the impacts of climate change, such as rising sea levels and increasing damage to ecosystems and biodiversity.

Prior to the adoption of the SDGs in September 2015, the global community agreed to reinforce the Goals with a new international framework to address the inextricable link between disaster risk reduction and sustainable development. In March, the Sendai Framework for Disaster Risk Reduction 2015-2030 replaced the Hyogo Framework for Action 2005-2015. The Sendai outcome will guide the international community in its collective support to regions and countries in strengthening their resilience to disasters. In addition, member States will gather for the United Nations Climate Change Conference in Paris, in December, to forge a new international agreement on climate action, ideally backed by the necessary resources for climate mitigation and adaptation. These new frameworks will have a profound impact on the lives of people all over the world for years to come.

The countries of Asia and the Pacific have borne the lion's share of natural disasters. Over 40 per cent of the 3,979 disasters that occurred globally between 2005 and 2014 occurred in our region, resulting in the loss of half a million people, representing almost 60 per cent of the total global deaths related to disasters. More than 1.4 billion people were affected by these disasters, constituting 80 per cent of those affected globally. Our region has also faced severe economic damage of more than half a trillion dollars over the same time period, accounting for 45 per cent of global total.

This year was no exception to these trends. Across Asia and the Pacific disasters have continued to undermine hard-won development gains. In March 2015, cyclone Pam caused widespread damage in Vanuatu, and also impacted neighboring countries: almost 166,000 people - more than half of Vanuatu's population - were affected. In April, an earthquake of 7.6 magnitude struck Nepal, leaving nearly 9,000 people dead and destroying more than half a million houses. This massive destruction has impeded Nepal's bid to graduate from the status of a least developed country to a developing country by 2022. In May and June, India and Pakistan reported more than 1,000 deaths from a heat wave. In July and August, heavy monsoon rains claimed hundreds of lives and affected more than a million people in South and South-East Asia.

For a region at such high risk of disasters, building resilience is not a question of choice, but rather a collective imperative. Therefore, countries in Asia and the Pacific have identified disaster risk reduction as one of their core priorities, and requested that ESCAP intensify its regional partnership and support for disaster risk reduction and resilience as an integral part of achieving sustainable development in the region.

ESCAP's work stands out for the assessment, identification and monitoring of a range of hazards, be they droughts, tropical cyclones, earthquakes or floods, including their impacts on people, economies, cities and the environment. This is why we have promoted the benefits of early warning and information management, some of which are often neglected, and advanced South-South cooperation to tap into the knowledge of more experienced partners. Building resilience of communities calls for long-term risk management, through strengthening of catastrophic insurance systems, social safety nets and relief delivery mechanisms, which become critical in times of disaster. Effectively managing the ecosystem, and deploying solutions based on emerging science and technology, are some of the best disaster risk mitigation approaches. ESCAP continues to offer a platform for exchanges on transboundary disaster risk in Asia and the Pacific. Integration of disaster risk reduction is at the heart of sustainable development, and this Report offers insights on how to operationalize the process in a way that fosters risk-sensitive development.

Regional cooperation is effective in addressing disasters, constituting a fundamental point underpinning all of ESCAP's work. Only by coming together in the spirit of cooperation can the Asia-Pacific region hope to become truly disaster resilient and achieve sustainable development in the future.

In this context, the 2015 *Asia-Pacific Disaster Report* is a useful guide in the pursuit of greater disaster resilience and sustainable development for all.

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

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ABBREVIATIONS

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
AAL	annual average loss
ABU	Asia-Pacific Broadcasting Union
ADB	Asian Development Bank
ADBI	Asian Development Bank Institute
ADPC	Asian Disaster Preparedness Center
APDR	Asia-Pacific Disaster Report
APIS	Asia-Pacific Information Superhighway
ASEAN	Association of Southeast Asian Nations
BNPB	Badan Nasional Penanggulangan Bencana (National Agency for Disaster Management)
CAP	Common Alerting Protocol
CAPRA	Central American Probabilistic Risk Assessment
CBDRM	community-based disaster risk management
CBR	cost-benefit ratio
CCA	climate change adaptation
CERN	European Organization for Nuclear Research
CNES	Centre national d'études spatiales
COP	Conference of the Parties
CPP	Cyclone Preparedness Programme
CRED	Centre for Research on the Epidemiology of Disasters
DRG	disaster risk governance
DRM	disaster risk management
DRR	disaster risk reduction
DPNet	Disaster Preparedness Network
EM-DAT	Emergency Events Database
ENISA	European Network and Information Security Agency
ESA	European Space Agency
ESCAP	Economic and Social Commission for Asia and the Pacific
EWS	early warning systems

FAO	Food and Agriculture Organization of the United Nations
FEMA	Federal Emergency Management Agency
G20	Group of Twenty
GAATES	Global Alliance on Accessible Technologies and Environments
GDACS	Global Disaster Alert and Coordination System
GDP	gross domestic product
GDT	Global Dairy Trade
GEOGLAM	Group on Earth Observations for Global Agricultural Monitoring
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	geographic information systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GLC	Global Land Cover
GLOF	glacial lake outburst floods
GPS	Global Positioning System
UNEP/GRID	United Nations Environment Programme Global Resource Information Database
GSDP	gross state domestic product
GSDMA	Gujarat State Disaster Management Authority
GSMA	Groupe Speciale Mobile Association
HAZUS	Hazards US risk assessment tool
HFA	Hyogo Framework of Action
HKH	Hindu Kush-Himalayan region
ICIMOD	International Centre for Integrated Mountain Development
ICT	information and communications technology
IDMC	Internal Displacement Monitoring Centre
IFAD	International Fund for Agricultural Development
IFRC	International Federation of Red Cross
IGBP-DIS	International Geosphere-Biosphere Programme Data and Information Systems
IOC	Intergovernmental Oceanographic Commission
IOTWS	Indian Ocean Tsunami Warning System
IPCC	Intergovernmental Panel on Climate Change
IRBI	Indonesia disaster risk index
ISO	International Organization for Standardization
ITU	International Telecommunication Union
IUCN	International Union for Conservation of Nature

KNMI	Royal Netherlands Meteorological Institute
LDCs	least developed countries
LLDCs	landlocked developing countries
MDGs	Millennium Development Goals
MODIS	Moderate Resolution Imaging Spectroradiometer
MIRA	multi-cluster initial rapid assessment
MRB	Mekong river basin
NDDI	Normalized difference drought index
NDMI	National Disaster Management Institute
NDVI	Normalized difference vegetation index
NDRRMC	National Disaster Risk Reduction and Management Council
NGO	non-governmental organization
NMHS	national meteorological and hydrological service
NRWP	Natural Water Resources Policy
NTT DoCoMo	Nippon Telegraph and Telephone DoCoMo Mobile Phone Operator
OECD	Organization for Economic Co-operation and Development
ODA	Official Development Assistance
ODI	Overseas Development Institute
OFDA	Office of United States Foreign Disaster Assistance
PAP	programmes, activities and projects
PEDRR	Partnership for Environment and Disaster Risk Reduction
PDNA	post-disaster needs assessment
PPP	public-private partnership
PTC	WMO/ESCAP Panel on Tropical Cyclones
RADIUS	Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters
RESAP	Regional Space Applications Programme for Sustainable Development
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
RSMC	Regional Specialized Metrological Centre
SAARC	South Asian Association for Regional Cooperation
SASCOF	South Asian Climate Outlook Forum
SCADA	supervisory control and data acquisition
SDGs	Sustainable Development Goals
SELENA	Seismic Loss Estimation model
SDI	spatial data infrastructure

SFDRR	Sendai Framework for Disaster Risk Reduction 2015-2030
SIDS	small island developing States
SMEs	small and medium-sized enterprises
SMS	short message service
SOPAC	Secretariat of the Pacific Community Applied Geoscience and Technology Division
SOPs	standard operating procedures
TC	ESCAP/WMO Typhoon Committee
TCI	thermal condition index
TCP/IP	Transmission Control Protocol / Internet Protocol)
UAV	unmanned aerial vehicles
UN	United Nations
UN ASIGN	United Nations Adaptive System for Image Communication over Global Networks
UN HABITAT	United Nations Human Settlements Programme
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNCCD	United Nations Convention to Combat Desertification
UN-DESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
UNITAR	United Nations Institute for Training and Research
UNOOSA	United Nations Office for Outer Space Affairs
UNOSAT	United Nations Operational Satellite Applications Programme
UNSDI	United Nations Spatial Data Infrastructure
UNU	United Nations University
UNU-EHS	United Nations University Institute for Environment and Human Security
USGS	United States Geological Survey
USAID	United States Agency for International Development
VSWI	vegetation supply water index
WFP	World Food Programme
WMO	World Meteorological Organization
WRI	World Resources Institute

EXPLANATORY NOTES

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The term "ESCAP region" in this publication refers to the group of countries and territories/areas comprising: 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.

The term "developing ESCAP region" in this publication excludes Australia, Japan, New Zealand and North and Central Asian economies from the above-mentioned grouping. Non-regional members of ESCAP are France, the Netherlands, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

The term "East and North-East Asia" in this publication refers collectively to: China; Hong Kong, China; Democratic People's Republic of Korea; Japan; Macao, China; Mongolia; and Republic of Korea.

The term "North and Central Asia" in this publication refers collectively to Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan and Uzbekistan.

The term "Central Asian countries" in this publication refers collectively to Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

The term "Pacific" in this publication refers collectively to American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

The term "South and South-West Asia" in this publication refers collectively to Afghanistan, Bangladesh, Bhutan, India, the Islamic Republic of Iran, Maldives, Nepal, Pakistan, Sri Lanka and Turkey.

The term "South-East Asia" in this publication refers collectively to Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste and Viet Nam.

The term "countries with special needs" in this publication refers collectively to least developed countries, landlocked developing countries and small island developing States in the Asia-Pacific region as indicated below.

13 least developed countries

Afghanistan,* Bangladesh, Bhutan,* Cambodia, Kiribati,** Lao People's Democratic Republic,* Myanmar, Nepal,* Samoa,** Solomon Islands,** Timor-Leste,** Tuvalu** and Vanuatu**
(*also a landlocked developing country, **also a small island developing State);

12 landlocked developing countries

Afghanistan,* Armenia, Azerbaijan, Bhutan,* Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic,* Mongolia, Nepal,* Tajikistan, Turkmenistan and Uzbekistan.
(*also a least developed country)

16 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.*
(*also a least developed country)

Values are in United States dollars unless specified otherwise.

The term "billion" signifies a thousand million. The term "trillion" signifies a million million.
Reference to "tons" indicates metric tons.

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.

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EXECUTIVE SUMMARY

DISASTERS WITHOUT BORDERS

REGIONAL RESILIENCE FOR SUSTAINABLE DEVELOPMENT

The Asia-Pacific region is exposed to natural disasters of many types which each year kill thousands of people and wreak vast economic destruction – often striking a number of countries simultaneously. Reducing disaster risk therefore means combining concerted local and national action with effective regional cooperation. Countries across Asia and the Pacific have made some progress, but still have much to do – and must remain vigilant since rapid economic growth, rising populations, and burgeoning cities are exacerbating existing risks and creating new ones.

This is a pivotal year for disaster risk reduction in Asia and the Pacific: 2015 marks the end of the 'Hyogo Framework for Action'. It also marks the beginning of a new 15-year plan – the 'Sendai Framework for Disaster Risk Reduction 2015-2030'. In addition, in 2015 the world is transitioning from the Millennium Development Goals to the Sustainable Development Goals – whose achievement will depend critically on building much greater resilience to disasters.

Over the period 2005-2014 the Asia-Pacific region had 1,625 reported disaster events. Approximately 500,000 people lost their lives, around 1.4 billion people were affected, and there was $523 billion worth of economic damage. Many of these disasters were on a vast scale, but there were also multiple smaller events that never hit the global headlines. Indeed since the 1970s, most disasters in Asia and the Pacific have had fewer than 100 fatalities but cumulatively have affected 2.2 billion people and caused over $400 billion worth of damage. Even these figures are probably underestimates, since there is no standardized methodology for gathering disaster statistics, and many disasters go unreported.

The most disaster-prone subregion has been South-East Asia – many of whose countries lie along the earthquake-prone Pacific 'Ring of Fire', or along major typhoon tracks. There are also high seismic and flood risks in South and South-West Asia. The subregion with the greatest economic damage, however, has been East and North-East Asia which has the greatest concentration of exposed economic assets. In the Pacific island States the absolute number of people affected may be smaller, but this still represents a substantial proportion of their populations. In general, the most vulnerable countries are those with special needs – including small island developing States, least developed countries and landlocked developing countries.

Cross-border threats

Many of the disasters in Asia and the Pacific are transboundary. The region has the world's two most seismically active fault lines which cross many national frontiers. It also has three major ocean basins, so that a cyclone that develops in one of these basins can travel across many countries, causing heavy rainfall and flooding. Countries also share rivers and river basins, so floods too regularly spread across national boundaries. In addition, excessive snowmelt in high mountains, and glacial lake outbursts, can flood a number of countries downstream. And countries affected by the same climatic events can simultaneously be hit by drought.

People at risk – Across Asia and the Pacific 772 million people live on less than $1.25 a day and are particularly vulnerable to disasters. They tend to live in low-value, hazard-prone areas – not just city slums, but also steep slopes, seismic zones, floodplains and river banks or remote areas. The poorest lack the resources to take preventive measures, or buy insurance, and do not have savings to draw upon should disaster strike. Nor can they be sure of adequate government support through social protection. Disasters are likely to further impoverish many people – or push the 'near-poor' into poverty.

Economies at risk – Though the immediate concern is for human life and health, countries across Asia and the Pacific are also concerned about the economic cost – which appears to be increasing. And given the importance of Asia and the Pacific in the global economy, disaster impacts can soon reverberate around the world. Between the 1970s and the decade 2005-2014 damage to property, crops and livestock in Asia and the Pacific increased from $52 billion to over $523 billion – mostly in housing, transport and agriculture, with long-term costs persisting even decades later in some cases. On present trends, by the year 2030, annual losses in the region could average $160 billion per year.

Cities at risk – Half the region's people live in urban areas, and by 2050 that proportion could rise above two-thirds. Many cities already struggle to provide basic services such as roads, water supplies, and sewage disposal, leaving the poorest people, especially those in slum areas, highly exposed to sudden shocks. Around 740 million city dwellers in Asia and the Pacific are now at 'extreme' to 'high' disaster risk – often living in multi-hazard hotspots that are vulnerable to cyclones, earthquakes, floods and landslides.

Environment at risk – One of the best defences against many natural disasters is a healthy natural environment with robust ecosystems. Unfortunately, much of this protection has been weakened. Over the past 50 years, humans have degraded the region's forests, grasslands, deserts, tundra, mountains, and agricultural areas, as well as freshwater and coastal and ocean ecosystems – steadily reducing their capacity to protect against hazards.

An additional factor is climate change. The most significant impacts on ecosystems are likely to be in coastal areas, with risks of sea level rise, greater storm intensity, higher wind speeds, greater wave action and higher sea surface temperatures. A complex sequence of events involving human activity, climate change and natural disasters then creates a vicious feedback loop. Breaking this cycle will require more effective management of ecosystems – along with measures for social protection, disaster risk reduction and climate change adaptation.

Investing in resilience

Most international assistance for disasters is for emergency response and rehabilitation rather than prevention. Over the period 2004-2013, aid for disasters was $28 billion, of which most was for emergency response. However, the share of international aid going for prevention and preparedness has been rising in recent years.

Investing in disaster risk reduction is cost effective because it averts or minimizes costly damage. Investments in hydrometeorological early warning systems in Asia and the Pacific for example, can have returns between 4 and 36 times the initial investment. Nevertheless, over the last 10 years, countries in Asia and the Pacific have not made sufficient progress. Based on self-assessments for the Hyogo Framework of Action, for around half the countries progress was 'not substantial' or 'relatively small'.

DROUGHT – THE FORGOTTEN DISASTER

One of the region's most devastating natural disasters is drought. But this is a slow and silent killer, and therefore often forgotten, generally receiving less attention from the media, policymakers and politicians. Since 1970, across Asia and the Pacific drought has affected more than 1.6 billion people and cost an estimated $53 billion in damage. These figures are likely to be underestimates because droughts are hard to delineate: there are uncertainties about when they start or finish, and their impact is indirect and often spreads across several countries so it can be difficult to capture the full costs.

In Asia and the Pacific drought can take on distinctive forms. Elsewhere in the world, drought is typically experienced as a long period of low rainfall, resulting in dry, cracked earth, severe crop loss, dying livestock and famine. Asia and the Pacific has these droughts too, but it also has different, shorter forms – during severe winters, for example, or even during erratic monsoons.

Drought has significant impacts on many sectors, including fish and aquaculture, forestry, and industry. This report focuses, however, on agricultural drought, which takes four main forms: prolonged periods of low rainfall; irregularities in the monsoon season; reduced snowmelt or glacial runoff; and winter drought and '*dzud*'– a combination of events leading to inadequate pasture or fodder for livestock.

A prolonged drought will slow down income growth not just in agriculture, but also in related activities, particularly agro-processing, with knock-on effects for employment and incomes in other parts of the rural economy. Poor farmers respond to drought in different ways. Some may be able to absorb the impact, by migrating, or drawing on savings. But others may resort to 'erosive' coping mechanisms, such as removing children from school, taking high-interest loans, or selling off income-generating assets. In some cases farmers driven into debt have committed suicide.

Water and land management

By 2030, to meet rising demand, food production in Asia and the Pacific will need to increase by 50 per cent. But the region is already reaching its limit of available arable land, so it is vital to increase crop yields, which will rely on reliable sources of water. Some areas can be protected from drought by irrigation systems. However, in many of the region's agrarian countries these systems are not very extensive or have fallen into disrepair. Moreover, in some catchments more groundwater is being withdrawn than is being replenished. Water availability can also be reduced by pollution from seawater or other contaminants.

Drought is particularly damaging when the soil is already degraded. Drought then further weakens the soil structure. In the most extreme cases this leads to desertification. A reduction in vegetative cover can then make the climate even drier, triggering a downward spiral. This makes it difficult to sustain rural development: in some countries soil and water degradation have negated one-third of productivity gains from technical progress.

Exacerbating all of these water and land management factors is the potential impact of El Niño. In 2015, the tropical Pacific Ocean is experiencing moderate El Niño levels. The strongest precipitation will be in South-East Asia and parts of the Pacific, especially in the dry season. In the wet season reduced rainfall could have significant impacts in the Central and Southern islands of the Pacific that depend on subsistence agriculture.

Drought risk will also be increased by climate change. Higher temperatures could result in changes to precipitation patterns, earlier snowmelt, and increased evapotranspiration, which could increase the risk of hydrological and agricultural drought. Glaciers, for example, are already retreating at an alarming rate, and the Northern hemisphere has seen a reduction in spring snow cover. In addition there have been changes in the patterns of extreme climate events. There are also likely to be more frequent heat waves.

Regional Drought Mechanism

Signs of drought can be observed in satellite-based data and images, many of which now come from the region's spacefaring countries: China, India, Japan, the Republic of Korea, the Russian Federation and Thailand. Because many poorer countries lack the institutional capacity to integrate these high-end knowledge products into their operational drought monitoring and early warning systems ESCAP has established the Regional Drought Mechanism – which gathers data and imagery from the spacefaring countries and shares it with other countries, while building the capacity of experts and officials to use satellite-based data effectively. This service complements WMO's Global Framework for Climate Services by providing more detailed, localized forecasts that can be updated during the growing season – allowing mid-course corrections and measures for drought mitigation.

Building resilience to drought

For drought, as for other disasters, building resilience requires a full disaster management cycle approach: mitigation and adaptation to minimize the risk; preparedness to respond as necessary; relief to assist those in need; and investment in long-term recovery. For this purpose, governments may have a dedicated drought management policy, or they may integrate drought management under disaster management, or address it under other sectoral plans, such as those for agriculture or water.

While the approach will differ from country to country there are often common elements. These should include:

- *Long-term risk management* – If farmers know in advance that there is a strong likelihood of drought conditions, they can plant drought-resistant crops, budget water resources more carefully, or introduce water-saving techniques.
- *A livelihood approach* – Drought mitigation should support poverty eradication as part of inclusive and sustainable development, with investment in rural infrastructure and in rural education.
- *Maintaining ecosystems* – Ensuring healthy watersheds and soil systems.
- *Multisectoral management* – End-to-end drought management requires extensive coordination and planning across all key stakeholders.
- *Using science and technology* – The opportunities have expanded dramatically, particularly in space applications, hydrology and meteorology.
- *Agricultural insurance* – This can be weather based, with payouts triggered by rainfall or temperature thresholds, with opportunities for public-private partnerships.
- *Social safety nets* – Relief packages can include resources or equipment or temporary alternative employment.
- *Regional cooperation* – Opportunities include the Regional Space Applications Programme for Sustainable Development (RESAP) and the Regional Drought Mechanism.

THE VALUE OF EARLY WARNING

A key component of disaster risk reduction is an effective early warning system – which combines science and technology with practical local approaches, and is fully integrated into broader national and regional strategies. The importance of early warning is clearly recognized in the Sendai Framework for Disaster Risk Reduction 2015-2030, whose seventh global target is: "(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030".

An end-to-end early warning system has four main elements: risk knowledge; monitoring and warning; dissemination and communication; and response capability. Of these the region has made more progress in risk knowledge, and in monitoring and warning, but rather less in communication and response capacity. Across Asia and the Pacific there are still many gaps in early warning chains, particularly at the local level to cover the 'last mile'. The ultimate test of an early warning system is whether it provides timely and actionable information to the most vulnerable people – including children, women, the elderly and people with disabilities.

Where possible, early warnings for individual hazards should be integrated into a multi-hazard system. This brings economies of scale, and is also more efficient and sustainable. And since a multi-hazard system will be activated more regularly it is likely to be better maintained and more readily available for hazards such as tsunamis that occur infrequently. For each hazard, there should be standard operating procedures, with one entity authorized to issue official warnings providing clear and unambiguous information to multiple actors.

Regional cooperation

The same hazard can affect many countries simultaneously – those that share coastlines, for example, or mountain ranges, or rivers. On their own, many countries would be unable to afford a comprehensive warning system for major disaster events, but they can achieve more if they share the costs and expertise with other countries and relevant regional and international organizations. For addressing tropical cyclones, for example, the Asia-Pacific region has two intergovernmental platforms – the ESCAP/WMO Typhoon Committee and the WMO/ESCAP Panel on Tropical Cyclones, whose activities are backed up by regional specialized meteorological centres in New Delhi and Tokyo. Another major step forward was in 2009 when, with support from ESCAP, governments established the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) which now has 12 member States and 19 collaborating countries.

A further impetus for regional action came from the 2004 Indian Ocean tsunami. This had a profound impact on the Hyogo Framework for Action – stimulating extensive operational and technical work and triggering greater investment in prevention and mitigation. Another milestone was the establishment in 2011 of the Indian Ocean Tsunami Warning and Mitigation System.

Since then there has been further progress. The necessary technology has reached a high degree of sophistication. But still there are major disparities and gaps, particularly in countries that face high disaster risks but have low coping capacity – in ensuring fast and reliable dissemination of warnings, and in building the knowledge and capacity of communities to act appropriately – especially for transboundary river basin floods, landslides and flash floods.

Developments in forecasting

Many meteorological systems now provide weather information at the global or regional level, but users are increasingly seeking local forecasts. For this purpose, Asia and the Pacific can take advantage of its strength as a hub for science, innovation and good practices. The region has, for example, been adopting 'climate model-based seasonal hydrologic forecasting' – which couples climate scenarios, river-basin hydrology and flood forecasting.

In 2011 RIMES and WMO, with financial support from ESCAP, started a joint effort to strengthen the national meteorological and hydrological service in five high-risk countries, where forecast generators and users now meet in biannual 'monsoon forums'. In the Pacific, a group of countries have cooperated on the WMO-led Severe Weather Forecasting Demonstration Project, which allows smaller countries to take advantage of weather services from neighbouring countries.

Economic benefits of early warning

The costs of early warning systems are generally far outweighed by the economic benefits. In Asia and the Pacific, investments in hydrometeorological warning services could have a benefit-cost ratio of between four and 36. Much of the investment required is in people – specifically the technical staff of national meteorological and hydrological services, to enable them to make forecasts more accurate and user friendly, and to increase warning lead times. For high-frequency, low-impact hazards, such as storms and floods the priority should be to improve local and national warning systems. However, for low-frequency, high-impact hazards, such as tsunamis, it would be more economical to take a collective or regional approach.

To strengthen the sustainability of early warning systems, warning information should be targeted to the needs of end users in multiple sectors of the economy. In this way, the early warning system can become an enabler for sustainable development, with clear economic benefits.

Given the resource constraints, the best way to maximize the impact of finance, especially donor funds, is through pooled funding. One example is the ESCAP Multi-donor Trust Fund for Tsunami, Disaster and Climate Preparedness. Others are the World Bank's Global Facility for Disaster Reduction and Recovery, and the Global Initiative on Disaster Risk Management.

Future priorities

Early warning systems and services are public goods that should be financed by government investment. The priorities should be to:

1. Integrate the concept of 'early warning as a public good' into national planning policy and decision-making.

2. Strive to make early warning systems multi-hazard and people centred – reaching 'the last mile'.
3. Ensure that forecasters take into account the different needs of specific end users and tailor products and services accordingly.
4. Use effective communication channels including broadcast media.
5. Link standard operating procedures with operational tests, including local evacuation drills.
6. Strengthen regional cooperation in early warning, going beyond coastal hazards to include hazards such as transboundary river basins floods.
7. Concentrate external assistance on low-capacity, high-risk countries.

RIGHT INFORMATION, RIGHT PEOPLE, RIGHT TIME

A critical part of disaster risk management is managing the flow of information. Getting the right information to the right people at the right time saves lives and reduces losses, while also boosting people's resilience. Some Asia-Pacific countries now have state-of-the-art disaster information management systems, but others have major gaps in both data and analysis.

Right information – Each phase of the disaster cycle – preparedness, response and recovery has specific tasks. During the response period, for example, these include impact and humanitarian needs assessments, and the coordination of resources.

Right people – Each phase also has its own primary stakeholder groups – disaster risk reduction actors, relief agencies and development practitioners who in turn may be operating at the international, regional, national and local levels.

Right time – There are windows of opportunity for collecting and providing information to each target audience. This requires a degree of predictability through regular reporting structures, as well as elements of flexibility to fulfil ad hoc information requests.

Before disasters happen, all potential risks should be evaluated. These pre-disaster assessments will combine qualitative judgments of vulnerability and exposure with quantitative methods that use multiple layers of geospatial data along with socioeconomic indicators. These assessments should be interactive two-way processes, with exchanges of information between risk assessors, managers, interested groups and the general public.

In the immediate aftermath of a disaster, information needs to be gathered rapidly and presented in situation reports. Again, one of the most valuable resources is satellite imagery, which can provide clear pictures of the situation before and after an event. In Asia and the Pacific, ESCAP, through its RESAP network, helps provide imagery from the region's spacefaring member countries, at no cost, to disaster-affected countries. The International Charter on Space and Major Disasters is a global agreement between space agencies, aimed at providing a unified system for accessing and delivering fast and free satellite imagery and space data to countries affected by disasters. Another form of technology increasingly used in the aftermath of disasters is unmanned aerial vehicles, though this also raises important ethical issues.

Damage and loss assessment

After disasters, governments as well as other institutions, public and private, need to estimate the damage. In the past such assessments have had a number of weaknesses. One has been a lack of pre-disaster baseline information. Another has been that economic estimates often cover stocks not flows – that is, they assess the destruction of assets but not the cost of the interruption of business, for example, or the shortages of labour.

In 2013, the UN, the World Bank and the EU produced guidelines for producing a post-disaster needs assessment (PDNA) for major disasters. Smaller-scale events can use the same methodology but downscaled to meet local needs. To assist in this process, and increase the speed of evidence-based assessment, ESCAP has produced a rapid assessment manual which combines the PDNA sectoral methodology with the use of real or near real-time satellite data.

When considering investment in disaster risk reduction, governments will want to assess potential future losses. One approach is to consider the average annual loss (AAL). An AAL calculation has three components: hazard modelling; measures of exposure and vulnerability; and risk estimation. It uses both historical experiences and modelled predictions to arrive at a comprehensive picture of what can be expected.

Another approach is based on climate risk assessment – downscaling regional climate change scenarios to the national level. This involves three steps: regional climate modelling, physical impact assessment, and economic assessment. A number of countries now have pilot programmes for comprehensive climate risk assessment. Estimates for five South Asian countries, for example, indicate that climate change will cost these countries on average 1.8 per cent of their annual GDP, rising by 2100 to around 8.8 per cent.

Transboundary information

The region's most established mechanism for transboundary information on disaster events is the Mekong River Commission – which works directly with the governments of Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam. Another is the Regional Flood Information System in the Hindu Kush-Himalayan region – which has helped set up hydrometeorological stations across Bangladesh, Bhutan, Nepal and Pakistan.

ESCAP is supporting these transboundary information efforts in various ways, including developing regional land cover maps. In addition, one of ESCAP's specialized regional institutions, the Asian and Pacific Centre for Development of Disaster Information Management, is promoting South-South and regional cooperation and helping countries address critical information gaps.

One of the most useful ways of sharing information is through web-based geoportals. ESCAP has worked with developing countries to establish cost-effective, easy-to-maintain portals for 'geo-referenced information systems for disaster risk management' (Geo-DRM). For this purpose ESCAP has been collaborating with UNOSAT, the Asian Institute of Technology, and the Applied Geoscience and Technology Division of the Secretariat of the Pacific Community. Portals have now been established in Bangladesh, the Cook Islands, Fiji, Kyrgyzstan, Mongolia and Nepal.

The Asia-Pacific region also has access to a variety of advanced subregional, regional and global geoportals. They include those developed by: the Indian Space Research Organisation; the Pacific Disaster Center; the International Centre for Integrated Mountain Development; the Global Disaster Alert and Coordination System; and ReliefWeb, a specialized digital service of the United Nations Office for the Coordination of Humanitarian Affairs.

Making communications systems resilient

During disaster events, information management systems are themselves vulnerable so should be designed to absorb shocks and maintain services when faced with limited connectivity or increased traffic volume. ESCAP's Asia Pacific Information Superhighway promotes resilient infrastructure backbones that have a balance of terrestrial and submarine fibre optic connectivity.

Individual items of energy and transport infrastructure, such as bridges or electricity substations, are typically monitored remotely by centralized SCADA (supervisory control and data acquisition) systems. But these are generally standalone and proprietary so need to be integrated as interdependent parts of a critical information network.

Nowadays large volumes of data are also generated by new information sources – smart phones, for example, and social media. Analysis of this 'big data' can give immediate indications of population movements, for example, or other behaviour that can be useful before and after disaster events. Cell phones can also be valuable for general disaster management – receiving text messages and warnings of incoming disasters, or transmitting crowd sourced imagery of damage and impact.

These applications depend on resilient data networks. To make best use of these tools, governments should focus primarily on maintaining the infrastructure – ensuring, for example, that commercial telecommunications networks can cope with disruptive events and handle usage spikes. For this purpose they can also use mobile and airborne base stations. In addition, emergency response teams can be equipped with dedicated communications networks such as terrestrial trunked radio.

A roadmap to effective and resilient information management

Providing the right information to the right people at the right time, entails five principal steps.

Step 1 – *Understanding risk* – Assessing risk in qualitative and quantitative terms, while considering issues of financing and insurance. It also means taking into account the culture and psychology behind risk, and creating partnerships for building resilience.

Step 2 – *Establishing information sharing policies* – Policies on data sharing should be in place before disasters strike. Policies can cover technical issues such as standardization and formats, platforms, procedures and protocols, timeframes, naming conventions, authorization and classification.

Step 3 – *Generating actionable information* – Governments need to establish a classification system for information types, along with the implied actions. As information comes into a disaster risk management system it can then be assigned to an appropriate actor.

Step 4 – *Customizing information and reaching people at risk* – This requires location-based information services and decision support tools – with strong institutional links for coordination between developmental and planning actors.

Step 5 – *Using real-time information* – Coordinating real-time data flows, particularly for disasters with transboundary origins, requires extensive regional and international cooperation.

P*rotecting ICT infrastructure* – Critical infrastructure should be planned and designed with disaster management in mind, as it underpins the functioning of effective and resilient information management systems.

AT THE HEART OF SUSTAINABLE DEVELOPMENT

Disaster risk reduction is an essential component of sustainable development. Measures to reduce the impact of disasters – building stronger infrastructure, for example, or better housing, or better organized communities – also support development in general. But the process works both ways, because countries with higher levels of development are also better able to defend themselves from disasters: as their economies grow, infrastructure becomes more robust and governments that have more resources can provide stronger social protection.

Disaster risk management should therefore be closely integrated with development planning and programming. This makes it a responsibility for every part of government – from education to health to transport to social protection. Just as every sector can be affected by earthquakes or floods or cyclones, so every sector needs to consider how to make its activities disaster resilient.

The Sustainable Development Goals

The understanding of the need for disaster risk reduction and its importance for sustainable development has increased over the years – from the 1987 World Commission on Environment and Development, to the 2005 Hyogo Framework for Action (HFA), to the 2015 Sendai Framework for Disaster Risk Reduction, 2015-2030. Disaster risk reduction is also central to the proposed Sustainable Development Goals (SDGs) which address this priority in goals related to poverty eradication, food security, infrastructure, cities and human settlements, climate change and ecosystems. Activities in all these areas should reduce existing risks and also avoid creating new ones – what is referred to as 'prospective' or 'anticipatory' risk management.

Legal and regulatory mechanisms

Risk management requires a sound legal and regulatory structure. This refers not just to laws covering disaster management but also legislation for all other relevant sectors. Recently, some Asia-Pacific countries have introduced specialized legislation on disaster management. The region's developed countries, however, generally do not have stand-alone national laws but have embedded risk reduction in legislation across various sectors. Another challenge for developing countries is to regulate the private sector – especially when enterprises are constructing critical infrastructure.

Institutional arrangements

In Asia and the Pacific the institutional arrangements for disaster risk reduction broadly follow one of three models. The first is a specialized authority, usually chaired by the head of government. The second is high-level interministerial coordination. In the third model, disaster management is the exclusive responsibility of a single agency or government department. For many years most countries used the third model. This is now giving way to the first or second models, but even these are not yet working effectively. Either the agencies and committees have not met regularly or they have not established the necessary actions and monitoring mechanisms, or are working in silos without effective outreach. Typically their high-level officials have been drawn from the armed forces, police and civil defence, who tend to focus on disaster response and preparedness – rather than integrating disaster risk reduction with other sectors. The HFA prescribed 'multisectoral national platforms, with designated responsibilities at the national through the local levels', but as of 2013 across Asia and the Pacific only 14 out of 64 countries had set up such platforms, and none were meeting regularly.

Policies and planning

Policy implementation broadly differs according to level of development. The region's developed countries have invested enormous resources in structural and non-structural measures –

and have introduced low-cost community-based initiatives for disaster risk reduction. Those countries that face high disaster risks have also started making such investments with some success. But most of the region's developing countries lack the necessary resources and capacity, and initiatives are often driven by UN agencies and donors with little buy-in from local governments. Moreover there may be no clear guidance on how national policies and strategic action plans are to be integrated across government sectors.

Finance and budgets

Countries that have special funds for disaster risk management have mostly used these for disaster response and humanitarian relief. National governments often make a commitment for community-based disaster management but fail to allocate the necessary resources, leaving the agenda in the hands of NGOs who have been managing small pilot projects. The mid-term review of the HFA found that although 86 countries had made local governments legally responsible for local disaster risk management, only 20 had made the corresponding budget allocations. International assistance for such measures is also limited: in the Asia-Pacific region, over the past decade only 0.65 per cent of total ODA was devoted to disaster prevention and preparedness.

Capacity building at all levels

Capacity development for disaster risk reduction should permeate all sectors, at all levels of government, across all stakeholder groups and for all types of hazard, natural and manmade. In the case of construction, for example, this means increasing the capacity of architects, engineers and masons, and designing or retrofitting buildings so as to be earthquake resistant. But it also means enhancing the supervisory and enforcement capacity of government officials.

At the same time countries will want to improve their institutional expertise. Universities and other institutions of higher learning can develop a pool of professionals on disaster risk management, while research institutions can engage in scientific, policy and applied research. Several countries in Asia and the Pacific now have specialized institutes for training on disaster management. ESCAP is partnering with those institutions in China, India and Indonesia to help them share their capacity-building programmes with other countries that have fewer resources.

Strategic frameworks and national guidelines

Integrating disaster risk reduction into development planning requires a strategic framework within the national development plan, complemented with national and sectoral guidelines. In the health sector, for example, these should ensure that programmes, activities, projects and critical infrastructure are protected from the risks of disasters, and further strengthened so that they respond during emergencies with pre-defined operation procedures. Similarly, in the education sector the aim should be to protect infrastructure, programmes, and activities, while also creating awareness of hazards, and building scientific, technical and professional skills. National guidelines should also cover cross-cutting issues such as poverty reduction, gender equality, child protection and disability.

There should also be guidelines for productive sectors. In agriculture, these can address such issues as soil and water conservation and accurate weather forecasts. In addition, the private sector should be encouraged to factor disaster risk into overall corporate planning and investment not only to protect themselves but also help make society as a whole more resilient. Even if a private businesses factor in the costs of hazards in their internal rates of return they will not generally take into account the external societal or environmental risks they are creating. Governments, on the other hand, should be able to do so – taking a longer-term and broader view and acting in the public interest.

Another priority is resilient infrastructure. All new infrastructure should be constructed with an appropriate margin of safety, and all existing critical infrastructure should be audited and upgraded to cope with worst-case scenarios. Similar considerations apply to buildings generally. Each city needs to identify and reduce the stock of unsafe buildings. This may require demolition or retrofitting – for which there could be both incentives for investment, and penalties for non-compliance.

Many disaster risk reduction measures are similar to those for climate change adaptation – particularly those related to hydrometeorological disasters, such as drought-proofing, flood protection, and saline embankments, and developing alternative livelihoods. Combining the two processes is likely therefore to be more efficient and cost-effective. At the local level in particular, the two must converge with clear plans of action, funding arrangements, and guidelines.

DISASTERS WITHOUT BORDERS

The scale of modern day disasters, combined with instant international communications, means that many disasters, national or regional instantly, become global phenomena. Mounting economic losses, combined with the spectre of climate change, are also bringing disasters to the centre stage of public policy.

There have been many encouraging developments – particularly in preparedness projects which have dramatically reduced disaster mortality. Other positive signs include the success of regional and global cooperation on disaster risk reduction, and the unprecedented participation of countries and other stakeholders in the recently concluded World Conference on Disaster Risk Reduction. The task now is to translate these opportunities and commitments into action throughout Asia and the Pacific – to establish disaster risk reduction at the heart of sustainable development.

ESCAP PHOTO/ARINDAM DUTTA

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RESILIENCE
TO DISASTERS IN ASIA AND THE PACIFIC

CHAPTER 1 RESILIENCE TO DISASTERS IN ASIA AND THE PACIFIC

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

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

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

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

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

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

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

THE DISASTER EPICENTRE

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

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

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

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

TABLE I-1

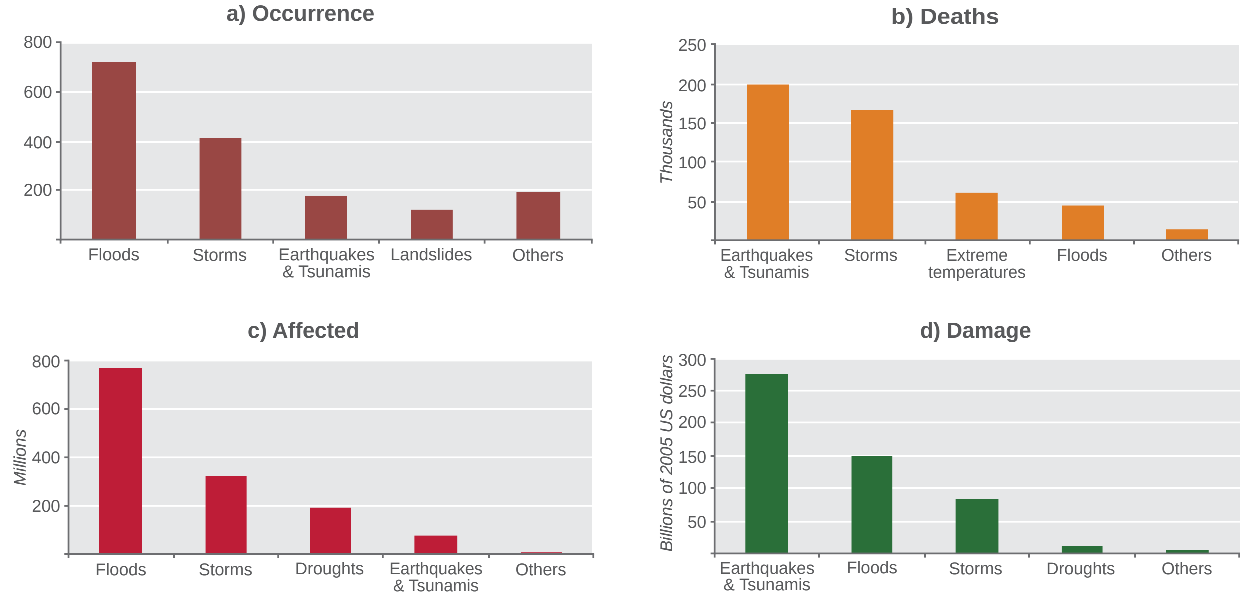
Human impact of disasters in Asia and the Pacific, total 2005-2014

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

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

FIGURE I-1

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



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

BOX I-1

Disaster statistics in Asia and the Pacific

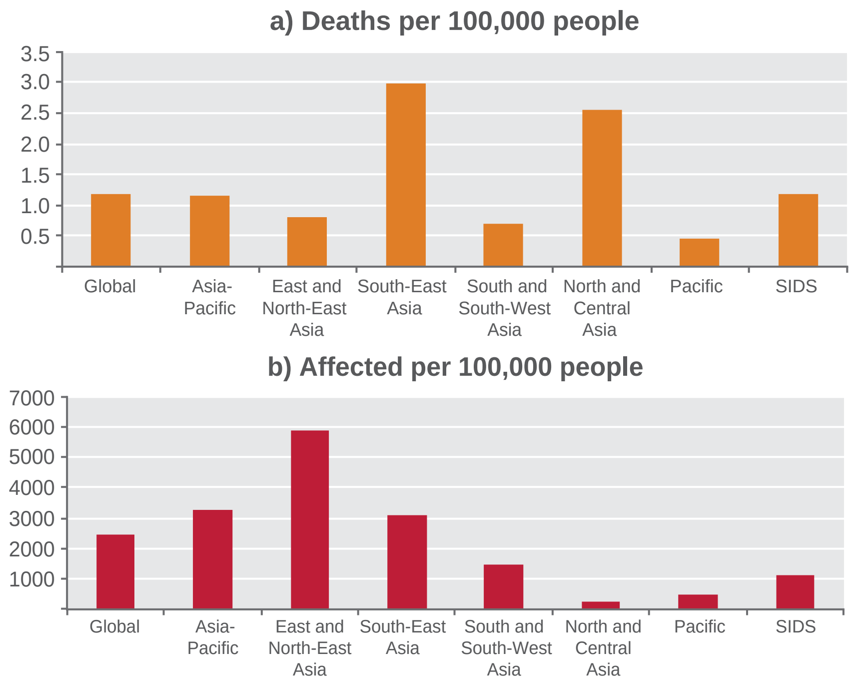
Access to reliable disaster data has been difficult. This is partly due to a lack of agreed classifications and definitions for even the most basic indicators – such as the number of events, the number of deaths and affected people, and the direct economic impacts. In the absence of standardized statistics,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

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

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

FIGURE I-2

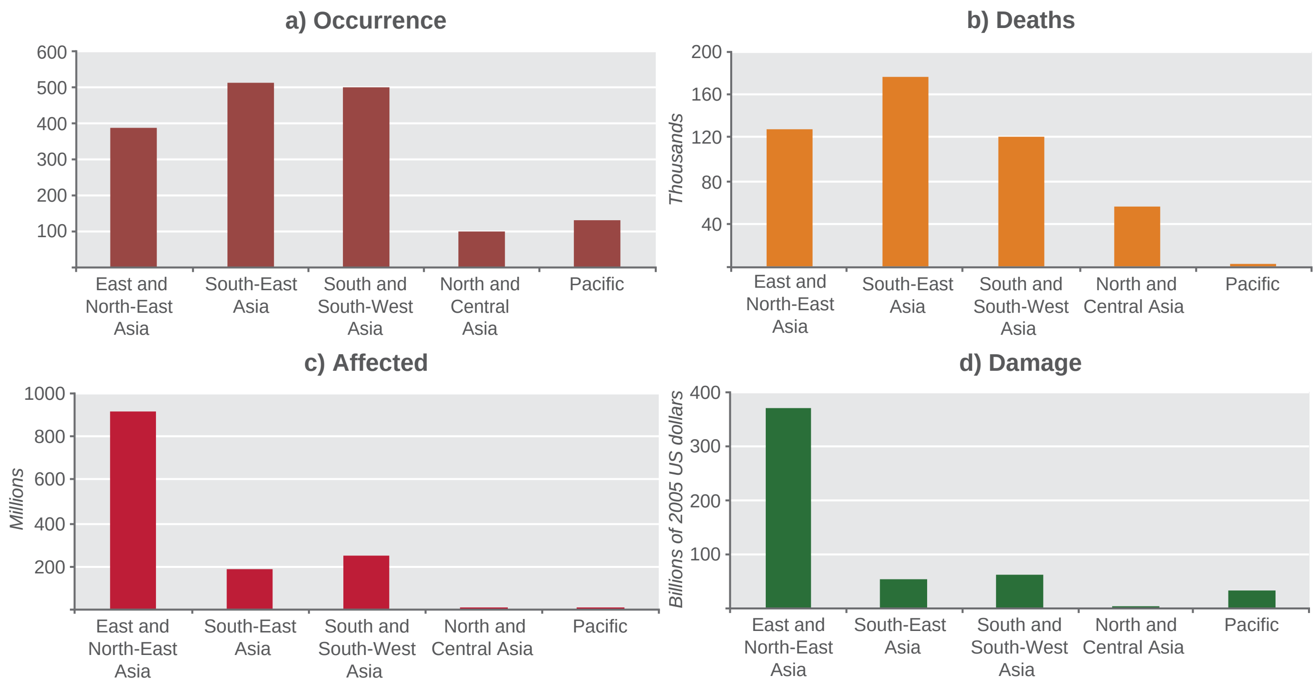
Mortality and numbers of people affected, 2005-2014



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

FIGURE I-3

Occurrence and impacts by subregion, total 2005-2014



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

DISASTERS LARGE AND SMALL

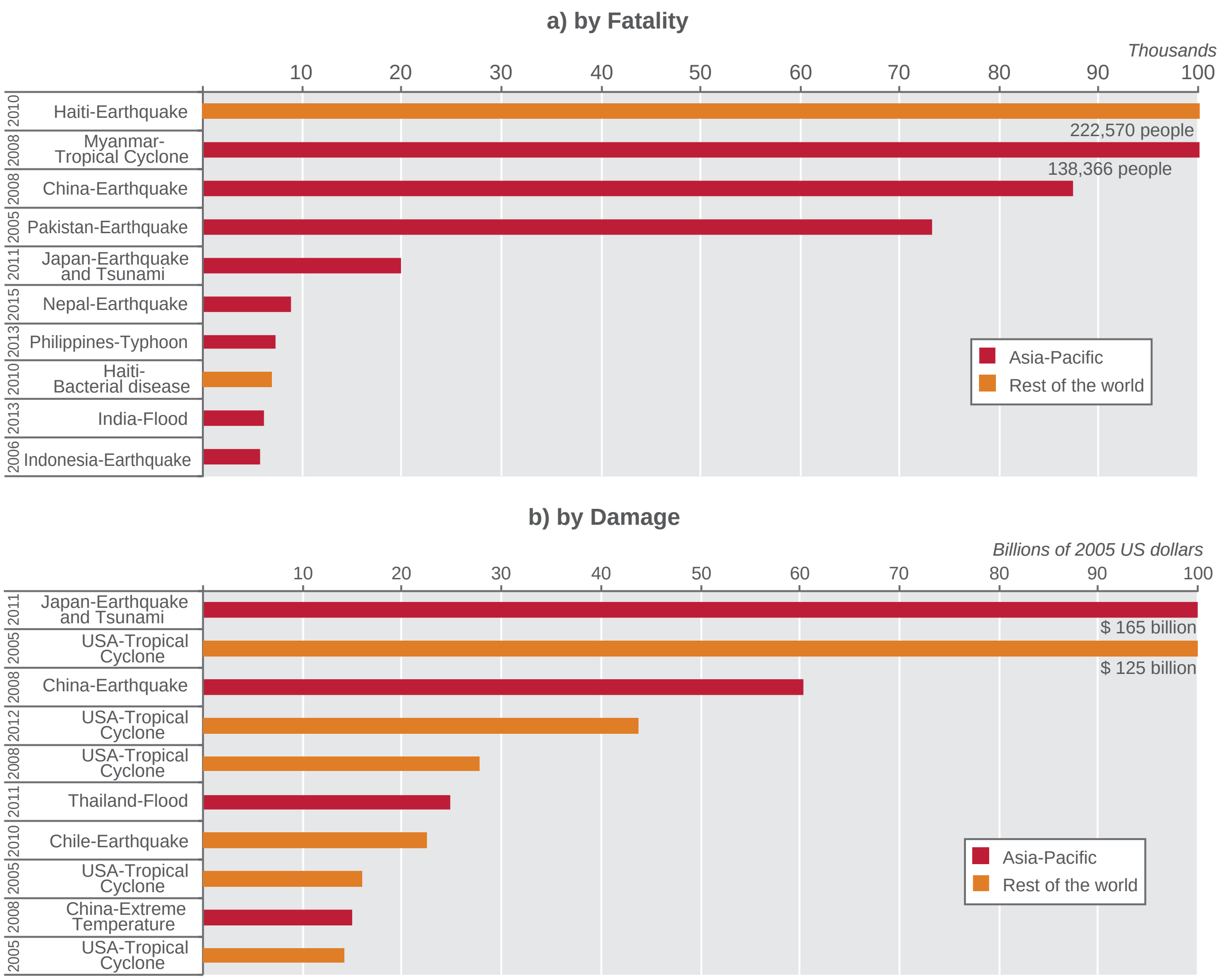
Asia and the Pacific is hit by most of the world's major disasters. Over the last ten years, the region has had eight of the ten largest disasters in terms of fatalities, and four of the ten largest in terms of economic damage (Figure I-4).

These included:

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

FIGURE I-4

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



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

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

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

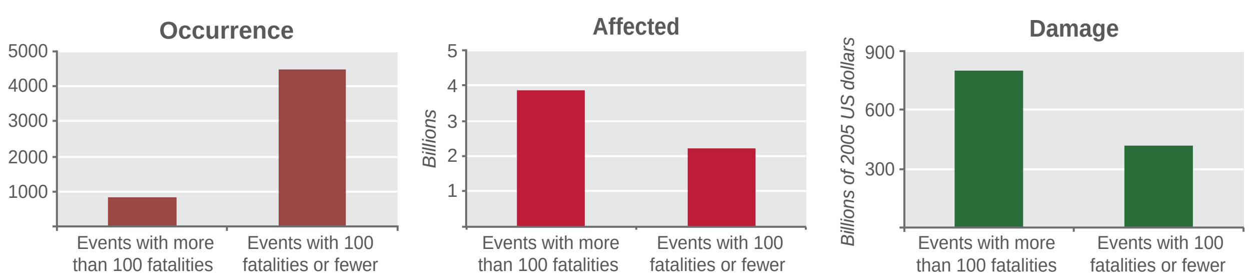
Cascading consequences

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

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

FIGURE I-5

Cumulative impacts of smaller, recurrent disasters, 1970-2014



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

EXPOSURE TO DISASTERS

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

Countries with special needs

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

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

TABLE I-2

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

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

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

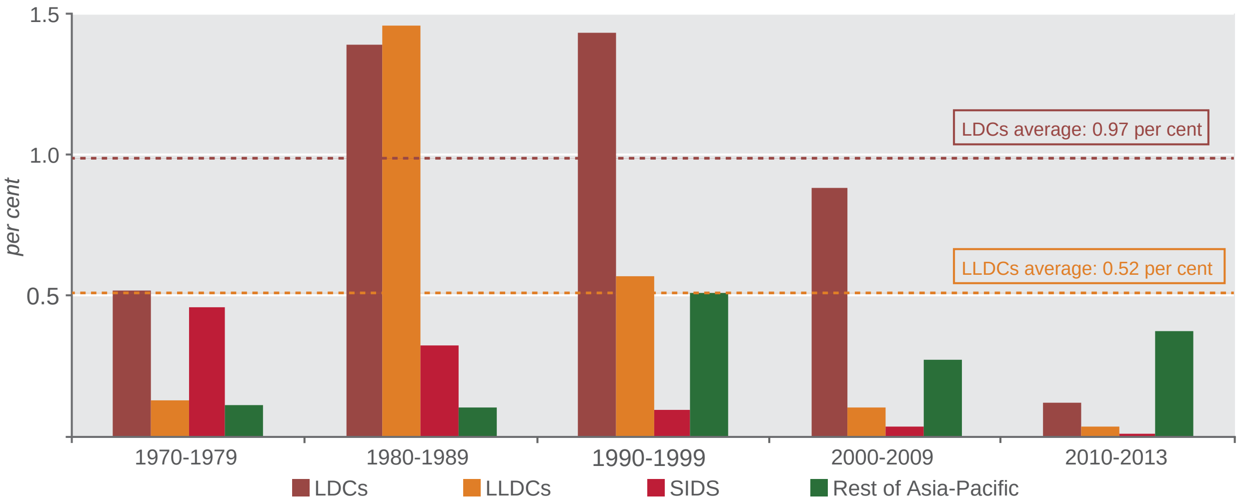
in the early 1990s, in Vanuatu in 1985, and in Mongolia in 1996 (Figure I-7). In 2015 in Nepal the earthquakes caused a combined damage and losses equivalent to one-third of GDP, and in Vanuatu cyclone Pam caused damage and losses equivalent to 64 per cent of GDP (Box 1-2).[15]

CROSS-BORDER THREATS

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

FIGURE I-6

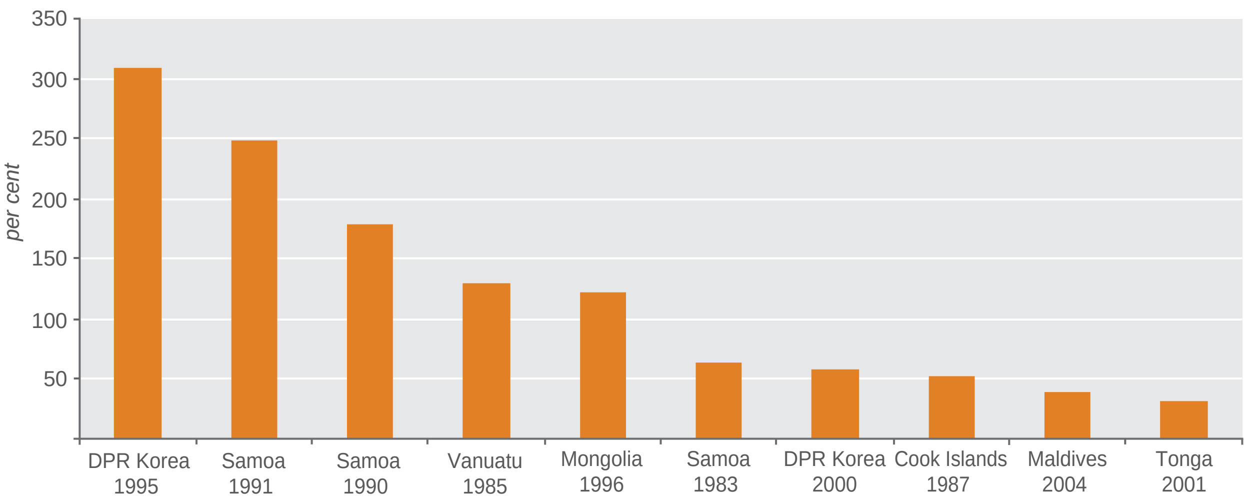
Countries with special needs, damage as a per cent of GDP



Source: ESCAP, 2015f.

FIGURE I-7

Damage from natural disasters as a per cent of GDP



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

BOX I-2

Cyclone Pam in Vanuatu

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

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

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


ESCAP PHOTO

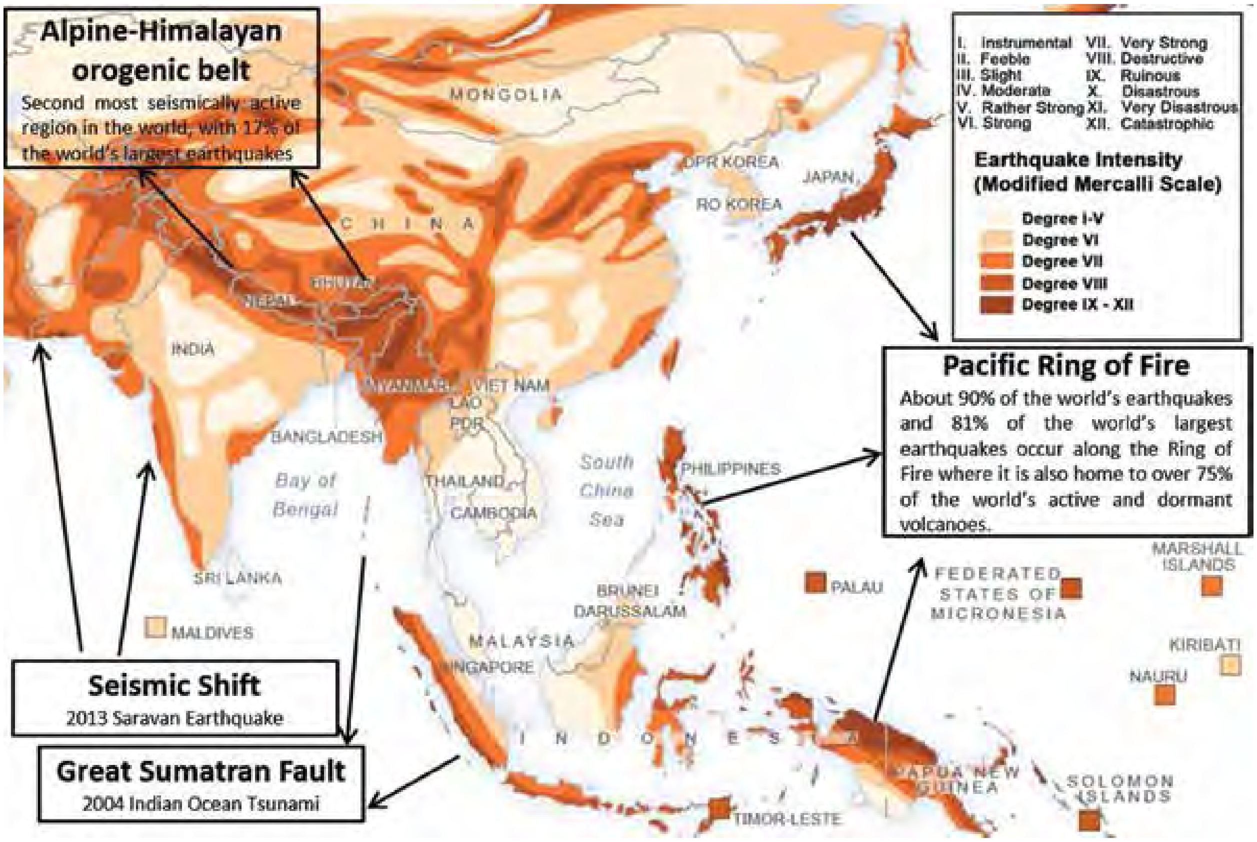
Earthquakes and tsunamis

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

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

FIGURE I-8

Seismic risk in Asia and the Pacific



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

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

BOX I-3

Nepal earthquakes, 2015

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

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

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

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

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

Tropical cyclones

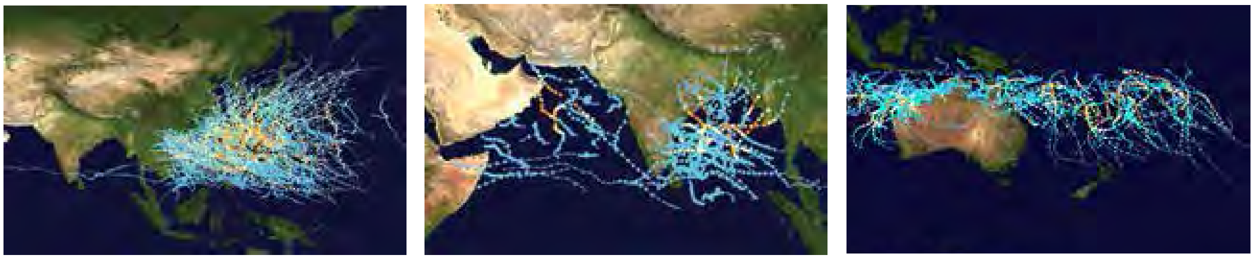
On average globally there are 86 tropical cyclones each year. Of these, 50 to 60 arise in three Asia-Pacific ocean basins whose coastlines are shared by multiple countries (Figure I-9).[25] A single cyclone can travel across many countries, causing heavy rainfall and flooding, until it finally makes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

Transboundary floods

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

FIGURE I-9

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



* a) surrounding countries/states: Cambodia, China, Hong Kong, China, DPR Korea, Guam, Japan, Lao PDR, Malaysia, Palau, Philippines, Republic of Korea, Singapore, Taiwan, China, Thailand and Viet Nam

* b) surrounding countries/states: Arabian Peninsula, Bangladesh, India, Myanmar, Pakistan, Somalia, Sri Lanka and Thailand

* c) surrounding countries/states: Australia, Fiji, New Caledonia, New Zealand, Papua New Guinea, Solomon Islands and Vanuatu

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

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

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

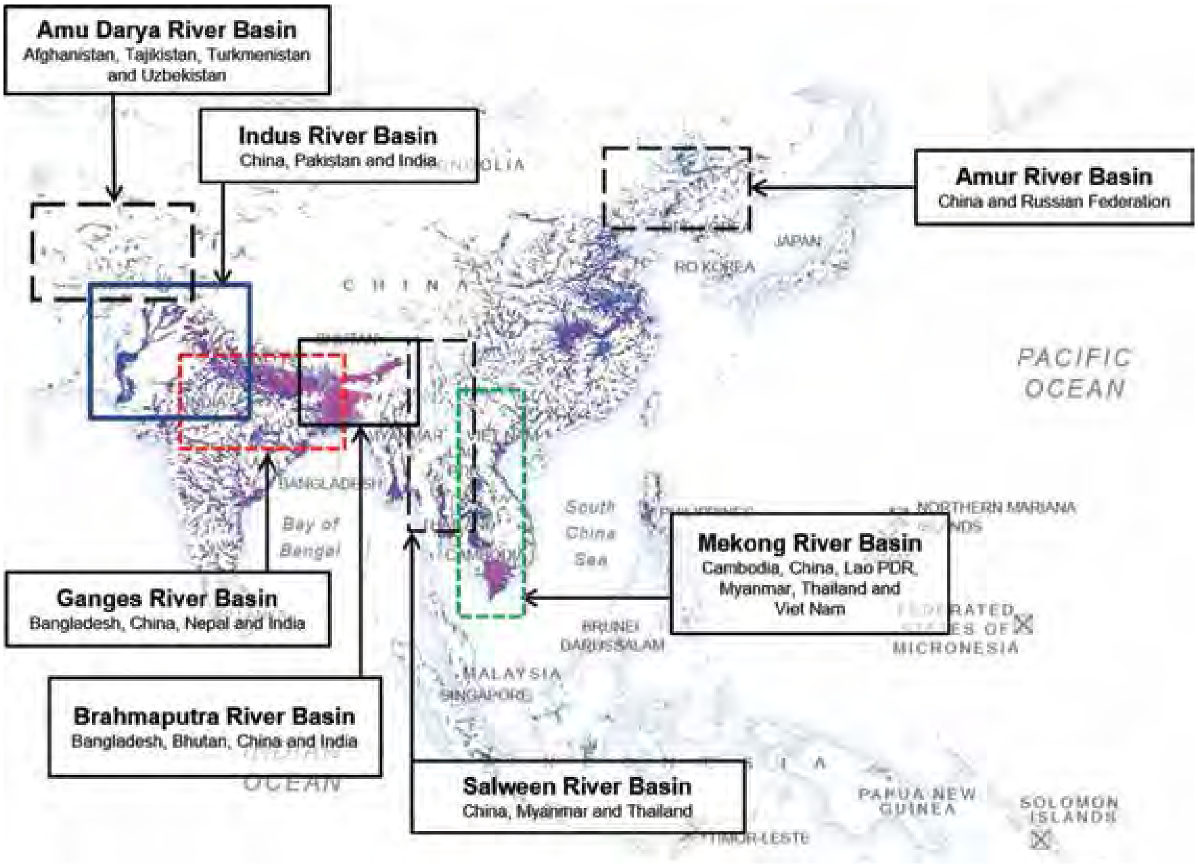
Mountainous regions can also give rise to glacial lake outburst floods (GLOFs). The Hindu-Kush Himalayas region, for example, covers Afghanistan, Bhutan, India, Nepal and Pakistan. Here, as the glaciers recede they create large meltwater lakes which are often unstable and can suddenly release vast quantities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

Volcanic eruptions

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

FIGURE I-10

Transboundary flood risk in Asia and the Pacific



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

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

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

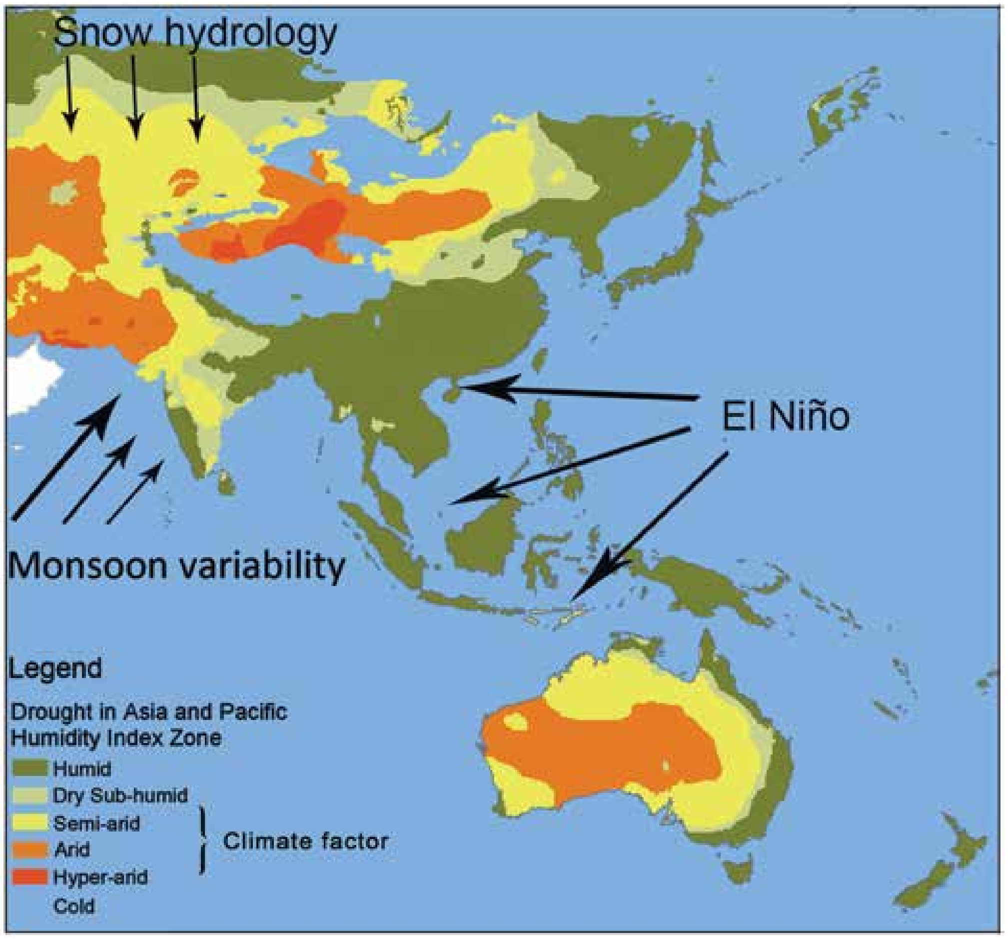
In 1991 the eruption of Mount Pinatubo in the Philippines killed 680 people and caused damage to crops, infrastructure and personal property of around $374 million.[33] Nevertheless, many lives were saved as a result of effective monitoring and forecasting and timely evacuation organized by the disaster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

Droughts

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

FIGURE I-11

Transboundary drought risk in Asia and the Pacific



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

ECONOMIES AT RISK

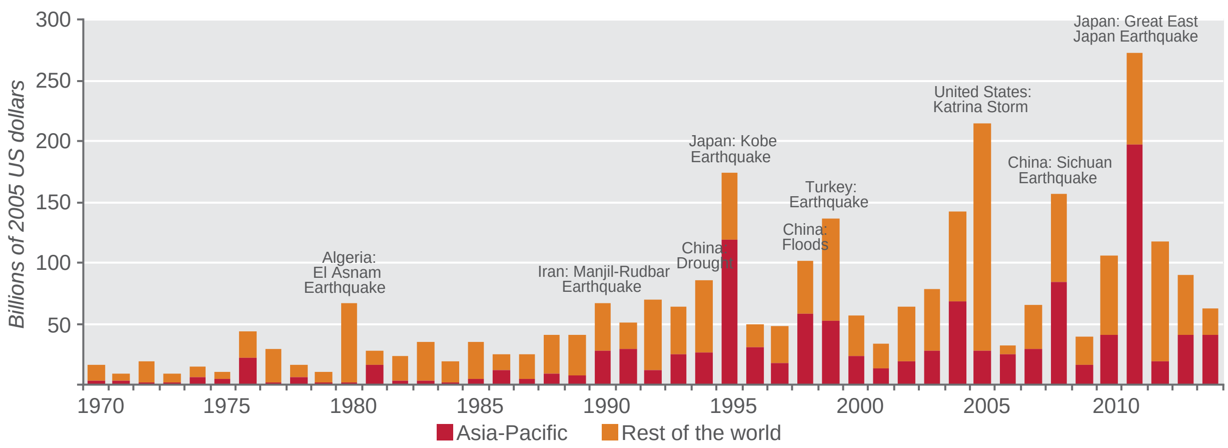
Though the immediate concern from disasters must be from the threats to human life and health, countries across Asia and the Pacific are also concerned about the economic cost – which appears to be increasing. Between the 1970s and the decade 2005-2014 damage to property, crops and livestock increased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

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

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

FIGURE I-12

Damage from natural disasters rising, 1970-2014



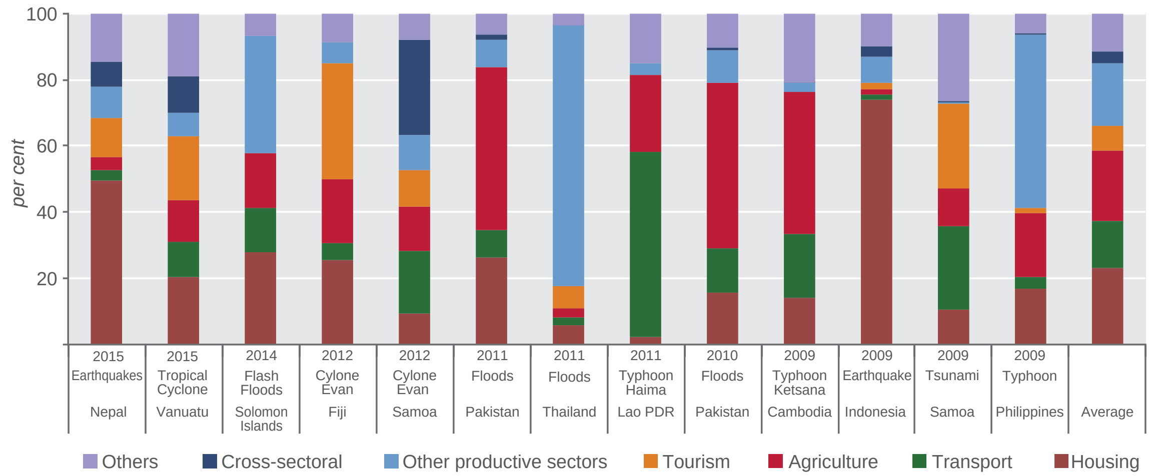
Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from http://www.emdat.be/ (Accessed April 2015).

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

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

FIGURE I-13

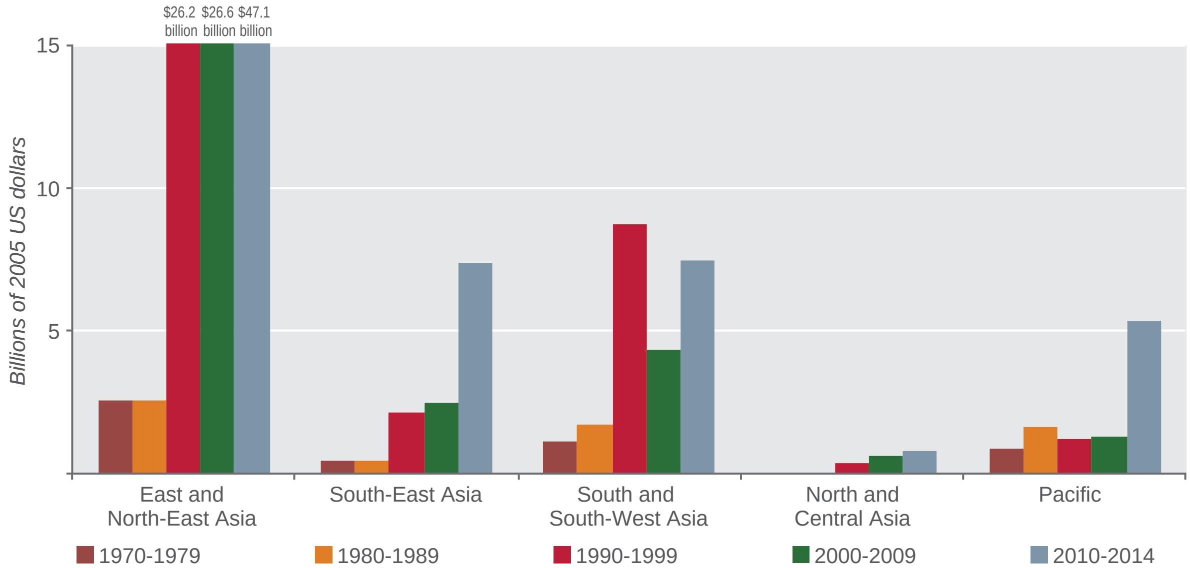
Sectoral damage and losses in disaster-hit countries, per cent of total



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

FIGURE I-14

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



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

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

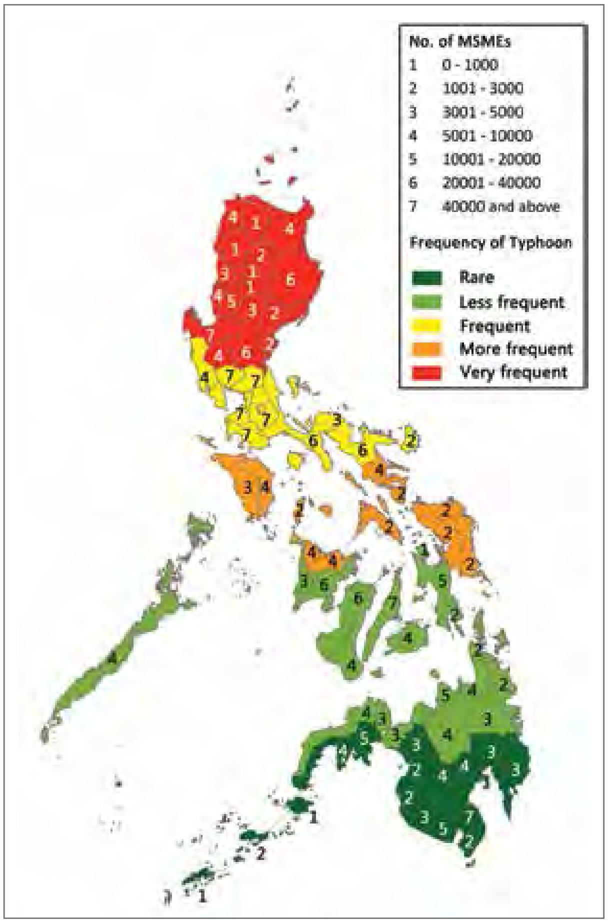
Small and medium enterprises

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

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

FIGURE I-15

SMEs in the Philippines located in areas of high typhoon frequency



Source: Ballesteros and Domingo, 2015.

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

Global repercussions

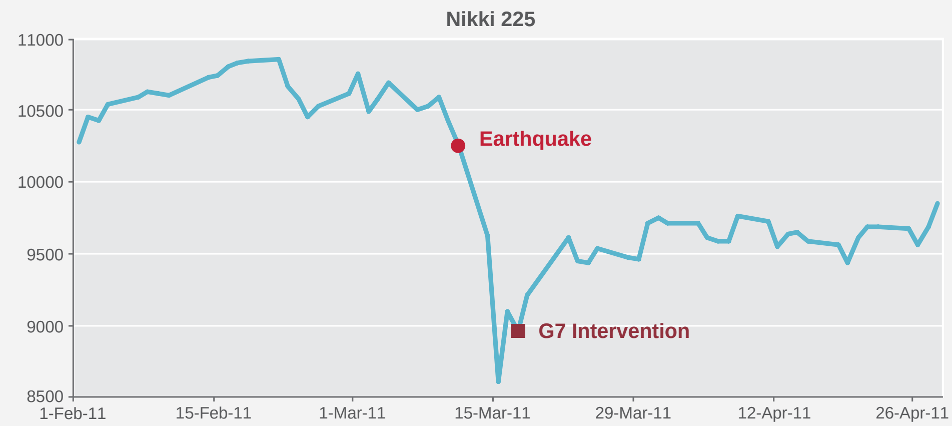
Given the significance of Asia and the Pacific in the global economy, the impact of major disasters in this region can soon reverberate around the world. The Japan earthquake of 2011, for example, affected global commodity prices (Box I-4). In New Zealand a major drought in 2013 led to an increase in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

BOX I-4

Impact of 2011 Japan earthquake on global markets and prices

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

Volatility of Japanese Nikkei 225 Index, February to March 2011

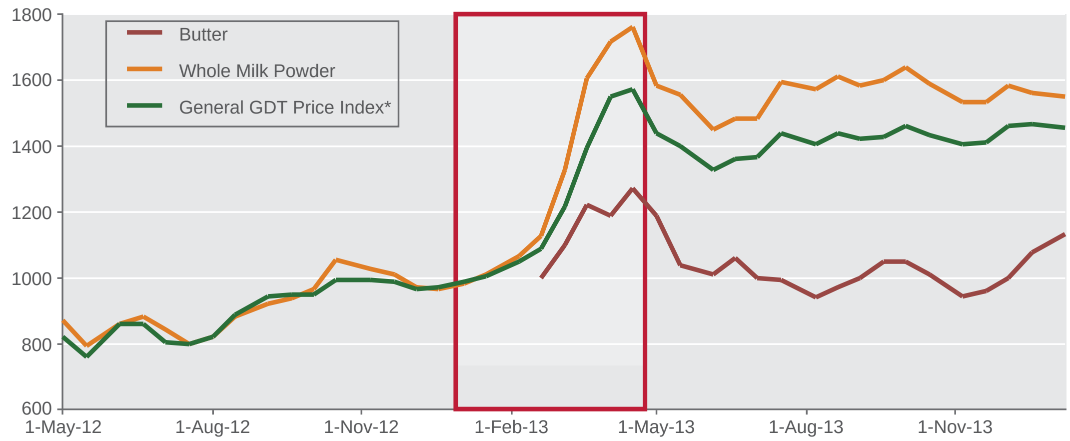


Source: Historical data obtained from various sources: Capital IQ, Thomson Financial Network, Morningstar Inc, SIX Financial Information, and Interactive Data Real-Time Services.

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

FIGURE I-16

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



* GDT = Global Dairy Trade

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

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

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


ESCAP PHOTO

Infrastructure exposed

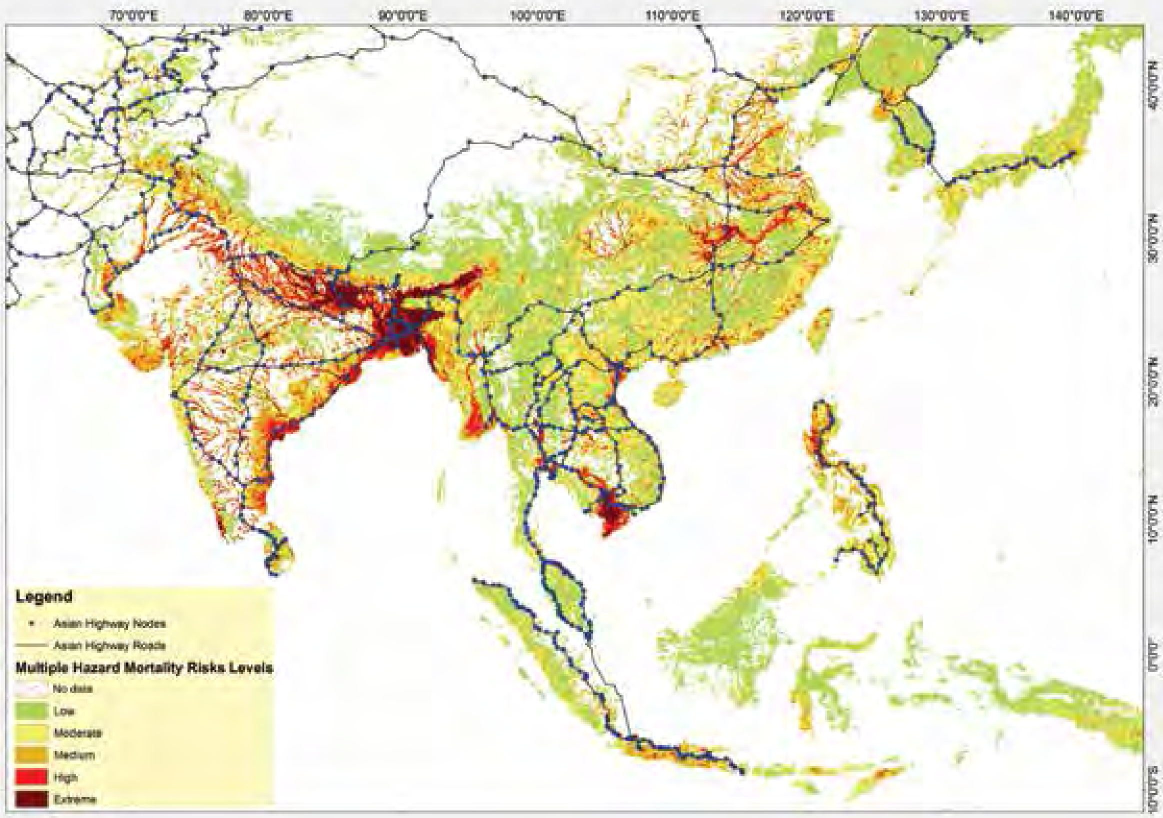
Disasters in Asia and the Pacific can have a severe impact on the region's infrastructure, much of which has multi-hazard disaster risk (Box I-5). Much of this infrastructure, however, has been built without careful consideration of the potential for disaster – putting at risk not just economic activities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

BOX I-5

Risks to transboundary transport networks

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

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



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

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

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

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

TABLE I-3

Recent investments in disaster-resilient infrastructure

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

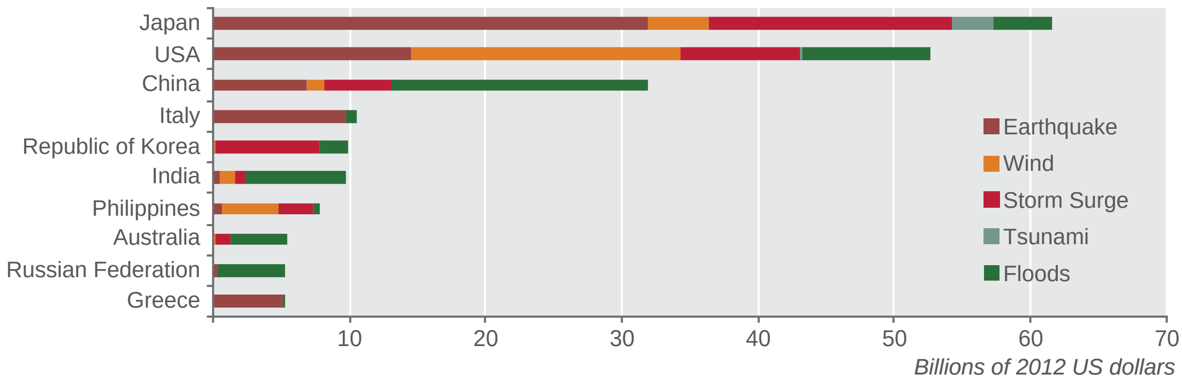
Source: ESCAP based on ADB, 2013.

Estimating future losses

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

FIGURE I-17

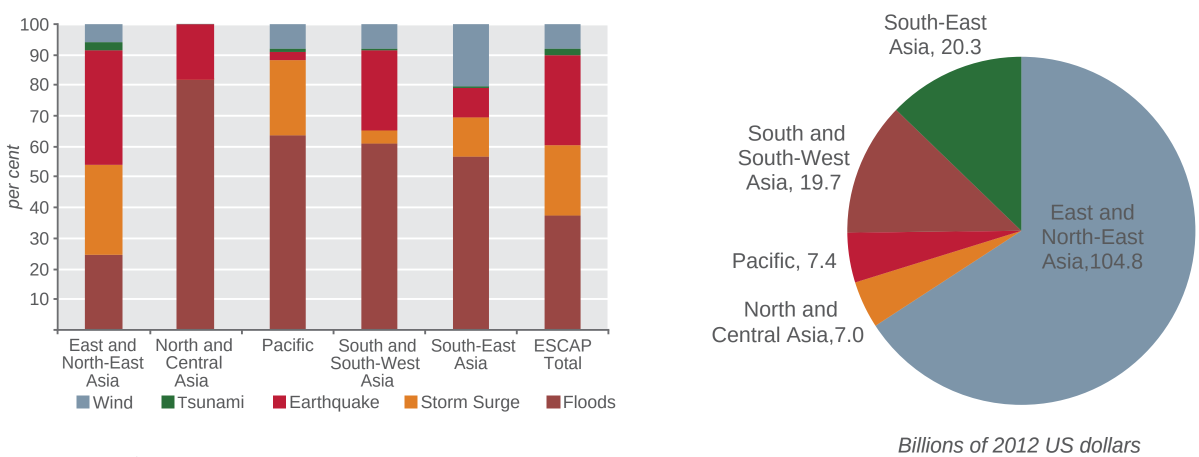
10 countries with the highest predicted annual average losses from disasters



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

FIGURE I-18

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



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

CITIES AT RISK

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

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

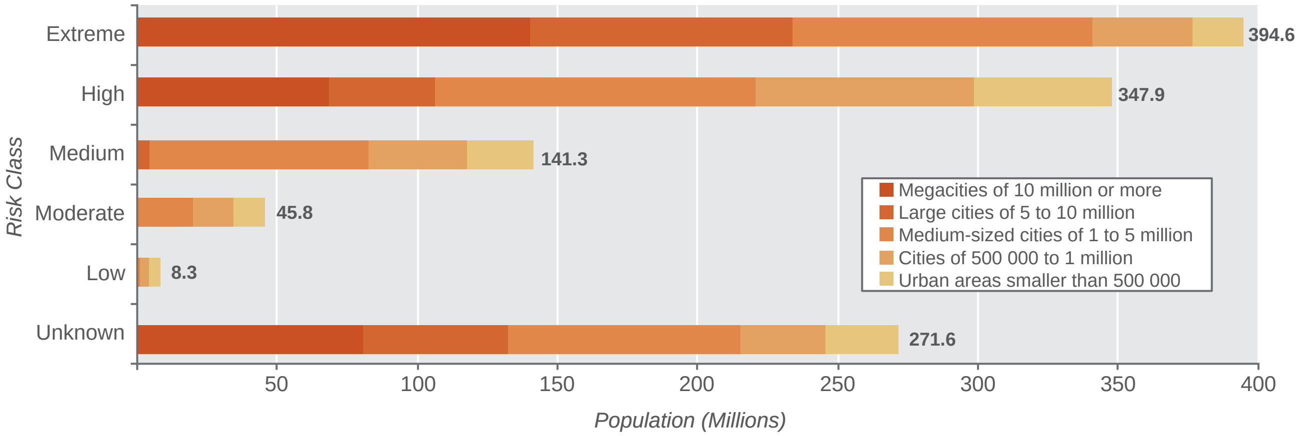
For example, the city of Mumbai in India is vulnerable to monsoon rains, yet has done little to mitigate flood risk. In 2005, the city was hit by a large monsoon that causes more than 400 casualties, as well as heavy damage to buildings and critical infrastructure.

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

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

FIGURE I-19

Asia-Pacific city dwellers exposed to multiple hazards, 2014



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

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

TABLE I-4

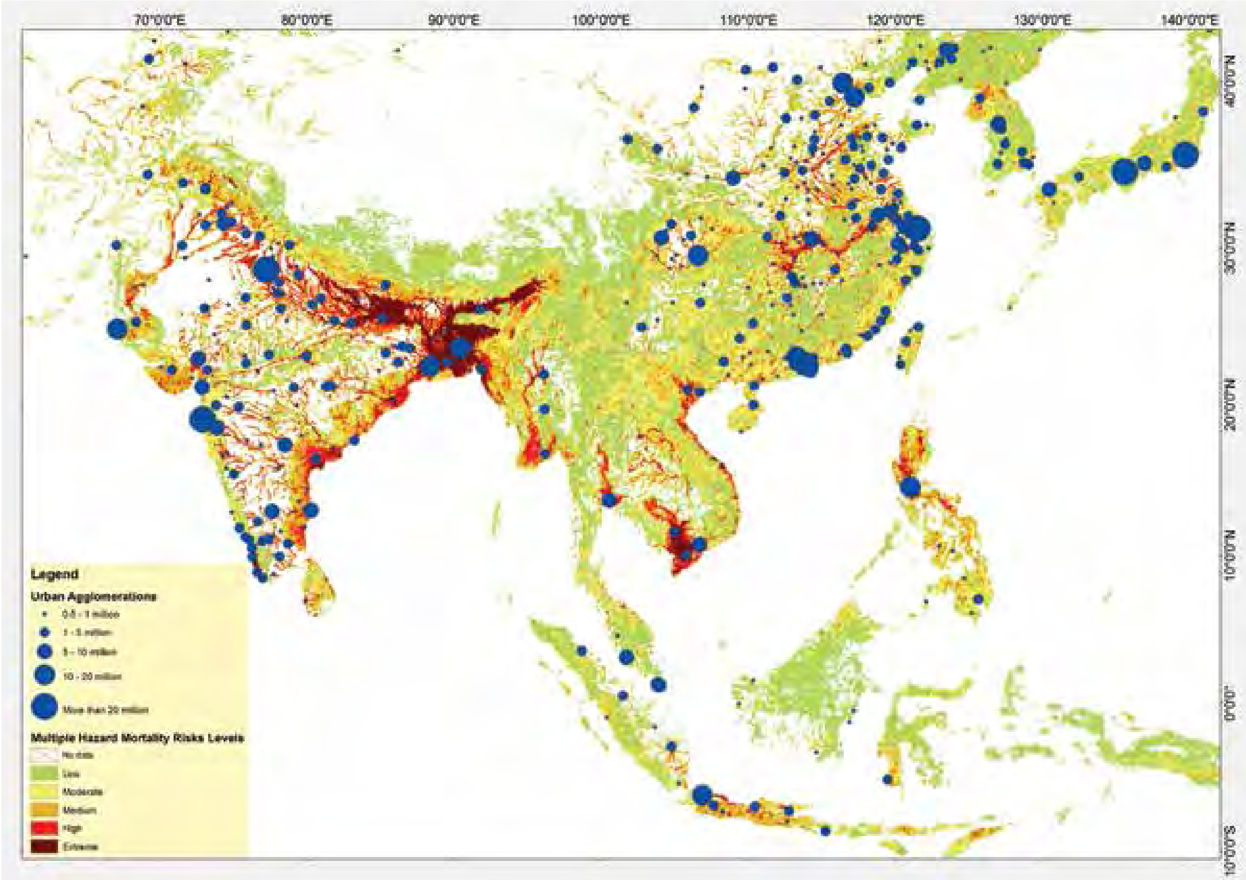
Multi-hazard hotspots

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

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

FIGURE I-20

Asia-Pacific cities exposed to multiple hazards



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

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

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

BOX I-6

Vulnerability of small cities: the case of Tacloban, Philippines

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

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

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

PEOPLE AT RISK

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

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

Disasters are thus likely to further impoverish people – or push the 'near-poor' into poverty. In rural Andhra Pradesh, India, the single most important factor contributing to impoverishment is drought.[79] But people can also be pushed into poverty by more sudden disasters. This was one consequence of the Sichuan Earthquake in 2008. Before the earthquake, 4 per cent of the province's population were covered under the 'basic provision protection', which provides subsidies to households with incomes below a certain threshold. Following the earthquake, however, the proportion rose to 6 per cent, where it stayed five years after the disaster.[80]

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

BOX I-7

Towards disability-inclusive disaster risk reduction

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

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

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

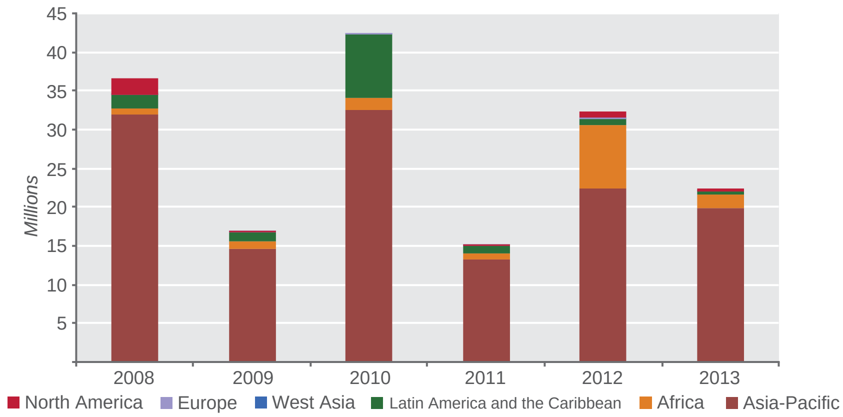
In Asia and the Pacific, the Incheon Strategy to "Make the Right Real" for Persons with Disabilities in Asia and the Pacific, the guiding document for the Asian and Pacific Decade of Persons with Disabilities, 2013-2022, promotes disability-inclusive disaster risk reduction in its seventh goal.

Displaced by disasters

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

FIGURE I-21

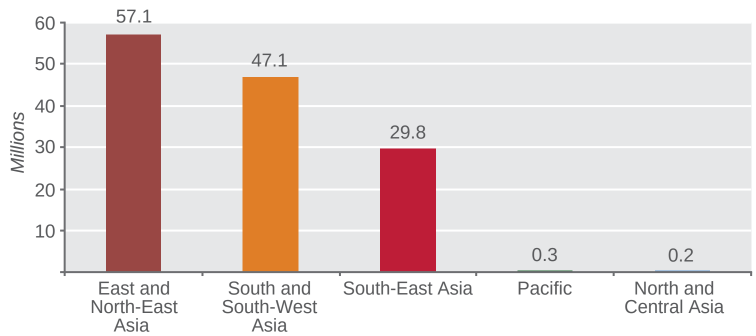
Displacement by natural disasters by region, 2008-2013



Source: ESCAP based on data from IDMC, 2014.

FIGURE I-22

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



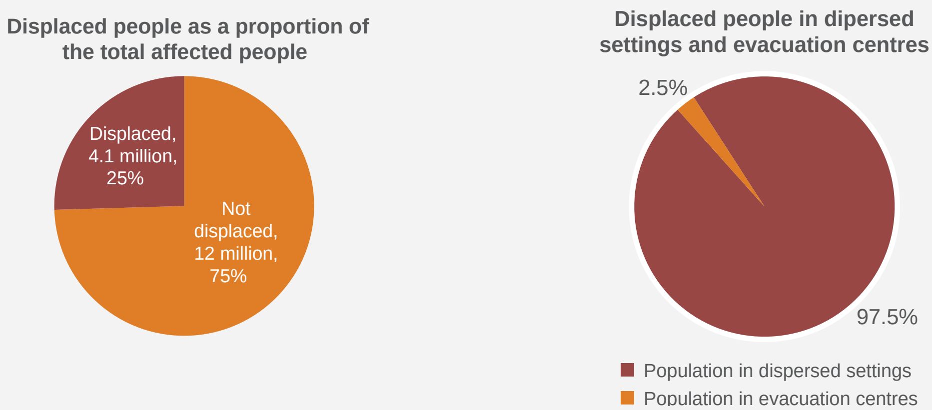
Source: ESCAP based on data from IDMC, 2014.

BOX I-8

Typhoon Haiyan (Yolanda)

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

Typhoon Haiyan displacement, Philippines 2013



Source: ESCAP based on Philippines, NDRRMC, 2014.

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

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

Social protection

One source of defence for the most vulnerable against disasters would be stronger systems of social protection.[95] At present across Asia and the Pacific these are limited – 60 per cent of the population are not covered by social protection.[96] Nor do most social programmes take into account the risks of natural disasters. A study of 124 social protection programmes in South Asia, for example, indicated that only 28 addressed disaster resilience. Typically they are small and fragmented safety nets financed by ad-hoc external resources that focus mainly on short-term emergency relief.[97]

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

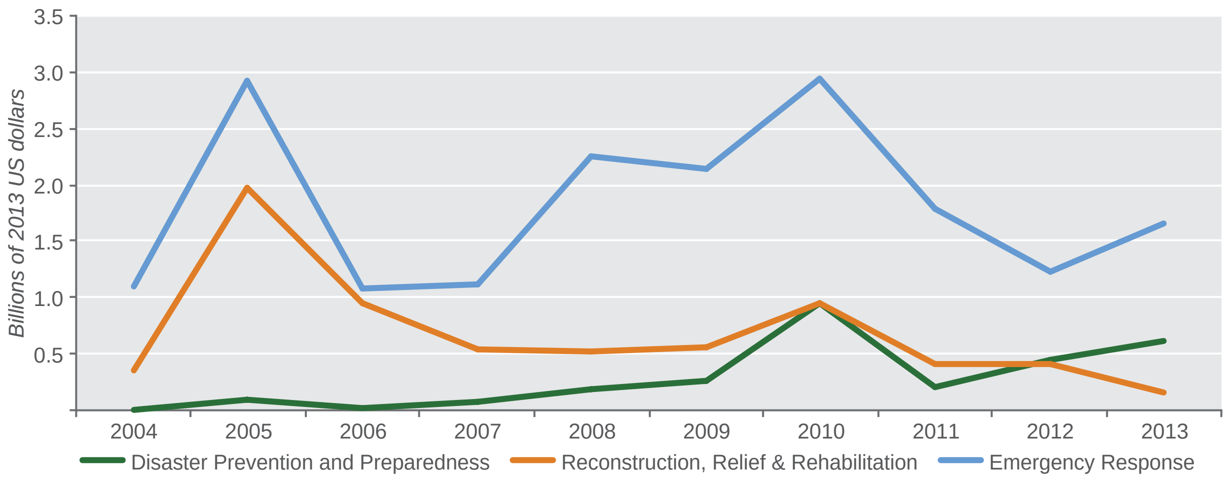
International assistance

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

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

FIGURE I-23

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



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

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

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

ENVIRONMENT AT RISK

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

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

BOX I-9

Mangrove ecosystems reduce loss of life and damage from cyclones

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

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

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

TABLE I-5

Ecosystems help mitigate disaster hazards

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

Source: PEDRR, 2010.

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

Ecosystem degradation

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

TABLE I-6

Land degradation classes in Asia and the Pacific, by country

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

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

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

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

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

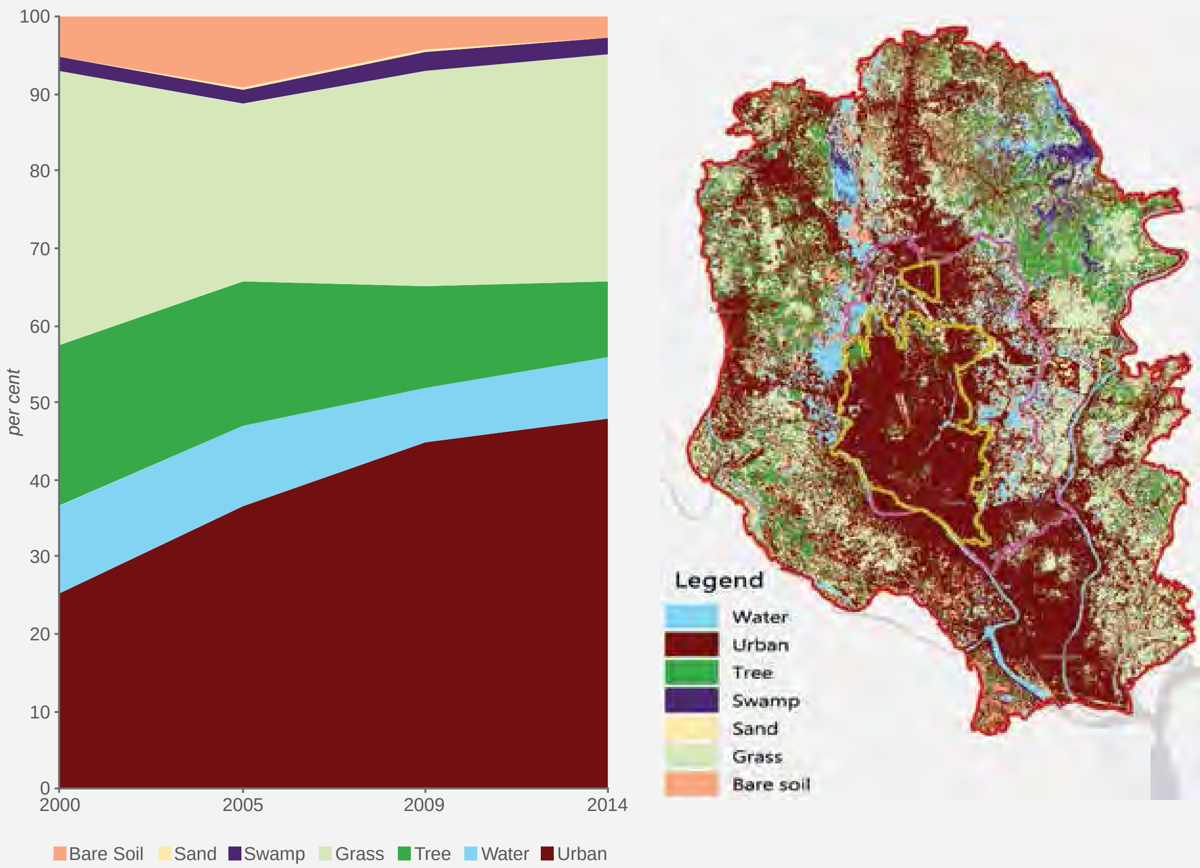
Degraded ecosystems can exacerbate the impact of natural hazards – affecting their magnitude, frequency, and timing. For example, in Pakistan deforestation has increased the susceptibility to floods and landslides during heavy rainfall.[111] Over time, such degradation steadily increases the risk. This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

BOX I-10

Ecosystem degradation and the accumulation of risk in Dhaka, Bangladesh

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

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



Source: ESCAP based on USGS database.

Disasters and climate change further degrade weakened ecosystems

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

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

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

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

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

BUILDING GREATER RESILIENCE

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

Nevertheless, over the last 10 years, countries in Asia and the Pacific have not made sufficient progress in building resilience.[118] This can be due to budget constraints, or lack of information or of political will. But there can also be limitations in human perception of risk – myopic behaviour in gauging unforeseen risks, as well as a tendency to overestimate the probability of unlikely events, and underestimate the probability of common ones.[119] Moreover when assessing risk and vulnerability there is a lack of standardized data, methodologies and tools. Although more countries now have disaster risk reduction policies and legislation, many have yet to incorporate these into development policies, planning, programmes and projects.[120]

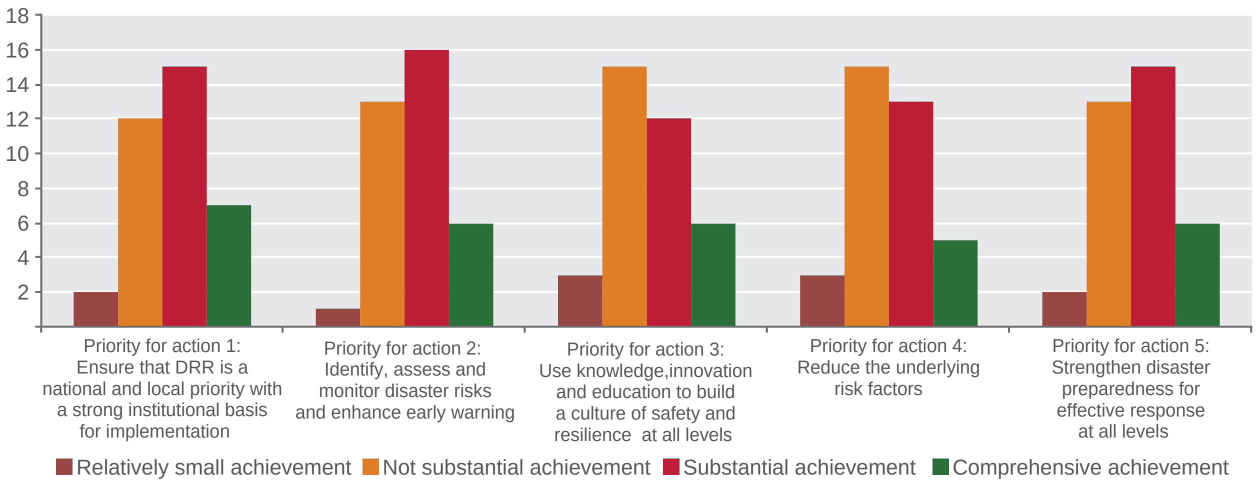
Some countries have increased their budget allocations for disaster risk reduction. Notably, in 2013 Mongolia spent 1 per cent of the government budget on disaster management,[121] and between 2006 and 2012 Indonesia increased investment in disaster risk reduction from about 0.4 per cent of the government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

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

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

FIGURE I-24

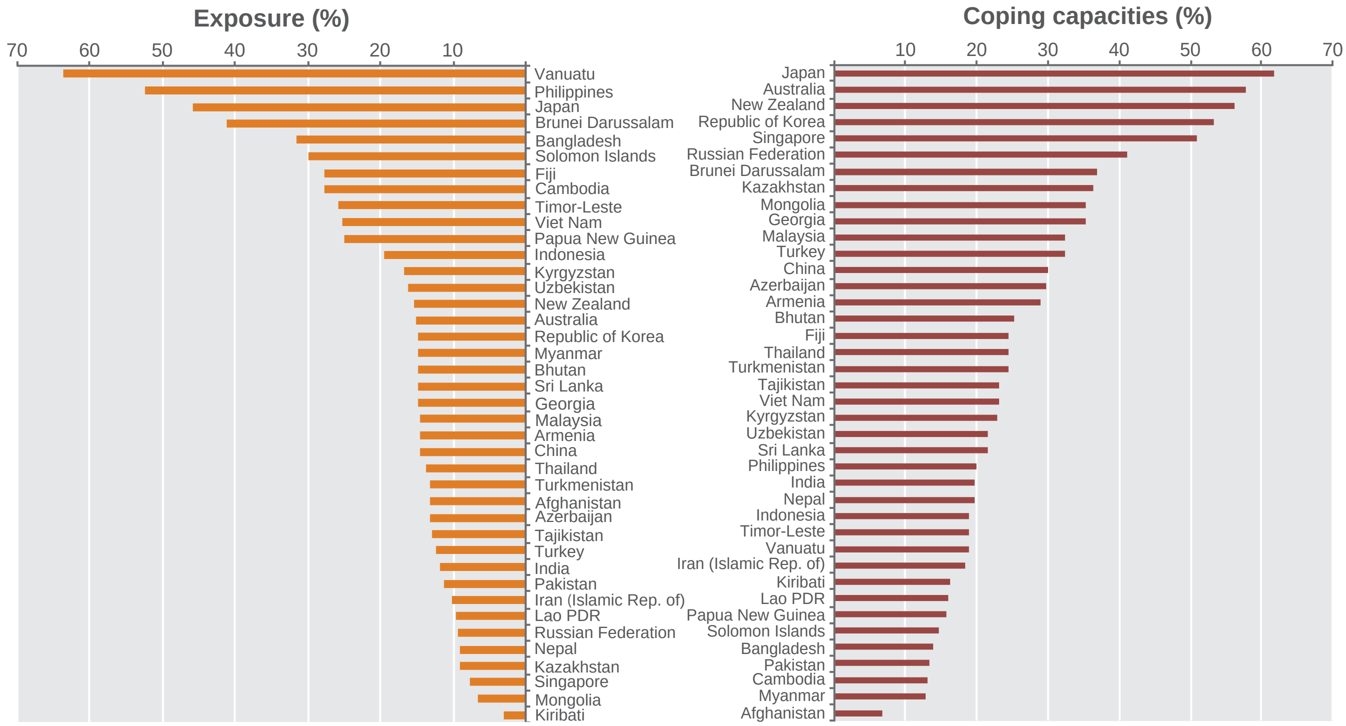
Asia-Pacific performance in the five HFA priorities for action, 2011-2013



Source: ESCAP based on UNISDR, 2013e.

FIGURE I-25

Exposure and coping capacities in Asia and the Pacific



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

BOX I-11

Building resilience in Gujarat, India

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

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

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

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

THE UNFINISHED AGENDA

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

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

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

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

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

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

ENDNOTES

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

2 ESCAP, 2013a.

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

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

5 ESCAP, 2013a.

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

7 UNDP, 2015b.

8 Myanmar and others, 2008.

9 ESCAP, 2015f.

10 Mahr and Sharma, 2015.

11 Samoa, 2013. In current US dollars.

12 Fiji, 2013. In current US dollars.

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

14 ESCAP, 2015f.

15 Nepal, 2015; Vanuatu, 2015a

16 Vanuatu, 2015a.

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

18 Vanuatu, 2015a and UNDP, 2015a.

19 OCHA, 2015b.

20 Vanuatu, 2015a.

21 USGS, 2015.

22 Local newspapers from India, China and Bangladesh.

23 Nepal, 2015. In current US dollars.

24 Nepal, 2015.

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

26 ESCAP, 2015b.

27 ESCAP, 2015b. In current US dollars.

28 ICIMOD, 2010.

29 ICIMOD, 2011.

30 Floodlist, 2015.

31 UNISDR, 2015b.

32 UNISDR, 2015b.

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

34 The Guardian, 2015b.

35 UNISDR, 2015b.

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

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

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

39 Lao PDR, 2009.

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

41 Nepal, 2015.

42 Hsiang and Jina, 2014.

43 ESCAP, 2013a.

44 ESCAP et al., 2015.

45 ESCAP and ADPC, 2014.

46 Ballesteros and Domingo, 2015.

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

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

49 New Zealand, 2013.

50 The Guardian, 2011.

51 Ono, 2014.

52 Ye and Abe, 2012.

53 Ye and Abe, 2012.

54 Ye and Abe, 2012.

55 ESCAP, 2013a.

56 DPNet, (n.d.)

57 Lao PDR, 2011.

58 Nepal, 2015.

59 Fiji, 2013.

60 Solomon Islands, 2014. In current US dollars.

61 PwC, 2013.

62 Palliyaguru and others, 2007.

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

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

65 UN-DESA, 2014.

66 World Bank, 2010a.

67 World Bank, 2012a.

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

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

70 Pelling, 2007.

71 UNDP, 2013a.

72 UN-HABITAT, 2007.

73 Philippines, NDRRMC, 2014.

74 ESCAP, 2014b.

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

76 Del Ninno and others, 2001.

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

78 UNISDR, 2011a.

79 ODI, 2013.

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

81 ESCAP, 2015f.

82 HelpAge International, 2013.

83 World Bank, 2015b.

84 Jia and others, 2010; Hoffman, 2009.

85 ESCAP, 2012.

86 ESCAP and others, 2014.

87 UNISDR, 2013f.

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

89 Philippines, 2014; OCHA, 2014b.

[90] Philippines, NDRRMC, 2014.

[91] OCHA, 2014b.

[92] Philippines and others, 2014.

[93] OCHA, 2014a.

[94] UNISDR, 2015b.

[95] ESCAP, 2013b.

[96] ESCAP, 2014b.

[97] Davies and others, 2013.

[98] World Bank, 2013a.

[99] World Bank, 2015b.

[100] Refugees International, 2010.

[101] Amnesty International, 2015.

[102] UNU, 2013.

[103] UNEP, 2014.

[104] Venkataramakrishnan, 2014.

[105] Nayak, 2009.

[106] Badola and Hussain, 2005.

[107] Das and Vincent, 2009.

[108] UNU, 2013.

[109] Millennium Ecosystem Assessment, 2005.

[110] FAO, 2011b.

[111] IUCN, 2006.

[112] Global Coral Reef Monitoring Network, 2006.

[113] IPCC, 2012.

[114] IPCC, 2014.

[115] Mimura, 2013.

[116] World Bank, 2011b.

[117] Hallegatte, 2012.

[118] UNISDR, 2015b

[119] ESCAP, 2013a.

[120] UNISDR, 2013e.

[121] Mongolia, 2015.

[122] Darwanto, 2012.

[123] India, GSDMA, 2002.

UN PHOTO/MUKHOPADHYAY SOMENATH

2

DROUGHT – THE FORGOTTEN DISASTER

CHAPTER 2 DROUGHT – THE FORGOTTEN DISASTER

"Before when we planted corn, it rained regularly.
Now, there isn't enough rain so we have to water and so it costs more money."

Farmer, Dak Lak, Viet Nam[1]

Drought is one of the region's most devastating natural disasters. But it is a slow and silent killer, and therefore often forgotten. Compared with earthquakes, tsunamis, typhoons and floods, drought is a gradual phenomenon – and the devastation it causes is indirect, by steadily reducing supplies of water and food. Combatting drought requires constant vigilance, combining high-tech monitoring with local information and knowledge – and determined efforts to protect ecosystems and livelihoods.

In the early part of the 20th century, millions of people in Asia and the Pacific died from drought and billions more were affected. Since 1970, across Asia and the Pacific drought has claimed far fewer lives at 5,700 people, but has still affected more than 1.6 billion people and cost more than $53 billion in damage.[2] But these are likely to be underestimates. The impacts of drought are difficult to delineate: a drought can reach over vast areas of land, often crossing country borders. It can also be hard to determine when it starts and finishes, and since the damage is indirect it is thus difficult to capture the full costs.

In Asia and the Pacific drought can take on distinctive forms. Elsewhere in the world, drought is typically experienced as a long period of low rainfall, resulting in dry, cracked earth, severe crop loss, dying livestock and famine. Asia and the Pacific has similar disasters but it also has different, shorter forms – during severe winters, for example, or even during monsoons. For these reasons, and because drought appears less dramatic, the impacts are generally not well recorded and receive less attention from the media, policymakers and politicians.

Drought has significant impacts on many sectors, including fish and aquaculture, forestry, and industry. This chapter focuses, however, on agricultural drought – when there is not enough soil moisture to support crop production or fodder for livestock. Asia and the Pacific is a very diverse region, and each country experiences agricultural drought in different ways. In general however, there are four main types of drought:

- *Prolonged periods of low rainfall* – Less than the long-term average rainfall. This is prevalent in semi-arid and arid regions and countries such as Australia, India, parts of China, the Islamic Republic of Iran, and countries of Central Asia, though also in some small island developing States.
- *Irregularities in the monsoon season* – A late start or early finish to the monsoon period, or a dry spell at a key time of the monsoon cropping season. This can have a devastating impact on agriculture. Most countries of South and South-East Asia are affected by this type

of drought. Since these events may be brief and localized, they often go unrecorded, even though they may occur annually.
- *Reduced snowmelt or glacial runoff* – A number of countries rely heavily on water from mountain glaciers and snowmelt. A year with limited snow will affect water resources later during the growing season. This affects Afghanistan, parts of China and India and countries in Central and South Asia.
- *Winter drought and dzud* – A *dzud* is a combination of events leading to inadequate pasture or fodder for livestock. This might, for example, result from a summer drought followed by a severe winter with heavy snow and low temperatures. Mongolia is particularly exposed. Other countries can also suffer during the winter from unusually low precipitation or low temperatures that damage winter crops.

Individual countries can also experience multiple types of drought. They might, for example, have an unpredictable monsoon season followed by a winter with below average precipitation. Likewise, countries can experience multiple disasters in different regions at the same time, such as flooding in one and drought in another.

DROUGHT AND DEVELOPMENT

Around four-fifths of the economic impact of drought is absorbed by agriculture.[3] It is thus of particular significance in Asia and the Pacific where many people – particularly in the poorest countries – still rely heavily on agriculture for their livelihoods. In 2014, employment in agriculture as a proportion of total employment in middle- and high-income countries was 12 per cent, but in the low and middle-income countries it was 50 per cent. The pattern is similar for agriculture's contribution to the economy. In 2014, for high- and upper-middle-income countries, agriculture generated 17 per cent of the value added to GDP, while for lower-middle-income countries it generated 40 per cent.[4]

A prolonged drought will slow down income growth not just in agriculture, but also in related activities, particularly agro-processing, with knock-on effects for employment and incomes in other parts of the rural economy. The impact is greatest on poor farmers. In rural Andhra Pradesh in India, one study found that drought was the single most important factor in pushing people into poverty.[5]

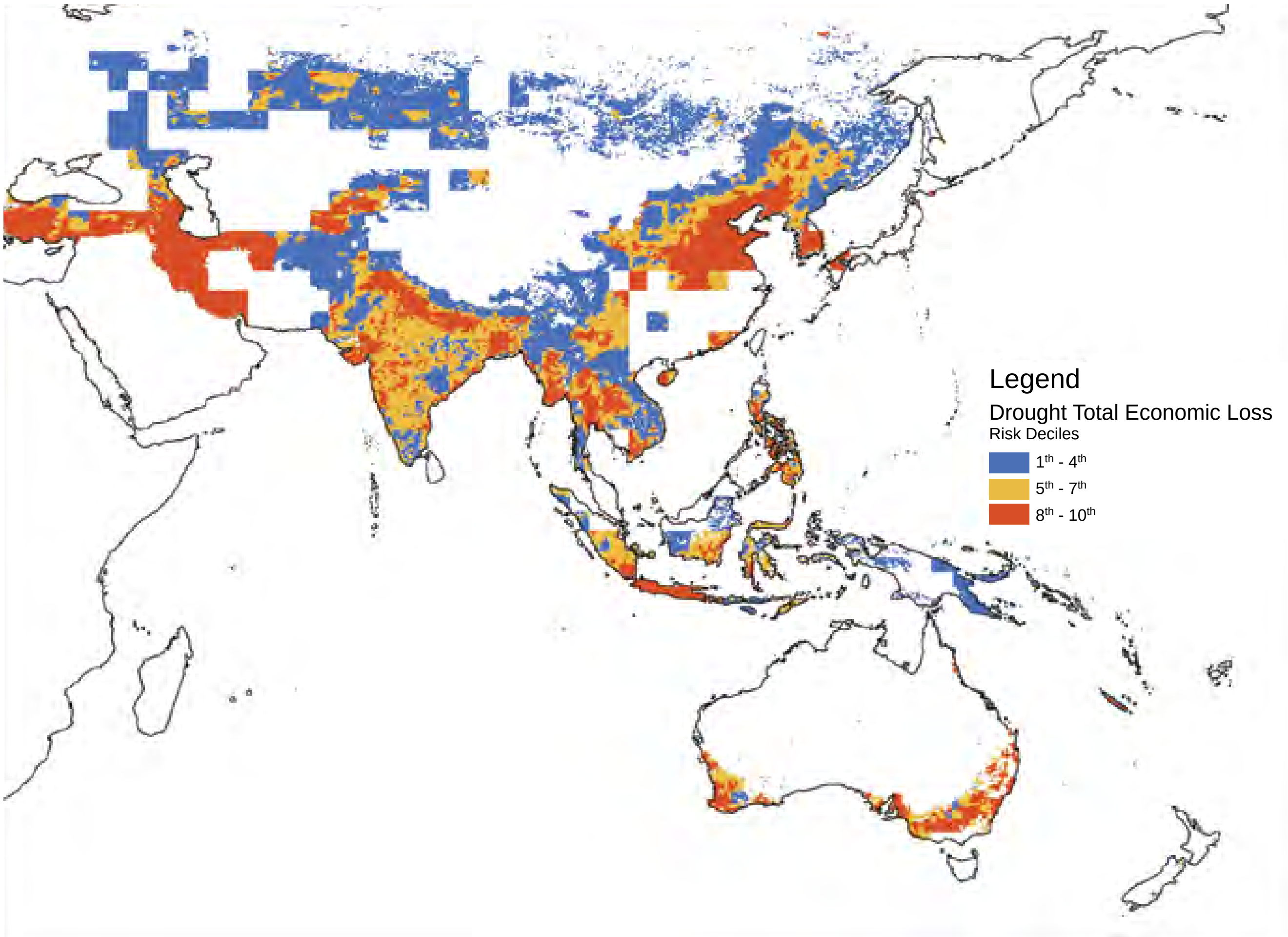
Though it is difficult to determine exact estimates of economic loss from drought, some efforts to map the risk of economic loss across the region have been made as shown in Figure II-1.

A study in three states in eastern India, for example, covering the period 1970-2002 found that in drought years farmers' incomes fell by around one-quarter (Figure II-2). In these states in a drought year almost 13 million additional people fell back into poverty which would translate at the national level to an increase in the rural poverty rate of 1.8 percentage points.[6] Part of the increase in poverty may be transitory, with some households being able to escape from poverty on their own. But other households whose incomes and assets fall below certain thresholds may end up joining the ranks of the chronically poor.[7]

The same study also considered the impact in north-eastern Thailand and southern China, though here the impact was less, because these areas have more diversified crops and livelihoods; as well as cultivating rice, farmers also grow

FIGURE II-1

Economic losses from drought



Source: World Bank, 2005.

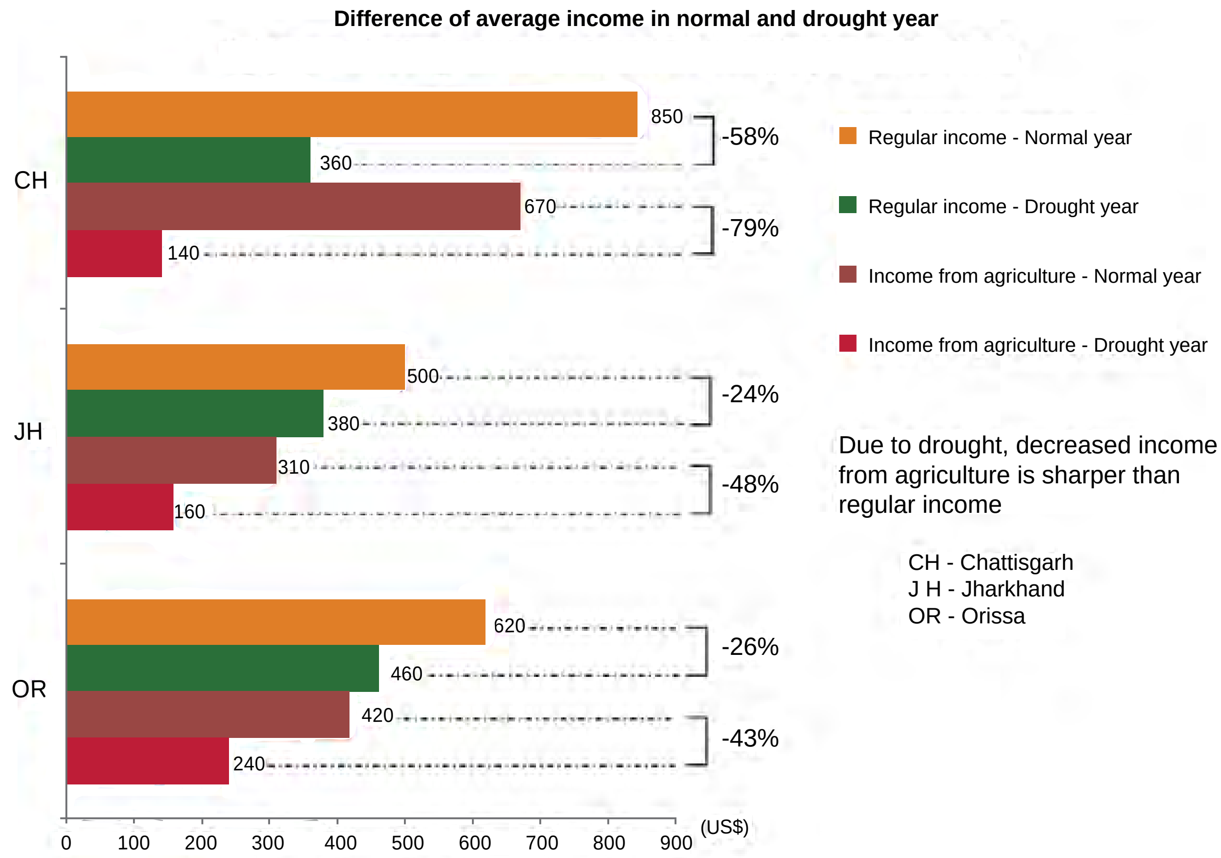
Notes: The economic risk ranges from 1-10, with 10 as the highest risk. By weighting the value of GDP exposure to drought for each grid cell by a vulnerability coefficient, it is possible to obtain an estimate of drought risk. This estimate of the drought risk can then serve as proxy for economic losses as a proportion of GDP per area. The vulnerability weights are based on historical economic losses recorded in previous disasters. The economic loss risks are then applied to GDP per unit area exposure. The weights are an aggregate index relative to losses within each region and according to the country's wealth classes over a 20-year period from 1981-2000 (classifications based on 2000 GDP).

commercial field crops that are less sensitive to drought, and in addition have more non-farm income.

Farming communities hit by drought respond in different ways. Some may be able to absorb the impact by migrating, or drawing on savings. But the poorest may resort to 'erosive' coping mechanisms, such as removing children from school, taking high-interest loans, or selling off income-generating assets (Table II-1).[8] In some cases farmers driven into debt have committed suicide.[9]

FIGURE II-2

Income loss due to a drought year in eastern India



Source: IFAD, 2009.

TABLE II-1

Major drought coping mechanisms of farm households – China, India, Thailand

Drought coping strategies	Southern China	Eastern India	North-eastern Thailand
Migration	+	++	+
Asset sale			
Livestock	0	++	+
Land	0	+	0
Borrowing	0	++	+
Consumption decline	0	+	0
Expenditure on social functions, medical treatment, and children's education	0	-	0
Use of cash and in-kind savings	+	+	+
Use of social network	+	++	+
Employment through food-for-work programme	0	+	0
Artificial rainmaking	+	n.a.	+

Source: IFAD, 2009.

Key: - Indicates a decrease, + indicates an increase, and 0 indicates no change. Double signs indicate larger change, while a single sign indicates marginal change; 'n.a.' indicates 'not applicable'.

WATER AND LAND MANAGEMENT

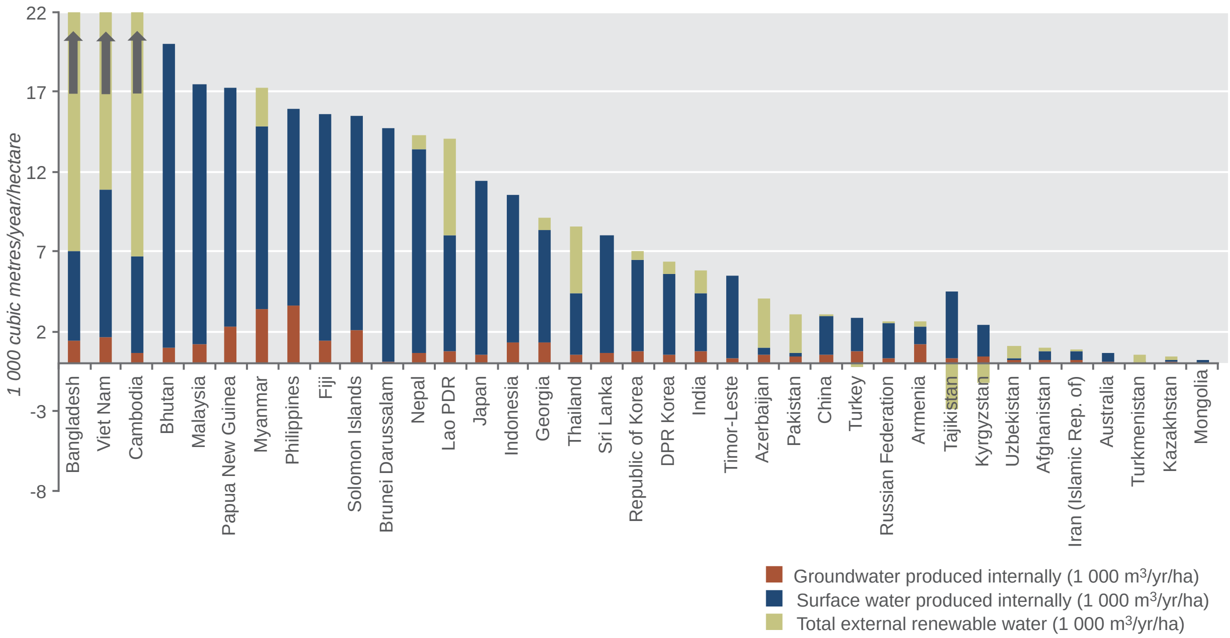
Currently around one-third of the land in Asia and the Pacific is used for agriculture – a proportion that has remained steady and is unlikely to increase since the region is already reaching its limit of available arable land.[10] Any restrictions in the available land and water have implications for food security, as it is estimated that food production will need to increase 50 per cent by 2030 and 70 per cent by 2050.[11] Drought significantly affects crop yield: estimates from India, for example, indicate that while floods reduce agricultural production on an annual average basis by 5 per cent, droughts reduce it by 12 per cent.[12]

There are three primary sources of freshwater – precipitation such as rain and snow, runoff from melting glaciers and snow, and groundwater. Figure II-3 shows the availability and source of freshwater by country as a function of the land area.[13] Consumption of freshwater for agriculture ranges from 60 per cent to more than 95 per cent in the majority of countries of Asia and the Pacific, with many countries in South, South-East and Central Asia using more than 90 per cent.[14]

Some agricultural products require more water than others, with agricultural products such as beef, rubber, cotton and biofuels using much more than other products. Livestock production in particular is very water intensive and accounts for around eight per cent of global freshwater use.[15] Several countries reliant on agriculture are relatively dry however, and therefore need strong water management strategies, particularly if water-intensive products are grown.

FIGURE II-3

Water resources by source



Source: Based on data from FAOSTAT. Available from http://faostat3.fao.org/home/E (accessed on 15 August, 2015).

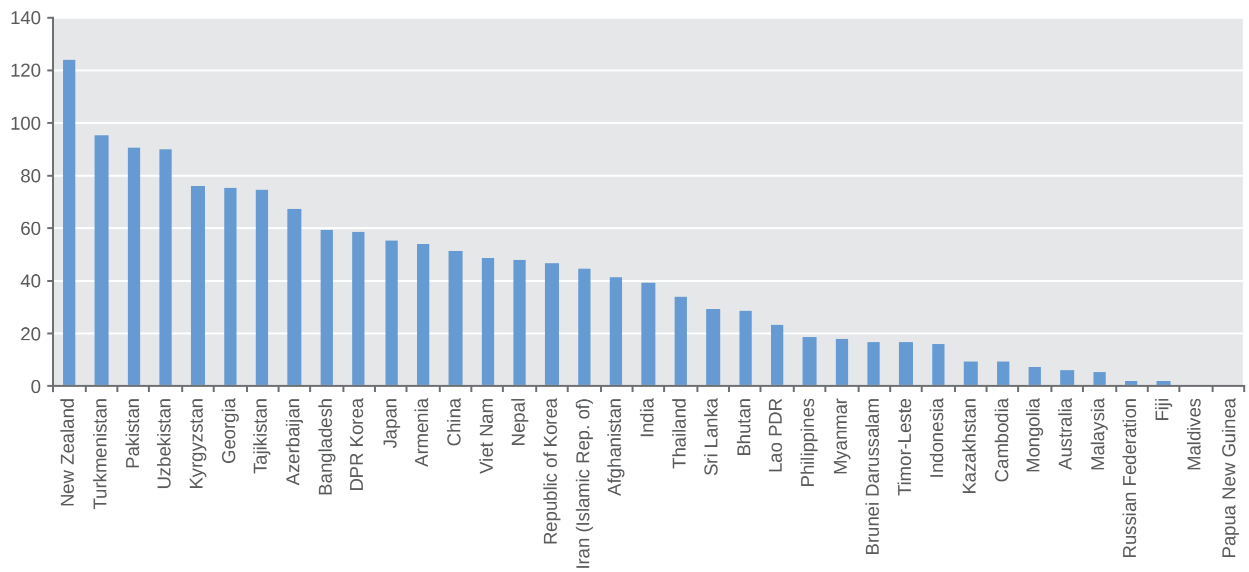
In some catchments, more water is withdrawn from sources, such as groundwater, than is replenished.[16] Water availability can also be reduced by pollution from seawater or other contaminants. This highlights the importance of water resource management which will vary from one area to another depending on how the land is managed, the type of agricultural activity, the climate and seasonal weather patterns.

Some areas can be protected from drought by irrigation, however irrigation systems in many of the region's agrarian countries are not very extensive or have fallen into disrepair. Figure II-4 shows that many countries reliant on agriculture have limited irrigation and those without generally rely on rainfall. This applies particularly to countries with regular monsoon seasons or many small island developing States, which are therefore very sensitive to irregular weather patterns.

Shortages in precipitation, combined with changes in evapotranspiration, and reduced groundwater quality and levels, can create stress and problems for crops. Drought is particularly damaging when the soil is already degraded due to the loss of soil resilience. Poor quality soils, which are less able to retain water and have less moisture available for crops, require more rainfall to produce a reasonable yield. Drought then further damages the structure, changing the composition of vegetation, or allowing noxious or poisonous species to encroach on grazing land. In the most extreme cases this leads to desertification.[17] A reduction in vegetative cover can then make the climate even drier, sustaining a downward spiral. Across Asia and the Pacific around 1,400 million hectares of land are affected by desertification – more than any other region in the world.[18]

FIGURE II-4

Percentage of cultivated area equipped for irrigation



Source: Based on data from FAOSTAT. Available from http://faostat3.fao.org/home/E (accessed on 21 August, 2015).

Since the 1970s, the land area affected by drought globally has doubled, eroding development gains and exacerbating poverty among the millions of people who depend directly on the land as a source of livelihood.[19] In South and South-East Asia, around 74 per cent of agricultural land has been severely affected by wind or water erosion, or polluted to the extent that it is no longer productive.[20] This makes it difficult to sustain development in rural areas.

El Niño

Exacerbating all of these water and land management factors is the potential impact of El Niño cycles, which in some countries increase the likelihood of drought. Scientists predicted a serious El Nino event for 2015 in Asia and the Pacific, and the tropical Pacific Ocean is already experiencing moderate El Niño levels.[21] In some parts of the region the effects can be beneficial, for example for commercial forestry, particularly in South Asia. But in many parts of Asia El Niño leads to higher temperatures and fewer rainy days which reduce the production of rice, maize and wheat.

ESCAP and the Regional Integrated Multi-hazard Early Warning System (RIMES) have assessed the likely effects in 2015 on key sectors of high-risk Pacific island countries. The strongest precipitation will be in South-East Asia and parts of the Pacific, especially in the dry season. Papua New Guinea, which is very exposed because they normally have very low dry-season rainfall, is already experiencing the impact, with more than 2.4 million people affected and dozens killed by drought.[22] In the wet season reduced rainfall could have significant impacts in the Central and Southern islands of the Pacific that depend on subsistence agriculture (Box II-1).

Climate change

It is difficult to establish a direct relationship between drought and climate change due to a lack of direct drought observations and geographical inconsistencies in monitoring drought trends. Nevertheless, climate change seems likely to increase drought risk. Compared with any preceding decade since 1850, each of the last three decades has been successively warmer at the Earth's surface. This has many implications for weather and water resources. Glaciers, for example, are an important source of water for many countries, and are already retreating at an alarming rate, and the Northern Hemisphere has seen a reduction in spring snow cover. In addition there have been changes in the patterns of extreme climate events.[23]

Increased temperatures could result in changes to precipitation patterns, earlier snowmelt, and increased evapotranspiration, which could increase the risk of hydrological and agricultural drought. There are also likely to be more frequent heat waves – which can affect agricultural production by adding stress to livestock and some crops, in turn requiring more water. A number of countries are also likely to be affected by irregular climate patterns, such as changes in the start or finish of the monsoon season.[24]

Many countries are already trying to adapt to climate change. One of the largest adaptation funds in the world is the Pilot Program for Climate Resilience. This demonstrates ways in which climate risk and resilience may be integrated into core development planning and implementation. The programme provides grants and concessional financing to a small number of countries for a wide range of activities, such as improving agricultural practices and building food security.

BOX II-1

Weather disturbances during El Niño

The Royal Meteorological Society of the Netherlands computed how El Niño perturbed the average weather over the last century.[25] This is indicated in the maps below. Blue circles indicate that during El Niño there was, on average, more rain than normal, while red circles indicate drought. From March to May the strongest effects were in the Western Pacific Ocean: along the equator rainfall increased, while at latitudes 10°-15°, North and South, rainfall decreased (Figure A). From June to August, eastern Indonesia often suffered droughts (Figure B). The rain zone moved east to the islands along the equator. The Indian monsoon was often weaker during El Niño.

Figure A: El Niño and La Niña over the last century for March-May

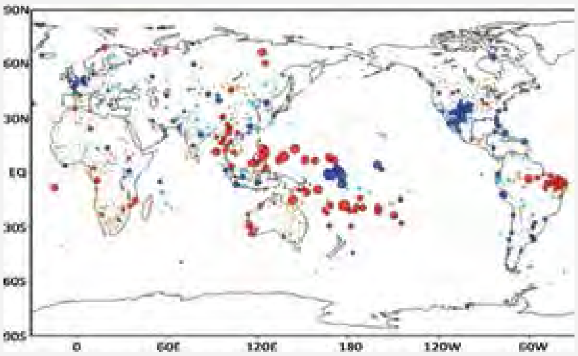
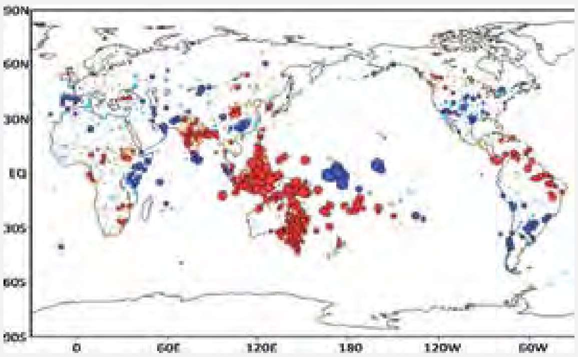
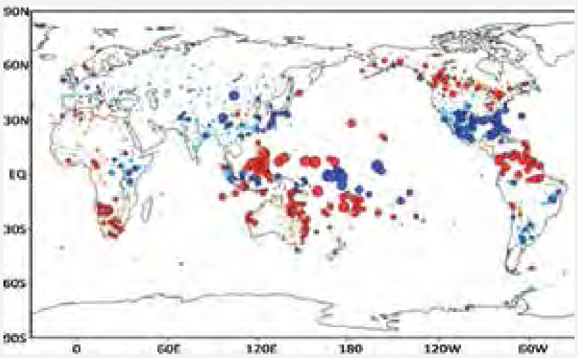


Figure B: El Niño and La Niña over the last century for June-August



From December to February, the Philippines and east Indonesia stayed drier, whereas the Pacific islands along the equator remained wetter (Figure C).

Figure C: El Niño and La Niña over the last century for December-February



Source: KNMI, 2014.

CHAPTER 2

REGIONAL DROUGHT MECHANISM

Signs of drought can be observed from space long before they are visible on the ground to the human eye. This satellite-based perspective would be useful for farmers: with suitable warnings they can take appropriate action, perhaps sourcing more water, or switching to crops that are more drought-resistant.

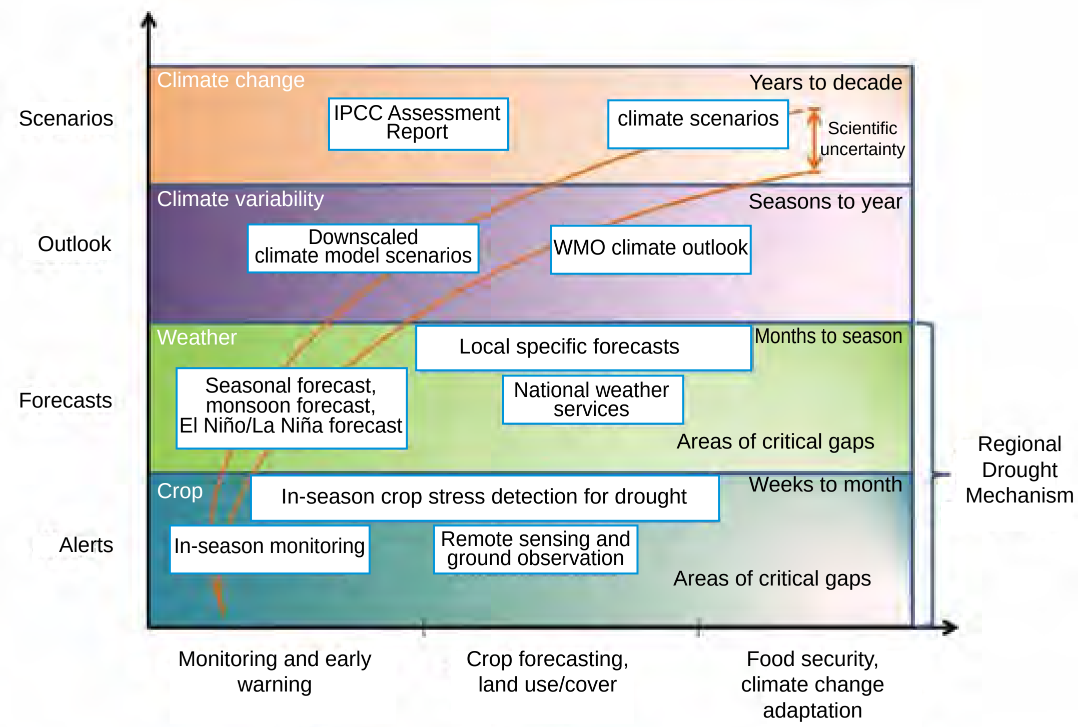
Some efforts have already been made to allow access to these tools and information, such as the Agriculture Stress Index System which detects agricultural areas with a high likelihood of water stress.[26] Many countries, however, do not have the institutional capacity to integrate these high-end knowledge products into their operational drought monitoring and early warning systems: they may be unable to set up the system, or to access or interpret the data.

A further obstacle to effective implementation is a lack of inter-agency cooperation – for sharing the information, or presenting it in ways that can be understood and used.

For this reason, ESCAP has established the Regional Drought Mechanism. This takes advantage of data and imagery from the region's spacefaring countries – such as, China, India, Japan, Thailand and others – and shares it with other countries, especially those perennially prone to drought. This service complements WMO's Global Framework for Climate Services by providing more detailed, localized forecasts and monitoring that can be updated during the growing season. The aim is to give a comprehensive real-time drought monitoring and early warning system and to seamlessly link long-term climate scenarios with the seasonal climate outlooks (Figure II-5). Countries can

FIGURE II-5

ESCAP Regional Drought Mechanism - Global Framework for Climate Services



use this for monitoring in-season crop stress and issuing timely alerts on the onset of agricultural drought over large areas – allowing mid-course corrections and measures for drought mitigation. The mechanism also develops partnerships, and works with national governments to clarify and build the institutional network required to ensure the early warning services reach the right people.

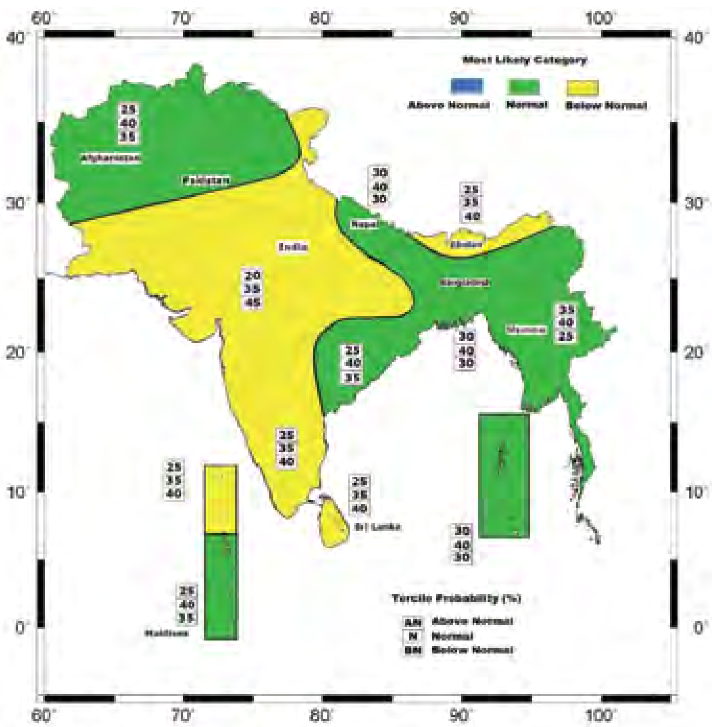
Currently, the Regional Drought Mechanism has two service nodes. Based in China and India, these provide space-based data, products, and capacity. On request, experts from these nodes and ESCAP work with member States to determine the most appropriate services, build their capacity to process and interpret the information, and disseminate the data to people that need it most.

The Regional Drought Mechanism was piloted for Sri Lanka in 2014. The pilot started with data from the WMO Regional Climate Outlook Forums and the outlook for the summer monsoon rainfall for South Asia in 2014 (Figure II-6) – which indicated an El Niño-associated drought. As a part of the drought mechanism, ESCAP and RIMES highlighted the consequent drought risk at regional, subregional and national levels, along with the potential impacts in various sectors.[27]

In addition to the seasonal outlooks, satellite data was used to determine the stress on vegetation during the growing season, indicating drought impacts. Indicators of vegetation stress (for example NDVI anomalies) were analysed for a drought year (2012) and a normal year (2005)

FIGURE II-6

Climate outlook reported for the summer monsoon in South Asia, 2014



Source: Fifth Session of South Asian Climate Outlook Forum, 2014.

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 validated through stakeholder consultations. These NDVI anomaly indicators were found to be closely linked with in-season drought conditions (Figure II-7).

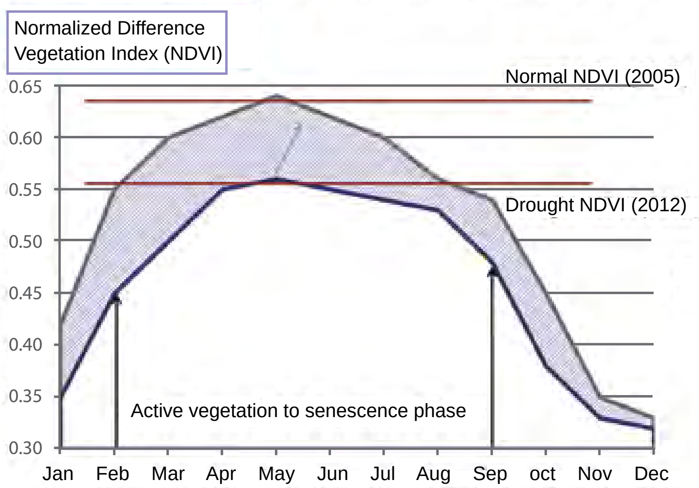
Using NDVI anomalies, Sri Lanka analysed the agricultural drought during the growing season in 2014 by comparing the degree of difference from the baseline drought year (2012) and the normal year (2005) (Figure II-8). The red areas indicate the extent to which there was less cover in 2014, and the green areas show where there was more. Analysis of this can also serve as a baseline for long-term strategies on drought mitigation, climate change adaptation and food security.

Another exercise was carried out in Mongolia. In this case the country worked with the regional service node in China. The aim was to investigate the *dzud* – drought leading to inadequate pasture or fodder, followed by a severe winter that kills much of the livestock. For this purpose, Mongolia used space and ground-based indicators such as forest cover, and the condition of the steppe and desert steppe. Figure II-9 shows a synthesis of various indices – offering an important baseline for developing a *dzud* early warning system. Other countries currently participating in the Regional Drought Mechanism include Afghanistan, Cambodia, Kyrgyzstan, Myanmar and Nepal.

The Regional Drought Mechanism is also seeking to collaborate with similar initiatives globally. These include the Group on Earth Observations for Global Agricultural Monitoring (GEOGLAM) launched in 2011 by the G20 countries. This partnership would be mutually beneficial: the mechanism would gain access to a broad range of specialized GEO data and products, while GEOGLAM would have another outlet for its forecasts. Both initiatives build on existing agricultural monitoring programmes and strengthen them through international networking, operationally focused research, and data and method sharing. Another important initiative is the Asia Rice Crop Estimation & Monitoring programme which would be strengthened by working with the Regional Drought Mechanism.

FIGURE II-7

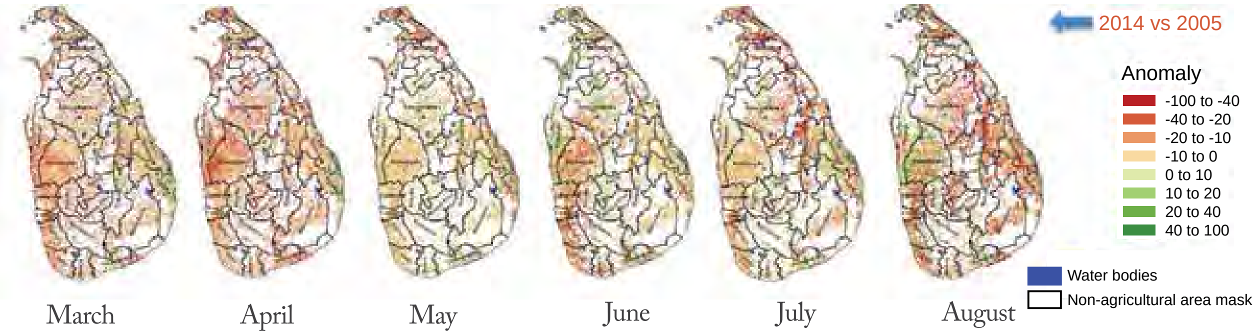
Vegetation index-based drought assessment, Sri Lanka, 2014



Notes: The normalized difference vegetation index (NVDI) is a measure of vegetation cover ('normalization' is required when combining different images to take into account differences in the sun's elevation).

FIGURE II-8

NDVI anomaly (vegetation stress) of Sri Lanka



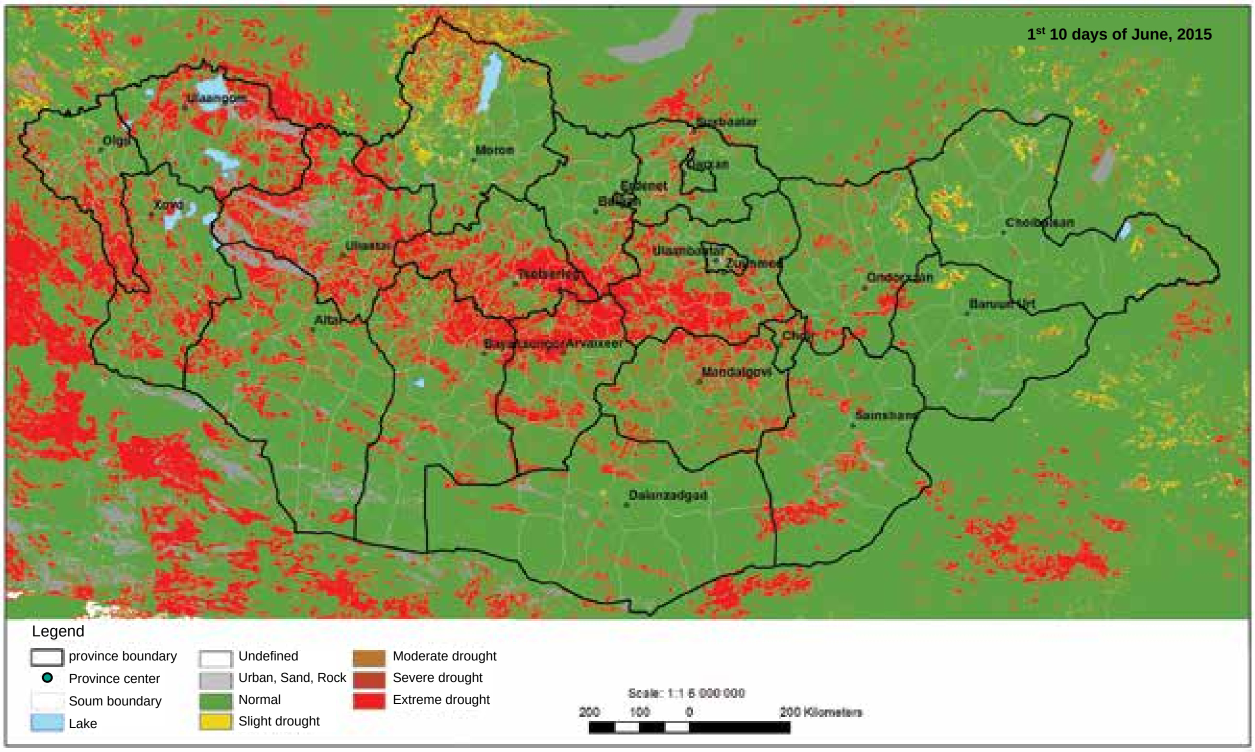
Notes: Year 2014 is compared to 2005 (normal year) and 2012 (drought year). The red areas signal high levels of vegetation stress.

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

Mongolia is particularly prone to *dzud* - a combination of drought and severe winter events leading to a lack of food for livestock.

FIGURE II-9

Drought in Mongolia



Source: Mongolia, 2015.

Notes: This map is based on a composite of various indices, including the normalized difference drought index, the vegetation supply water index, and the thermal condition index.

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

BUILDING RESILIENCE TO DROUGHT

For drought, as for other disasters, building resilience requires a full disaster management cycle approach: mitigation and adaptation to minimize the risk; preparedness to respond as necessary; relief to assist those in need; and investment in long-term recovery. In the case of drought this is usually complicated by the multiple institutions involved – for example, ministries concerned with agriculture, water management, land management, disaster response, and planning or finance. In practice, however, most of the current activity is for response, and even that is often quite late, since droughts develop slowly and may not be noticed until they become emergencies. However, this slow onset, if recognized, also provides more time to apply additional drought management strategies compared to other rapid onset disasters.

For anticipating and mitigating the impacts of drought, there are a number of options. Governments may, for example, have a dedicated drought management policy, or they may integrate drought management under disaster management, or they may address drought under other sectoral plans, such as those for agriculture or water. Each approach has its merits, meaning that governments will need to choose those most appropriate for their national circumstances.

- *India* – In 2005, India's Disaster Management Act established the National Disaster Management Authority chaired by the Prime Minister. In 2010 in consultation with various institutions this produced the National Disaster Management Guidelines: Management of Drought. So although drought falls under a broader disaster management strategy, it is also specifically addressed in a more comprehensive manner including mitigation, preparedness and response.
- *Australia* – In 1992, the Government developed a dedicated National Drought Policy with specific programmes and initiatives supported at the state, territory and local levels. The policy identifies the principles for addressing drought in a comprehensive manner and prioritizes it separately from other disasters.
- *Kiribati* – Kiribati has integrated various elements related to drought under its National Water Resources Policy.[28] This policy recognizes the unique circumstances of many SIDS, which rely only on freshwater available from rain, or a shallow layer, or lens, resting on seawater underground. It primarily covers issues related to sound water management and conservation.
- *Thailand* – The relevant agencies for drought are the Department of Disaster Prevention and Mitigation under the Ministry of Interior, the Ministry of Agriculture and Cooperatives, and others which operate under a single command system for prevention, preparedness, response and recovery. Depending on the severity and extent of drought, different agencies are responsible for mitigation, management and relief.[29]

In the majority of countries in the region, however, drought falls under a general disaster response policy, with the emphasis predominantly on relief.

- *Nepal* – The Natural Disaster Relief Act covers drought, yet to trigger action from the Ministry of Home Affairs there needs to be a loss of life, which may not occur until conditions are severe. Response then reverts to the Ministry of Agriculture to offer relief programmes.[30]
- *Indonesia* – The country has a National Board for Disasters Management which is also focused on emergency response.[31]
- *Republic of Korea* – Drought management falls under the Framework Act on the Management of Disasters and Safety and Countermeasures Against Natural Disasters Act. Droughts are regular but generally localized so responsibility rests with local government authorities. This has advantages though there can also be difficulties in coordination, such as accessing water resources under the responsibility of another district authority.[32]

In 2013, UN-Water, a network of international and United Nations institutions involved in water-related issues, launched an Initiative on Capacity Development to Support National Drought Management Policies. This helps drought-prone countries formulate effective risk-based national policies that assist stakeholders at all levels of government.

While the approach will differ from country to country there are often common elements, as indicated in the following sections which cover eight key issues.

- Long-term risk management
- A livelihood approach
- Management of natural resources
- Multisectoral coordination
- Using science and technology
- Regional cooperation
- Agricultural insurance
- Social safety nets

Long-term risk management

Rather than relying on short-term relief and response, countries should give a greater priority to preparedness and long-term risk management – which can mitigate the effects and allow for adaptation to changing environmental conditions. If farmers know in advance that there is a strong likelihood of drought conditions, they can plant drought-resistant crops, budget water resources more carefully, or introduce water-saving techniques (Box II-2).

Australia's most recent policy reforms, for example, recognize drought as a recurring part of the country's climate and encourage farmers to prepare for and manage this risk. In addition to offering relief in times of hardship, the Government has programmes for mitigating and adapting to the risk of drought. India uses techniques of climate variability management, which encourages farmers to build reserves during favourable seasons that they can draw on in drier seasons.[33]

Risk reduction, preparedness and mitigation can include:

- *Alternative crops* – changing to crops that demand less water or varieties that are drought-resistant;
- *Early warning and improving access to data* – for strengthening seasonal forecasts and early warning systems, along with planning and risk management;
- *Knowledge and communications networks* – for transferring information from government agencies to farmers;
- *Land management* – improving information for land management and drought planning;
- *Employment* – diversifying employment or livelihoods;

BOX II-2

Watershed management in Karnataka, India

Between 2001 and 2009 the state government of Karnataka in India partnered with several NGOs and the World Bank in seven rain-fed districts to develop a successful watershed programme called Sujala.[34] This combined cutting-edge technology with bottom-up local participation. GIS mapping was used to integrate large volumes of satellite data with non-spatial data on such issues as rainfall, literacy, and demography. This formed the basis of a comprehensive action plan for each micro-watershed that communities could use to construct a small model that enabled them to see the bigger picture and the potential risks and prioritize areas to be treated.

The Sujala project helped increase crop yields by about 25 per cent, reduce soil erosion and run-off by up to 21 cubic metres per hectare, and increase the proportion of land irrigated by between 6 and 14 per cent.[35] Farmers were able to increase their incomes and diversify to other non-farm activities, with the benefits extending to women, the land less and other vulnerable groups.[36]

- *Water conservation* – improving water retention and building storage systems;
- *Improving irrigation* – introducing high-tech irrigation systems such as drips, sprinklers or spray jets or rehabilitating irrigation and drainage systems;
- *Ecosystem management* – improving land care, water quality and environmental management;
- *Land rehabilitation* – for degraded land;
- *Education* – improved education of community and farmers for changing agricultural practices (e.g. no tillage);
- *Livestock management* – migration of stock or destocking;
- *Stockpiling* – seedbanks, feedstock and water storage at a community level;
- *Zoning* – planning and zoning to restrict agricultural practices in high-risk areas, or encourage cultivation of suitable species;
- *Improve water management* – increase water storage in watersheds, reservoirs, soil, groundwater and inland fresh water bodies;
- *Migration* – arranging temporary or permanent migration;
- *Financial risk management* – strategies during good seasons to support households during drought events.

Because most of the region's poor and vulnerable people rely on agriculture it is also important to have relief options. But these schemes should be carefully targeted because recurrent relief will drain valuable resources that could be better used for other development purposes.

A livelihood approach

Drought mitigation should support poverty eradication as part of an inclusive and sustainable development programme. This should include investment in rural infrastructure and in rural education to increase farmers' capacity to cope.[37]

- *India* – The Mahatma Gandhi National Rural Employment Guarantee Act provides employment and wages while building productive assets leading to sustainable livelihood opportunities. In addition, the National Rural Livelihoods Mission under the Ministry of Rural Development provides livelihood development opportunities to poor rural families – emphasizing capacity building of self-help groups and their federations, along with financial services and training.
- *Afghanistan* – The Government has taken steps to mitigate drought, although the policies still remain in a nascent stage. One of the best options is community-based water harvesting and sustaining micro-watersheds in drought-prone areas.[38]
- *Pakistan* – The Pakistan Poverty Alleviation Fund has made significant investments in drought mitigation and preparedness. It aims to strengthen community capacities for coping with drought. It has encouraged farmers to adjust their cultivation practices – changing crops and cropping patterns – which has led to higher yields.[39]

Maintaining ecosystems

Agriculture is part of a complex ecosystem involving interactions between living organisms and the physical environment. Agricultural systems thus need to remain within the limits of these ecosystems. This should mean, for example, maintaining healthy watersheds – allowing water to return to natural ecosystems, such as forests or groundwater aquifers, so that these resources will be available for seasons and generations to come. It is also important to maintain healthy soil systems, and limit practices that can degrade soils. This will allow water to be retained and utilized in the most efficient manner and enable the ecosystem to produce acceptable yields while reducing the need for fertilizers. Maintaining biodiversity can reduce the impact of pests and disease that can devastate a single crop – as well as reducing the need for pesticides.

Farmers are the custodians of the land and it is in their family's best interest to maintain these resources within acceptable limits. In Asia and the Pacific, they have been tackling uncertain climate conditions and drought for centuries. One example is the *wewa* water basins of Sri Lanka, some of which are 2,000 years old and still in use. This ancient system, which covers nearly 80 per cent of the country, consists of hydrologically interconnected man-made reservoirs, one below the other. This cascade model not only reuses water but also controls both floods and droughts in the dry and intermediate zones.

Farmers who have experience in adapting to changing environmental conditions can also advise policymakers on how best to support their livelihoods. A survey of seven Asian countries – Bangladesh, China, India, Indonesia, Nepal, Pakistan and Viet Nam – found that in some countries, almost a half of the respondents were concerned about changes to the environment. Many farmers were already rotating crops or planting different ones but only a few felt informed about what they could do to cope with these changes.[40]

A number of countries emphasize the importance of involving farmers in ecosystem management.

- *Australia* – The 1992 National Drought Policy recognizes the role of farmers in national resource management, the importance

UN PHOTO/MARTINE PERRET

of maintaining and supporting the natural resource base during drought and climate change, and the need to enhance long-term sustainability and resilience.

- *India* – India has taken a watershed development approach to agricultural production and has been improving and reforesting ten million hectares of degraded land in an effort to restore important watersheds and their ecosystem services.[41] These programmes were established under India's National Disaster Management Guidelines: Management of Drought, and include a participatory approach, including ecosystem-based and technical interventions as well as economic and social support – for example, women's self-help development and capacity building. A number of market and non-market benefits have been identified (Box II-3).
- *Turkey* – The agricultural policy includes a basin-based support programme that provides incentives for growing crops in areas that have the most suitable ecological conditions.[42]
- *Viet Nam* – Considerable work has been undertaken to reforest around five million hectares of land to protect and regulate water resources and watersheds.
- *Russian Federation* – Conservation-based practices have been helping mitigate the impacts of drought. These include the use of new drought-resistant crops zoned for particular areas, protective afforestation, planting to help maintain soil moisture, and the use of agricultural methods that are less likely to damage the soil.[43]
- *Kiribati* – Goal one of the water management policy recognizes the importance of sustainable water resource management. Goal two emphasizes community involvement and responsibility.[44]

A number of the SDGs highlight the importance of sustainable agriculture. To achieve this, goal 2.4 states '(b)y 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'.

Multisectoral drought management

An effective end-to-end drought management programme is multisectoral. It requires extensive coordination and planning, along within formation sharing arrangements across all the key stakeholders – involving many government ministries as well as subnational and local authorities and other non-government stakeholders as appropriate. This is a complex process and may take years of refinement and revision.

- *Thailand* – Drought management falls under comprehensive disaster management legislation coupled with a master plan on drought, primarily administered by the Disaster Prevention and Mitigation Policy Bureau. Requirements under the plan vary depending on the level of government and the severity of drought and involve a large number of institutions in various aspects of drought mitigation, early warning, response and management (Table II-2).
- *India* – Guidelines adopted in 2010 under the Disaster Management Act 2005 identify the roles and responsibilities of various sectoral departments from national to local levels. The National Disaster Management Authority, headed by the Prime Minister, has the primary responsibility for developing and implementing policies, plans and guidelines; though a number of other institutions are

BOX II-3

Watershed development for drought mitigation

Watershed development provides many valuable market and non-market benefits – though these are often neglected or undervalued in decision-making. Assigning an economic value to these benefits can assist policymakers in making funding decisions and also increase public awareness of the value of an ecosystem-based approach. Economists have developed methods for quantifying non-market benefits, such as stated preference, revealed preference, and benefits transfer approaches. The tables below summarize the benefits from a watershed development programme in Kumbharwadi, India.

Market and non-market benefits of watershed development in Kumbharwadi, India

Market benefits	Non-market benefits
Improved crop sales	Carbon sequestration
Improved livestock sales	Habitat improvement/biodiversity
Avoided travel cost for migratory work	Improved nutrition and health
Avoided travel cost for drinking water	Improved diversity in diet
Avoided cost of government supplied water tankers	Increased enrolment in education
Improved fuel wood and fodder supplies	Female empowerment
	Community development
	Improved resilience to drought
	Pollination
	Water filtration

Indicators of watershed improvement

Indicator	Unit	Reporting year		
		1998	2002	2010-2011
Government-supplied water tankers	Number/year	25-30	0	0
Average depth of water table below ground level	Metres	6.5	3.5	3
Land under irrigation (perennial)	Hectares	0	9.72	50
Total crop area	Hectares	457	510	566
Value of cropland	Rupees/hectare	15,000	65,000	65,000
Wells	Numbers	63	85	91
Agricultural employment	Months per year	3-4	8-9	12
Agricultural wage rate	Rupees	25	65	225

Source: WRI, 2013.

TABLE II-2

Multisectoral drought management in Thailand

Institution	Drought risk assessment	Drought database and GIS system	Drought monitoring and forecasting system	Drought database and hazard map update	Mobilizing human resources and equipment during drought	Post-drought
Department of Disaster Prevention and Mitigation	x	x	x	x	x	
Department of Royal Irrigation	x	x	x	x	x	
Department of Land Development	x	x	x	x	x	
Department of Agricultural Extension	x	x	x	x	x	
Department of Groundwater Resources	x	x		x	x	
Thai Meteorological Department	x	x		x	x	
Geo-Informatics and Space Technology Development Agency (Public Organization - GISTDA)		x	x	x	x	
Department of Water Resources	x			x		
Department of Forest				x		
Department of Natural Parks, Wildlife and Plant Conservation				x		
Permanent Secretary Office of ICT			x			
Department of Public Relations			x			
Provincial and District Offices of these Departments	x	x	x	x	x	x
Local Administration Authority	x	x	x	x	x	x
Bangkok Metropolitan Authority	x	x	x	x	x	x
Ministry of Finance					x	x
Ministry of Labour						x
Ministry of Public Health						x
Ministry of Agriculture and Cooperatives						x
Ministry of Human Development and Social Security						x

responsible for administering various programmes, in particular the Ministry of Agriculture.[45]

- *Australia* – In 2013, an Intergovernmental Agreement on the National Drought Program Reform was reached between the commonwealth, state and territory governments and identified the roles and responsibilities of each. The National Drought Policy 1992, which still underlies drought legislation and programmes, identifies the Department of Agriculture as having the primary responsibility for the National Drought Policy development. Prior to this, drought was treated as a natural disaster under the Natural Disaster Relief and Recovery Arrangements administered by the Australian Government Attorney-General's Department.[46]

- *Sri Lanka* – The Government is establishing a drought monitoring and response programme which involves several sectoral agencies including agriculture, water management, irrigation, meteorology, natural resource management, disaster management, statistics, and science and technology. With the support of ESCAP's Regional Drought Mechanism, the Government established a network of relevant institutions through memorandums of agreement identifying their roles and responsibilities.[47]

One forum which could serve countries well in bringing together various government agencies and other institutions is the Monsoon Forum which has been established in a number of Asia-Pacific countries.

Using science and technology

Science and technology play an important role in planning, mitigation, adaptation, forecasting and early warning of drought. Malaysia, the Philippines and Thailand, for example, have been seeding clouds as a method of mitigating drought. In addition, a number of countries have research programmes for adapting plant species to be more drought tolerant.

Over the past decade, the opportunities for using advanced technology have expanded dramatically, particularly in the area of space applications, hydrology and meteorology. Global satellite systems can identify and monitor areas affected by, or prone to, drought. This data, with other information, can be fed into geographic information systems to build an extensive drought monitoring model to aid the accurate estimation of soil moisture and indicate how it will affect crop production (Box II-4).

BOX II-4

Land cover mapping

Measures for drought mitigation and adaptation benefit from close monitoring of land cover. This is because different land uses retain water better than others. Geospatial science can monitor changes in land cover and allow farmers to act accordingly before dryness or drought sets in. Currently, there are several sets of global land cover maps at different levels of resolution. Until 2014, the highest resolution product (300 metres to one pixel) was GlobCover produced by the European Space Agency (ESA). The resolution of other datasets such as IGBP-DIS Cover from USGS, UMD GeoCover from the University of Maryland, and BU_MODIS from Boston University, all have resolutions of 1,000 metres. In 2010, China launched Remote Sensing Mapping and Research on Key Technologies of Global Land Cover (GlobeLand30 or GLC30), which provides a 30-metre spatial resolution.

In terms of total land use, this type of mapping indicates, for example, how more land is now being swallowed up by urban areas. In Asia and the Pacific over the period 2000-2010 around 25,000 square kilometres were lost – 72 per cent came from cultivated land, followed by grassland (15 per cent), forest land (7 per cent), bare land (5 per cent) and shrub land, wetland and water bodies (all less than 1 per cent).

Combining these data with ground-based information, such as hydrological, meteorological and soil quality data, can produce a variety of ecological, climatic and hazard maps. The Russian Federation has had 20 years of experience in utilizing satellite data for detecting drought losses. China and India have also been developing drought monitoring and hazard maps (Figure II-10).

Mapping based on microwave remote sensing technology can be particularly valuable for monitoring snow and ice cover, since countries reliant on snowmelt and glacial runoff for water resources may have more time for adaptation if they get the information several months in advance – planting drought-resistant crops, perhaps, or importing additional food supplies. The mountains of Kyrgyzstan and Tajikistan, for example, are an important source of water for the Amu Darya watershed. Mapping demonstrated that the water available from snow and ice fell between 2010 and 2011 (Figure II-11).

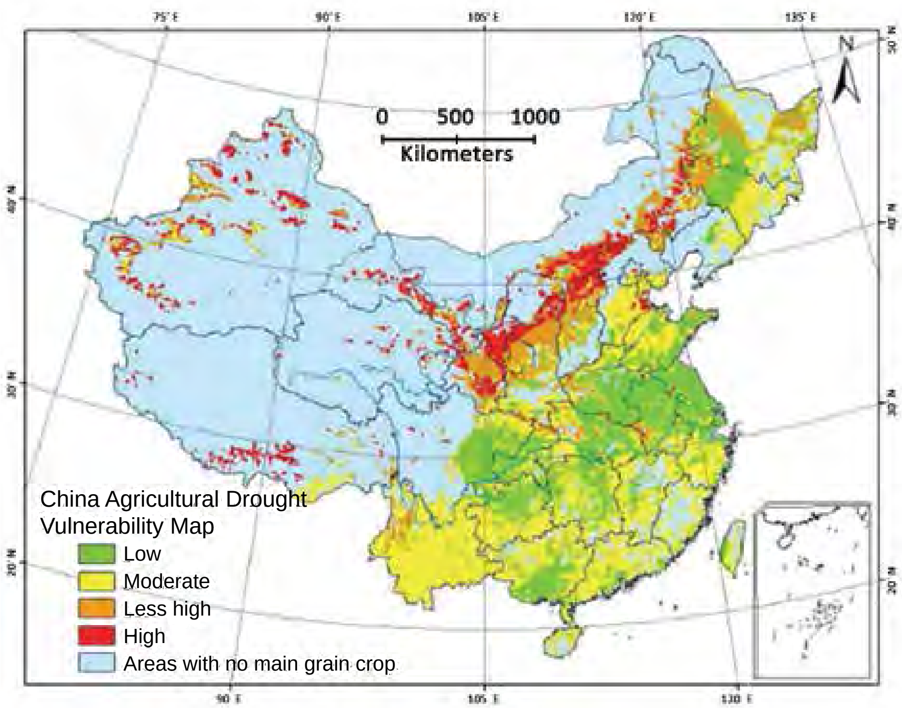
A number of other innovative technologies are discussed in greater detail in Chapter 4.

Regional cooperation

Watershed catchments and drought do not recognize national boundaries and water problems and solutions are often transboundary. This provides a good opportunity for subregional and regional cooperation. The Regional Space Applications Programme for Sustainable Development, for example, helps countries

FIGURE II-10

Satellite-based drought vulnerability map for China

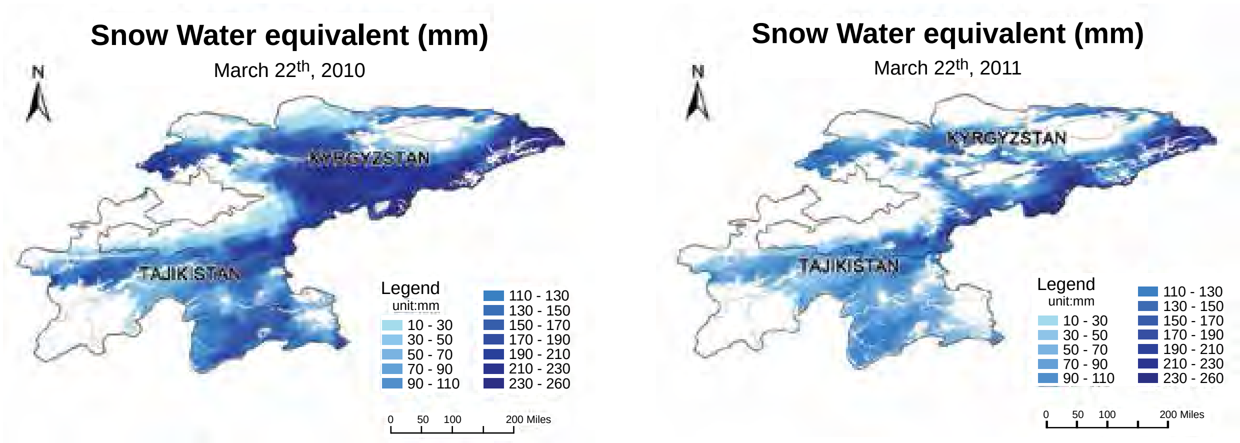


Source: Beijing Normal University, 2015.

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

FIGURE II-11

Snow water equivalent monitoring in Kyrgyzstan and Tajikistan, 2010 and 2011



Source: Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, 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.

collaborate on space-derived information. The Regional Drought Mechanism now offers an opportunity for using this data to monitor drought. In Central Asia, Kyrgyzstan has expressed an interest in becoming a focal point for the Regional Drought Mechanism, while Kazakhstan and Kyrgyzstan have established a joint emergency and disaster risk reduction centre. Pacific island States in particular have great potential for establishing a subregional institution with the necessary technical capacity to serve the needs of member States.

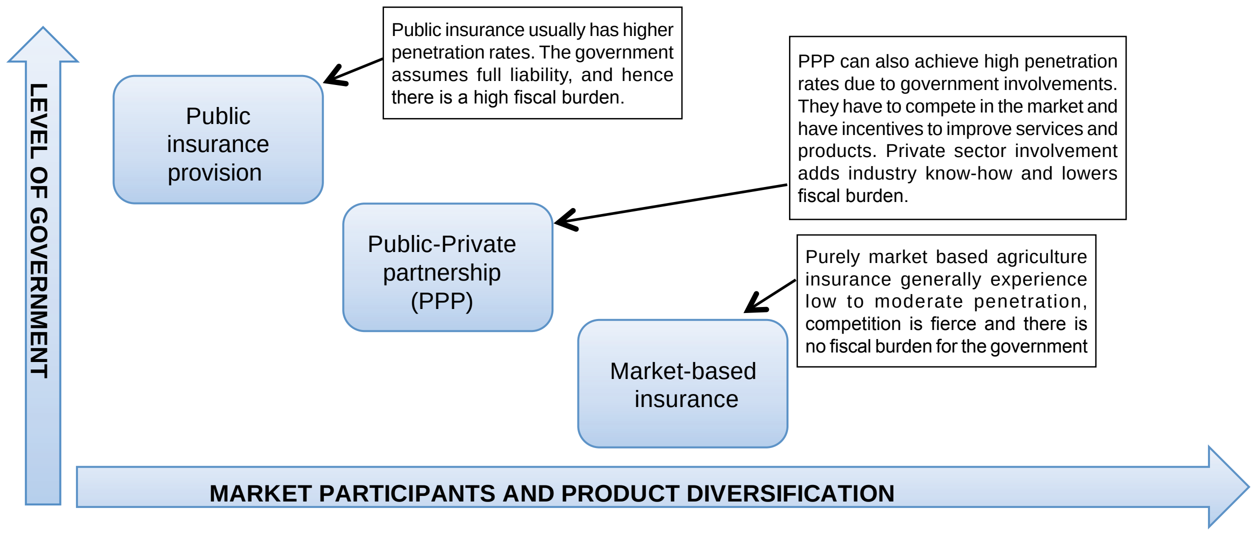
Considerable opportunities also exist for other forms of regional cooperation for drought. Food banking initiatives are already taking place in some subregions, and great potential exists for sharing food production or drought mitigation technologies and knowledge, including genetic materials and seeds for drought resistant crops. Seed banking and emergency food aid from neighbouring countries can help during times of crisis. An ecosystem based approach would also require subregional cooperation where watersheds cross national boundaries. Efforts in sharing policy information and experience, including financial strategies, institutional arrangements and social protection policies, would greatly help the many countries of the region which are only at the preliminary stage of addressing drought in a holistic manner.

Agricultural insurance

To some extent households should be able to build up their own resources to act as a buffer should they be hit by drought. But they could also have access to agricultural insurance products. These have long been available in the region's developed countries, but since the late 1970s, a number of developing countries have had programmes for multiple-peril crop insurance– as in Bangladesh, China, India, the Philippines and Thailand. These can be provided by the public or private sectors, or by public-private partnerships (Figure II-12).

FIGURE II-12

Agricultural insurance models



Source: Iturrioz, R., 2009.

In general, agriculture insurance schemes have not been very effective for drought protection. Commercial insurers are often unwilling to cover natural disasters and there are problems of adverse selection if the insurance is taken out primarily by those most at risk. Moreover, insurers often struggle to quantify drought risk, especially when the onset and end times are uncertain. On the demand side, farmers might regard insurance as an expensive luxury especially if they expect post-disaster compensation and tax breaks. They may also worry that they will have to wait for on-site inspections before they get compensation.

In many countries, agricultural insurance is provided by the government. But for drought this can be difficult to manage. In the Russian Federation, for example, there is no standardized definition of drought; agro-meteorologists use one definition while the Ministry of Agriculture uses another.

In these circumstances, a useful alternative is parametric or weather index insurance. In these schemes, payouts are based on defined parameters such as rainfall or temperature data issued by public institutions. Insured farmers receive the same payout if predetermined thresholds are reached. Such schemes do not require on-site assessment and can payout quickly. And generally they are more transparent which is especially useful in countries where the trust in the insurance industry is low.

Nevertheless parametric insurance is still in its early stages and needs further development to become a sustainable drought risk financing product. There are a number of issues. One is that in the absence of accurate crop growth modelling, the payouts may not correspond well with the actual damage – leading to under- or over-compensation. Parametric insurance also requires a higher technical capacity than traditional insurance along with accurate and frequently updated data. Fortunately, computing technology should help improve the actuarial calculations.[48] This should be an opportunity for public-private partnerships. An example of a parametric insurance scheme for India is outlined in Box II-5.

Social safety nets

When farmers lose their crops or livestock as a result of drought they should be able to rely on public social safety nets. If these measures need to be employed regularly, however, they can become a serious burden on the government – underlining the importance of comprehensive disaster management to minimize the risk and impact. Many Asia-Pacific countries already have significant experience in administering relief packages:

- *China* – A variety of agencies are involved during a drought event. Storehouses around the country contain daily necessities, equipment and material that can be accessed rapidly. The system guarantees that people affected by a hazard can receive aid such as food, clothing, and clean water within 24 hours. The hazard relief emergency fund provides financial assistance for daily needs and for water pumps, though insurance is also increasingly important for compensating losses.[49]
- *Malaysia* – The Government has offered a number of forms of aid to relieve the impacts of drought. During 2014, for example, it provided RM1,400 ($400) per hectare of damaged crop to paddy farmers and set up a fund of initially RM10 million, later

BOX II-5

Weather-based parametric crop insurance

Parametric insurance was introduced as early as 2003 in India – the Weather Based Crop Insurance Scheme. This has been heavily subsidized, with an average subsidy of 63 per cent of the premium which has made it difficult for private sector companies to compete.[51] The Government has however recently agreed to issue the same subsidies to private sector parametric insurance companies.[52]

Subsequently parametric insurance has been provided in Asia and the Pacific by a number of private companies. The major players include ICICI Lombard and IFFCO Tokio General Insurance Company. But there are also some micro-insurance providers such as BASIX, which specializes in products for smallholder farmers with limited access to formal credit and risk transfer channels.

One problem in India is that many drought-prone regions do not have daily weather data. It is estimated that an additional 10,000 weather stations would be needed to improve weather data quality, which could cost $6 million to set up, and an additional $1.5 million annually for maintenance. Moreover, there are significant time lags in getting the information from weather stations which hinders the timely provision of compensation.

In 2008 China has initiated a pilot with the World Food Programme and the International Fund for Agricultural Development. While the pilot did raise awareness of the value of agricultural insurance it too suffered from a lack of weather data infrastructure.

increased to RM50 million, for assistance to the agriculture sector.[50]

- *India* – The main relief option during a drought is the provision of employment. Each state government provides work programmes within a five-kilometre radius. However, funding for these activities is generally inadequate, and there are restrictions on the number of family members who can be employed. The state governments also try to combine these employment schemes with water conservation programmes.[53]
- *Thailand* – During a drought event, a number of actions are triggered at the provincial level. Emergency response teams mobilize equipment such as water pumps and provide food for cattle. The Department of Royal Rainmaking and Agricultural Aviation will often try to trigger rainfall events. Several agencies are involved in surveying and preparing a list of victims, loss and damage, and issuing loss certificates for compensation. If necessary, further financial support is allocated from the Ministry of Finance.

A COMPREHENSIVE ECOSYSTEM-BASED APPROACH

The most effective way to address drought is through comprehensive risk management focusing on long-term mitigation and adaptation rather than just short-term relief. This begins by recognizing that agriculture is part of an ecosystem that needs to be maintained to ensure productivity. Drought risk mitigation also needs to address livelihoods, helping people where appropriate to diversify from agriculture to sustainable non-farm incomes. At the same time the risk of drought should encourage constant vigilance, combining high-tech monitoring with local information and knowledge, along with regional cooperation, such as through the Regional Drought Mechanism. But countries also need ways of mitigating risk, through insurance, for example, and governments should help people in need when drought becomes a crisis. This can be a long and complex process but is essential for poverty eradication, long-term food security and sustainable development.

UN PHOTO/MD. AKHLAS UDDIN

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3

THE VALUE OF EARLY WARNING

CHAPTER 3 THE VALUE OF EARLY WARNING

"I acted as soon as I heard the warnings.
That was the day before the cyclone was supposed to make landfall,
but I went anyway. I did not want to risk anything."

Kamala from Odisha, India, after cyclone Phailin in 2013.[1]

A key component of disaster risk reduction is an effective early warning system. Around Asia and the Pacific such systems save thousands of lives and many millions of dollars. An effective warning system combines science and technology with practical local approaches and is fully integrated into broader national and regional strategies for building resilience and reducing disaster risks.

Early warning systems build resilience to disasters and thus mitigate their impact. This is clearly recognized in the Sendai Framework for Disaster Risk Reduction 2015-2030, whose seventh global target is:

> "(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030."

Member States and their partners are thus committed to making early warning systems more people-centred, and also to improving access to risk information for end users. In disaster risk management, this will mean combining scientific information with practical approaches.

Each national government is responsible for its own early warning systems. But many hazards cut across national boundaries and affect multiple countries simultaneously – those that share coastlines, for example, or mountain ranges or rivers. There are therefore many opportunities for international and regional cooperation. As a result, in Asia and the Pacific, regional warning mechanisms have been set up, especially for tsunamis and tropical cyclones, with linkages to global networks, and there is a general trend towards strengthened regional and South-South cooperation.

At both national and regional levels, well-functioning, people-centred early warning systems save lives and livelihoods.[2] There is evidence of this from across the region.

- *Bangladesh* – The Cyclone Preparedness Programme has strengthened early warning at the local level, in particular through a network of over 50,000 community volunteers, and done so within a coherent, overall framework for disaster risk reduction. Combined with the construction of shelters and other structural measures this has made a major difference (Box III-1).
- *India* – In October 2013 the country was struck by cyclone Phailin, the second-strongest storm

BOX III-1

Improved early warning and preparedness reduces cyclone impact in Bangladesh

Over the past 40 years, the Government of Bangladesh and its partners have made great strides in reducing the human and economic impact of tropical cyclones. As part of the overall national strategy on disaster risk reduction, there has been a strong focus on strengthening the early warning system down to the local level. One of the key measures has been the Cyclone Preparedness Programme (CPP), which was introduced in 1972 as a joint programme of the Government of Bangladesh and the Bangladesh Red Crescent Society.

The CPP supports a local early warning system for the coastal population. Through a network of over local 50,000 volunteers, the CPP ensures rapid dissemination of official Bangladesh Meteorological Department cyclone warning signals to the communities. Once the community has been warned, the project also assists in sheltering, rescuing and providing immediate medical attention. As such, the CPP is a good example of a large-scale 'last-mile' project in early warning, which achieves results through community mobilization.

The CPP is one of several complementary measures that have contributed to the reduction in the number of deaths from cyclones in Bangladesh. Other key measures include the construction of embankments along the coastline, the construction of cyclone shelters and the re-fitting of public infrastructure. There have also been important improvements in hazard monitoring and a very active use of mobile technology for early warning dissemination.

Cyclone	Year	Strength (Saffir–Simpson scale)	Estimated death toll
Bhola	1970	Category 3	300,000
BOB 01	1991	Category 5	138,866
Sidr	2007	Category 5	4,234

Source: EM-DAT (accessed May 2015).

ever to make landfall in India. Nevertheless, timely and accurate warnings, combined with preemptive evacuations of over 550,000 people, helped minimize the casualties. Similarly in 2014 the arrival of cyclone Hudhud triggered large-scale evacuations that brought thousands of people to safety.

- *Myanmar* – Following the 2008 cyclone Nargis, which killed an estimated 138,000 people, the Government adopted a more comprehensive approach to disaster risk management. The benefits were evident in 2010 when Myanmar was struck by a storm of comparable strength – cyclone Giri. In the days prior to Giri making landfall, the Government worked with the Red Cross to pre-position relief items and evacuate over 50,000 people at risk. The Government also asked the United Nations and its humanitarian partners to remain on standby. This helped keep the number of casualties to a minimum.[3]
- *Nepal* – In 2014 two adjacent river basins, Karnali and Babai, experienced their worst floods in living memory. Across Bardiya district, which comprises both Karnali and Babai, over 100 lives were lost, about 3,000 homes were completely destroyed and over 11,500 more were partially damaged, displacing 81,000 people.[4] In Babai the forecasting station was washed away, so

CHAPTER 3

people were unaware of the severity of the imminent floods. In Karnali, however, the early warning system worked, vulnerable people were alerted and brought to safety and no casualties were recorded.

- *Vanuatu* – In March 2015, cyclone Pam, one of the strongest storms ever to hit the Pacific, caused massive devastation, affecting 188,000 people out of a total population of 272,000.[5] Yet the number of fatalities was limited to 11.[6] This was due to an effective early warning system built on traditional knowledge and effective communications technology, combined with disaster preparedness at the local level.[7] Updates and warnings were sent by radio and SMS, enabling residents to trace the path of the cyclone on maps printed in every telephone book. Encouraged by the Government and relief groups, many people sought shelter in robust buildings such as schools and churches, while others hid in caves or in traditional, low and windowless 'cyclone houses'.[8]

Despite progress in a number of countries, there are still many gaps in early warning chains. Filling these will require substantial additional investment, particularly at the local level to cover the 'last mile' – though it could just as well be called the 'first mile', given the importance of reaching the most vulnerable people who are usually at the forefront of any disaster.

A powerful reminder of this was the impact of typhoon Haiyan ('Yolanda') in the Philippines in 2013. National authorities had accurately forecast this typhoon, and the accompanying seven-metre high storm surge, several days in advance.[9] Nevertheless at least 6,300 people were killed, mostly by the storm surge. Subsequent research pointed to shortcomings at the 'last mile', including gaps in risk awareness, preparedness and communication. As a consequence many people did not evacuate, or moved to unsafe places.[10]

In the light of this experience, when typhoon Hagupit ('Ruby') was about to strike in December 2014 the authorities in the Philippines and their early warning partners made great efforts to raise awareness and drastically increased the scale of preemptive evacuations. As a result there were far fewer casualties (Table III-1).[11] In parallel, the Government also modified its Tropical Cyclone Warning System to generate simpler and more impact-based forecasts, thus making the warning information more accessible to end users.[12]

EARLY WARNING – BASIC CONCEPTS

Early warning has four main elements: risk knowledge, monitoring and warning, dissemination and communication, and response capability.[13] An early warning system with all these elements is referred to as an 'end-to-end' system (Table III-2).

TABLE III-1

Evacuations and casualties in the Philippines

Year	Name (international/local)	Strength at landfall	Pre-emptive evacuations	Casualties
2012	Bopha/Pablo	Category 5	41,608	1,901
2013	Haiyan/Yolanda	Category 5	125,604	6,354
2014	Hagupit/Ruby	Category 3	716,639	18

Source: Government of the Philippines, National Disaster Risk Reduction and Management Council.

Developing an effective early warning system can be difficult and time consuming – requiring careful coordination and an efficient division of labour between multiple actors at regional, national and local levels. For each hazard, there should be one entity authorized to issue official warnings. Given the need for inter-agency coordination, the early warning system requires standard operating procedures (SOPs) that spell out the main tasks, roles and responsibilities in the event of an emergency.[14] These SOPs need to be tested and revised on a regular basis.

A key requirement is clear and unambiguous information. Unreliable or conflicting messages from official and non-official sources can allow rumours and disinformation to spread. The flow of information needs to be coordinated and shared among multiple actors – with a high degree of redundancy in the dissemination channels, since people are most likely to act on warnings corroborated from multiple sources (Box III-2). Fortunately, science and technology are now providing more of the necessary information management tools and these will continue

TABLE III-2

The four elements of an end-to-end early warning system

	Risk knowledge	Monitoring and warning	Dissemination and communication	Response capability
Main activity	Systematically collect data and undertake risk assessments	Develop hazard monitoring and early warning services	Communicate risk information and early warnings	Build national and community response capabilities
Key questions	Are the hazards and vulnerabilities well known? What are the patterns and trends? Are risk maps and data widely available?	Are the right parameters being monitored? Is there a sound scientific basis for making forecasts? Can accurate and timely warnings be generated?	Do warnings reach all those at risk? Are the risks and the warnings well understood? Is the warning information clear and useable?	Are response plans up to date and tested? Are local capacities and knowledge made use of? Are people prepared and ready to react to warnings?

Source: Adapted from UNISDR: Basics of Early Warning. Available from http://www.unisdr.org/2006/ppew/whats-ew/basics-ew.htm (accessed 19 May 2015).

BOX III-2

Why do people respond - or not - to warnings?

Research supported by ESCAP has shown that people are likely to act on warning information when they:

- Know what specific actions can be taken to reduce their risks;
- Are convinced that these actions will be effective;
- Believe in their own ability to carry out the tasks;
- Have validation from multiple sources;
- Believe other people are also doing it.

to improve (Figure III-1). In Asia and the Pacific, regional trends suggest that such new technologies can significantly strengthen early warning systems but must be combined with people-centred approaches.

The ultimate test of an early warning system is whether it provides timely and actionable information to all of the most vulnerable people – including children, pregnant and lactating women, older persons, the sick and people with disabilities. For persons with disabilities, information should be provided in accessible formats. If such vulnerable groups are not adequately informed and supported, the system as a whole must be judged to have failed.

An early warning system that covers multiple hazards should be sufficiently flexible to allow for the appropriate timeframes for each type of hazard. Rapid onset disasters such as near-field tsunamis and flash floods only allow between 15 minutes and a couple of hours from detection to impact, so the warning system should be able to respond to imminent danger. Other hazards, such as cyclones and seasonal floods, may be detected days or even weeks in advance – allowing people to protect assets and livelihoods (Figure III-2). With sufficient warning, businesses can move productive assets to safe ground, and households can shutter windows and reinforce rooftops. Given these varying needs, the warning authorities need to carefully judge how to release information – achieving the optimum balance between timeliness and accuracy.

FIGURE III-1

Disaster forecasting – the current and likely future state of science

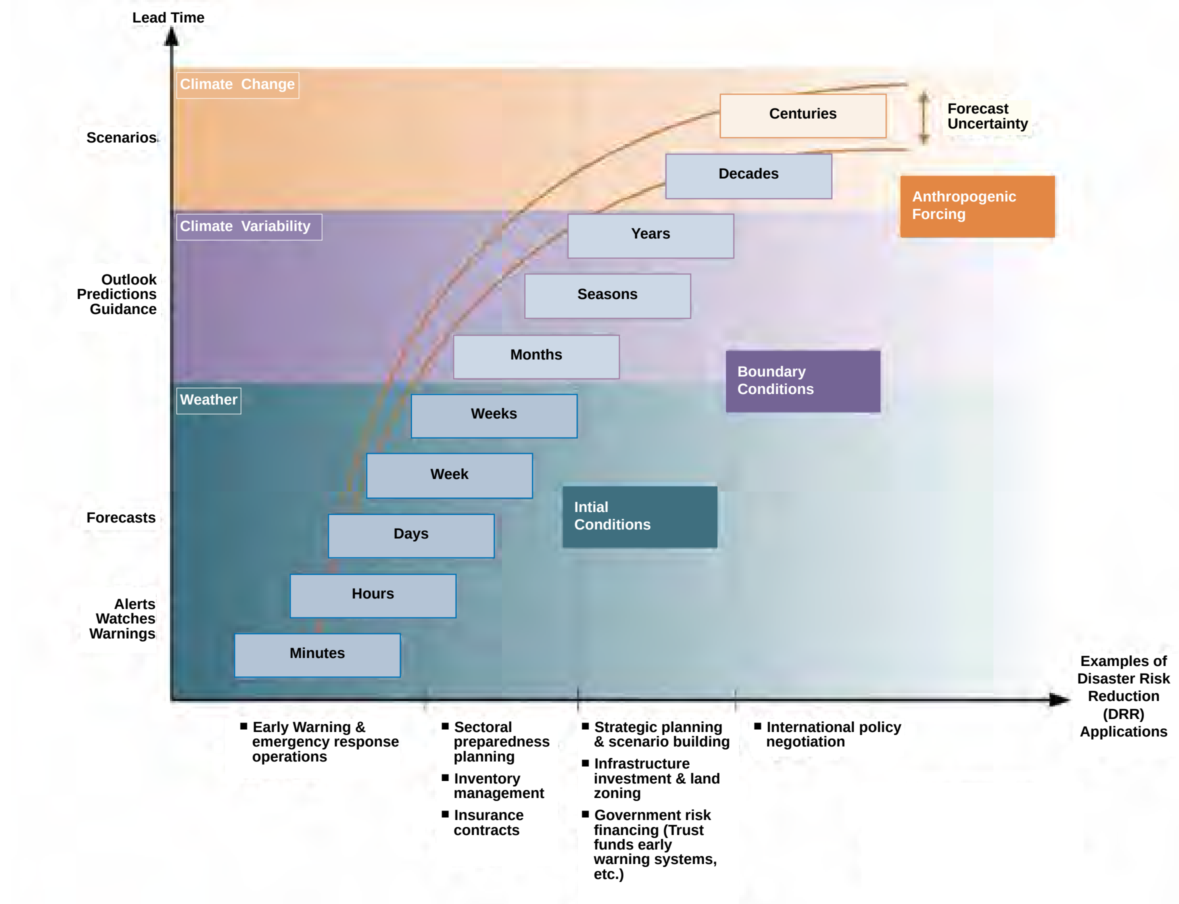
	Ability to produce reliable forecasts					
	Now (2014-2015)			2040		
	Space	Magnitude	Time	Space	Magnitude	Time
Geophysical hazards						
Earthquakes	2	1	1	3	2	1
Volcanoes	3	2	2	5	3	3
Landslides	2	2	1	3	3	2
Tsunamis	2	2	1	3	3	2
Hydrometeorological hazards	6 days ahead					
Storms	3	3	4	5	5	5
Floods	3	3	4	5	5	5
Droughts	5	5	5	5	5	5
Hydrometeorological hazards	6 months ahead					
Storms	2	2	2	3	3	3
Floods	2	2	2	4	4	4
Droughts	2	2	2	4	4	4

Source: Foresight Reducing Risks of Future Disasters: Priorities for Decision Makers (2012) Final Project Report. The Government Office for Science, London. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/286476/12-1289-reducing-risks-of-future-disasters-report.pdf

Notes: Numbers indicate the ability to produce reliable forecasts on a scale from 1 (low) to 5 (high).

FIGURE III-2

Lead times and applications of early warning information



Source: Adapted from a figure in the World Meteorological Organization Strategic Plan 2012-2015.

STATUS OF EARLY WARNING SYSTEMS IN ASIA AND THE PACIFIC

A number of Asia-Pacific countries have developed early warning systems over several decades. But the status of early warning for the region as a whole was transformed following the 2004 Indian Ocean tsunami which affected 14 countries in Asia and Africa, and led to over 230,000 deaths. With no tsunami early warning system in place at the time, most of the victims received no warning at all.

The 2004 tsunami was a watershed moment. It had a profound impact on the development of the Hyogo Framework of Action (HFA) only weeks later. And it led to major changes in policies and budgets – stimulating extensive operational and technical work and triggering greater investment in prevention and mitigation. This progress was assessed in the 2012 *Asia-Pacific Disaster Report* (APDR).[15] The report found there had been more frequent disasters such as typhoons, floods and landslides and greater damage to property and livelihoods.

Devastation in Aceh, Indonesia, following the 2004 Indian Ocean tsunami.

Yet in some subregions the death toll was decreasing – as a consequence of better disaster risk management, including investments in early warning systems and preparedness. However, the report also identified continuing weaknesses in a number of countries with limited capacities and resources.

Since then there has been further progress in the Asia-Pacific region. The technology for assessing risks and detecting approaching threats has reached a high degree of sophistication. But again there are disparities: some countries have made great advances, but many others with fewer resources are lagging behind, and often struggle to maintain their current early warning systems. The main obstacles to early warning saving more lives are usually related to gaps in (1) ensuring fast and reliable dissemination of warnings to all concerned, and (2) building the knowledge and capacity of communities to act appropriately. Of the four main components of early warning, the more advanced in Asia and the Pacific are risk knowledge, and monitoring and warning. But many countries still have gaps in communication and response capacity.

For all Asia-Pacific countries, a common weakness is that early warning is seen primarily as a science initiative. It can thus remain isolated from policy and decision-making in other areas, even in disaster management. As a result, there is often limited contact between forecasters and disaster managers, and various sectors of the economy make limited use of the existing warning and risk information.

REGIONAL COOPERATION

Many hazards and disasters in Asia and the Pacific are cross-border. Asia-Pacific countries have therefore developed regional cooperation mechanisms, notably for tsunamis and tropical cyclones. Indeed overall there is a general trend towards strengthened regional and South-South cooperation as well as building international frameworks.

A regional early warning system can be considered a 'public good' – in that its use by one country does not prevent other countries benefitting from it. Indeed the more countries that use the same system the better, because this will make it more valuable and sustainable for all members. On their own most countries would be unable to afford a comprehensive tsunami early warning system, for example, but they can achieve more if they share the costs with other countries and relevant regional and international organizations. They can also share expertise – in assessing risks, developing sustainable monitoring and warning services, improving dissemination and building capabilities for response.[16]

The Indian Ocean Tsunami Warning and Mitigation System

In the aftermath of the Indian Ocean tsunami, a major milestone of regional cooperation was the establishment of the Indian Ocean Tsunami Warning and Mitigation System (IOTWS) which became operational in 2011. In the IOTWS, Australia, India and Indonesia are responsible for issuing tsunami bulletins to member States. There are also region-wide communication tests twice a year, and full-scale regional exercises every two to three years. Along with the development of the IOTWS, 24 countries around the Indian Ocean have established national tsunami warning centres.

There have also been extensive investments in tsunami observation systems and in information sharing through regional and global networks. As a result, between 2004 and 2014, the number of Indian Ocean broadband seismometers detecting tsunamigenic[17] earthquakes and sharing near real-time data grew from 13 to over 140 (Table III-3).[18] Over the same period, the number of deep ocean tsunameters sharing data in near real-time and available for tsunami warning purposes increased from zero to nine while the number of real-time coastal sea level gauges grew from four to over 100. Taken together, these new resources networked through the IOTWS represent a major improvement in regional preparedness (Figure III-3). A study for ESCAP estimated that on average, over the next century the IOTWS will save at least 1,000 lives per year.[19]

The IOTWS was modelled on, and initially supported by, the Pacific Tsunami Warning and Mitigation System. Established in 1968, this system has remained a "gold standard" in early warning, and today can issue tsunami warnings in only seven minutes.[20] Since 2011, the service providers of the IOTWS have also reached a high degree of sophistication, and normally issue the first tsunami bulletins within 10-15 minutes of a tsunamigenic earthquake.

Regional cyclone warning mechanisms

The Asia-Pacific region also has intergovernmental platforms for addressing tropical cyclones (known as typhoons if they originate from the West Pacific). One is the ESCAP/WMO Typhoon Committee (TC) which covers storms emerging from the Western Pacific. The other is the WMO/ESCAP Panel on Tropical Cyclones (PTC) which covers the Bay of Bengal and the Arabian Sea. Since 2005, both have expanded and strengthened their activities, bringing about closer regional cooperation in early warning. They have also helped integrate the fields of meteorology, hydrology and disaster risk reduction – building capacities and developing joint strategies across countries and professional fields. The TC and the PTC undertake original research and pilot projects to further improve the understanding of tropical cyclones and related hazards.

TABLE III-3

Development of IOTWS networks, 2004-2014

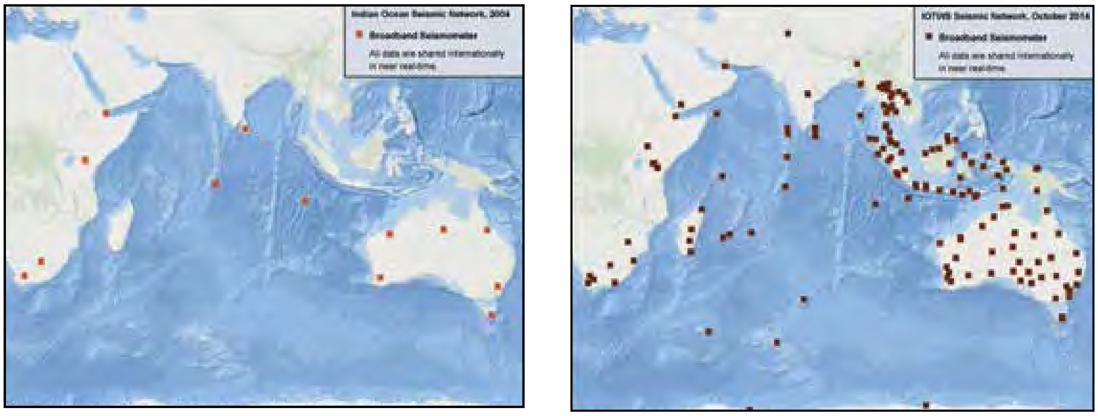
	2004	2014
Broadband seismometers sharing data in near real- time	13	>140
Coastal sea level gauges sharing data in real-time and available for tsunami warning purposes	4	>100
Deep ocean tsunameters sharing data in near real- time and available for warning purposes	0	9

Source: UNESCO, 2014.

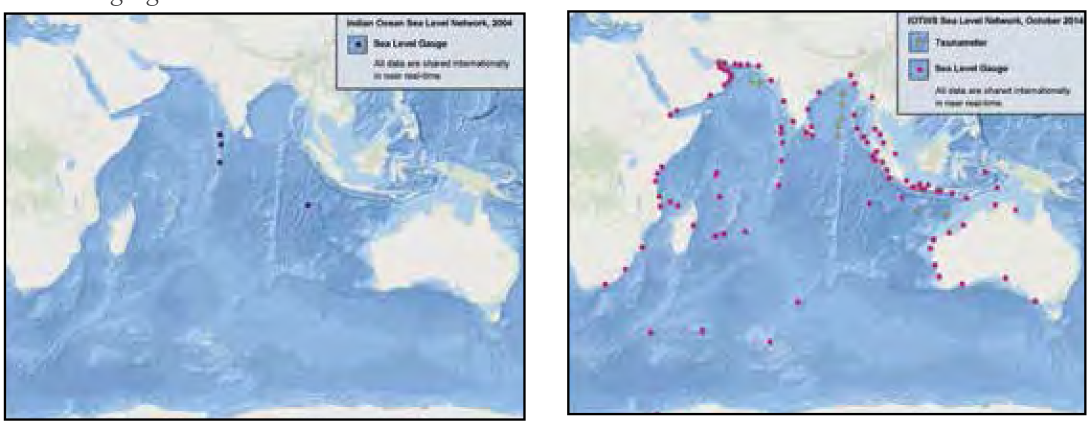
FIGURE III-3

Evolution of the Indian Ocean Regional Tsunami Observation System 2004-2014

Broadband seismometers



Sea level gauges and tsunameters



These maps illustrate the improvements between 2004 to 2014 in the core seismic network and the core coastal sea-level station and deep ocean tsunameter networks. Developed as part of the IOTWS, these networks share data regionally and globally in near real time.

Source: UNESCO, 2014.

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

In February 2015, the TC and the PTC held a joint session hosted by ESCAP during which they agreed to establish a mechanism for long-term cooperation – covering such issues as periodic joint sessions, technical projects, information sharing, research and analysis, and training activities.

Regional Specialized Metrological Centres

The activities of the TC and the PTC are backed up by the regional specialized meteorological centres in New Delhi and Tokyo. These centres operate within the framework of the WMO's World Weather Watch Programme and support countries with analysis, forecasting and training especially those with limited domestic capacity.

Regional Integrated Multi-Hazard Early Warning System for Africa and Asia

In 2009, with support from ESCAP, governments established the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES). This is an intergovernmental institution focusing on the generation and application of early warning information and supporting capacity building. By 2015, RIMES had grown to include 13 member States and 19 collaborating countries.

Gaps in regional cooperation

Despite progress in regional early warning systems, especially for tsunami and tropical cyclones, and the availability of technology, there are significant gaps for other hazards. Consequently, countries in Asia and the Pacific are calling for better regional early warning systems for hazards such as transboundary river-basin floods (e.g. in South Asia and South-East Asia), landslides, flash floods and glacial lake outburst floods.

There is a particular need for strengthened regional cooperation in early warning for transboundary river basin floods stemming from the Hindu Kush Himalayan region. A total of 1.3 billion people in 15 countries depend on this natural 'water tower', which feeds water into nine large river basins. At the same time, the area is prone to floods.

Given the transboundary nature of the river basin flood hazard, no country can ensure effective early warning on its own; the key to greater disaster resilience is regional cooperation. Such cooperation could involve sharing data and knowledge, including innovations such as nested modelling solutions that couple climate scenarios, river-basin hydrology and flood forecasting. Cooperation can also take the form of dialogues and institutional partnerships based on an integrated flood management approach. There have already been a number of initiatives including those from WMO, PTC and the International Centre for Integrated Mountain Development. Since river basin flood hazards are frequently transnational, these efforts need to be re-energized and consolidated into a regional warning mechanism.

The region also needs to make greater efforts on warning systems for landslides and flash floods. For this purpose there have already been a number of pilots that can be scaled up and replicated. In the Philippines, for example, with support from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), a landslide early warning system was successfully set up 2012 in the municipality of Saint Bernard in the province of Southern Leyte. This was one of the first of its kind in the Philippines, and has been integrated with existing warning systems.

Also in the Philippines, there is an innovative flash floods warning system in the city of Cagayan de Oro in Mindanao. This was set up with support from the Republic of Korea's National Disaster Management Institute following the devastation caused by typhoon Washi in 2011. Effective community-based flood early warning systems have also been established successfully in Nepal, by the Government and a wide range of partners participating in the Nepal Risk Reduction Consortium. These initiatives offer important advances that could be shared and further scaled up through regional cooperation.

DEVELOPMENTS IN FORECASTING

At the Third United Nations World Conference on Disaster Risk Reduction in March 2015, participants highlighted the need for impact-based forecasts and warnings, accompanied by specific recommendations for precautionary action.[21] End users too are increasingly seeking downscaled, customized forecasts to guide local preparedness and mitigation.

For this purpose, Asia and the Pacific can take advantage of its strength as a hub for science, innovation and good practice. This creates opportunities for using space technology, remote sensing and geographical information systems for assessing and monitoring impending hazards. Initiatives in the Asia-Pacific region include:

Climate model-based seasonal hydrologic forecasting

The region has been adopting global scientific innovations such as climate model-based seasonal hydrologic forecasting. Initially developed in the United Kingdom, this model couples climate scenarios, river basin hydrology and flood forecasting.[22] The resulting analysis is particularly useful for hydrologic forecasting and thus also for flood early warnings.

In Bangladesh, for example, the Government partnered with RIMES to apply this innovation and was able to increase the lead time for flood forecasting from three to ten days. They combined meteorology, hydrology and flood forecasting and developed a probabilistic system based on climate modelling and water discharge in the Ganges River and Brahmaputra rivers. The forecasts are shared with decision makers at national and district levels through fax and e-mail, and with pilot communities through SMS and flag networks. This has vastly improved the ability of authorities and communities to take early action to protect lives and livelihoods. An evaluation of the project found that, in 2014 alone, the average household saved $472, with even higher savings recorded for households living from fishing, agriculture and livestock.[23] This global-level innovation thus has the potential for replication elsewhere in Bangladesh and in the Asia-Pacific region as a whole.

Strengthening national services

In 2011 RIMES and WMO, with financial support from ESCAP, started a joint effort to strengthen the national meteorological and hydrological service (NMHS) in five high-risk countries – Bangladesh, India, Myanmar, the Maldives and Sri Lanka – and help them develop user-friendly forecasts. For each monsoon season there are biannual forums for forecast generators and users of the forecasts. In advance of each monsoon forum, RIMES and WMO work with the NMHS to develop the seasonal forecast and related products, and to train users, such as line ministries, local governments and their partners. At the forums themselves, the users discuss the corresponding preparedness and mitigation measures.

There are also many other initiatives underway to build the capacity of national forecasters, under the respective umbrellas of the TC, PTC and RIMES. In particular, the regional specialized metrological centres in New Delhi and Tokyo, working in the framework of the WMO, are training national forecasters. At their joint session in 2015, TC and PTC members recommended the further scaling up of such training.

Severe Weather Forecasting Demonstration Project

In the Pacific, a group of countries led by New Zealand has shown the value of the WMO-led Severe Weather Forecasting Demonstration Project. The project uses a 'cascading forecasting process' to provide guidance from global and regional weather models to participating countries such as Vanuatu and the Solomon Islands. In this way, national forecasters do not need to invest in expensive computing power. Instead, the system ensures that large-scale numerical predictions are created cost-effectively by a few national meteorological and hydrological services, and then shared with other countries.[24]

NATIONAL INITIATIVES

Beyond the progress at the regional level highlighted above, improvements are also apparent at the national level. Trends include:

- *Increasing national investments.* Since 2004, several countries have made major investments in national early warning systems. These include setting up state-of-the-art warning centres that are helping make the Asia-Pacific region a global hub of excellence in this field.
- *Promoting community-based disaster risk management.* In line with the approaches promoted by the HFA and the Sendai Framework, a number of countries and partners in the region have embraced the concept of community-based disaster risk management (CBDRM),[25] and implemented it in vulnerable communities, especially in coastal areas. CBDRM is a participatory process that leads to a locally appropriate and locally 'owned' strategy for disaster preparedness and risk reduction, which has been implemented successfully in countries such as India, Nepal, the Philippines and Viet Nam.
- *Addressing specific hazards.* Several countries are also making progress in addressing their unique warning requirements. In Mongolia, for example, the National Agency for Meteorology and Environmental Monitoring has worked with partners such as Mercy

Tsunami route evacuation sign, Sri Lanka

Corps and RIMES to strengthen early warning systems for weather-related hazards following the *dzud*[26] in 2010, in which 8.4 million head of livestock died.[27] With the goal of reducing the future impact of *dzud* and other weather-related hazards, RIMES provides daily weather information for herder communities in three pilot sites in Arkhangai province. The forecast and the interpretation are passed on to the communities via a local meteorological office. Local NGOs assist the communities in assessing the potential impact of severe weather events on livelihood systems and designing mitigation and coping strategies.

MULTI-HAZARD SYSTEMS

Each hazard has its own specific warning requirements and lead times. But where possible, early warnings for individual hazards should be integrated into a multi-hazard system. This brings benefits in terms of economies of scale, sustainability and efficiency. And since a multi-hazard system will be activated more regularly it is likely to be better maintained and more readily available for hazards such as tsunamis that occur infrequently. Such integrated systems may also help the public better understand the range of risks they face and the need to prepare and to respond to warnings.

In line with the vision of the Sendai Framework, a number of cities and countries have moved to multi-hazard systems.

- *Australia* – The multi-hazard system, which is operated by the Bureau of Meteorology, covers severe storms, tropical cyclones, hazardous winds, heat, fires, flooding, tsunamis, and marine and aviation hazards. Driven by the experiences of the 2004 Indian Ocean tsunami and the 2011 Queensland floods, warning operations have now been standardized.
- *Shanghai, China* – An effective multi-hazard early warning system provides alerts on tropical cyclones, storms surges, and extreme temperatures, as well as on floods, diseases, physical damage and other impacts.[28]
- *India* – The Government has integrated the early warning systems for tsunamis and storm surges, as a step towards bringing together warning information for a wider range of hazards.

One of the problems in developing multi-hazard systems is that responsibilities can be distributed across different departments and ministries. For example, many Asia-Pacific countries have already set up warning systems that are common for most hydrometeorological hazards. However, it can be difficult to combine these systems with those for geophysical hazards which are often managed by other ministries. One exception is in Myanmar, where responsibilities for both types of hazards rest in the Department for Meteorology and Hydrology, thus opening up opportunities for developing a truly integrated warning system in the future. Other examples are Indonesia and Malaysia.

With financial support from ESCAP, the TC and the PTC have developed a manual for multi-hazard SOPs. It is based on research from 13 countries and outlines ways of integrating the procedures for multiple hazards, improving operations and achieving synergies by combining systems. The manual is expected to be rolled out in 2016, by the TC, the PTC and their member States. A number of countries have also taken up new tools and standards such as the Common Alerting Protocol (Box III-3).

BOX III-3

Common Alerting Protocol

In their efforts to establish multi-hazard early warning systems, countries in Asia and the Pacific are increasingly deploying global standards and innovative technologies. One such standard is the Common Alerting Protocol (CAP). This is being implemented in a number of countries, including China, India, Japan and Thailand and, with support from ESCAP, is being introduced in the Maldives and the Philippines.

The CAP is a digital format for emergency alerts covering any hazard. It allows for a consistent alert message to be disseminated simultaneously over many different communications systems, such as TV, radio, the internet and SMS.

With the CAP, a single alert can trigger a wide variety of public warning systems, increasing the likelihood that the intended recipients are alerted by one or more communication channels. The CAP also allows warning authorities to target alerts to a geographically defined area. As such, it can significantly improve the dissemination and consistency of alerts.

Source: WMO.

FINANCING

Greater political commitment to disaster risk reduction has not been matched by corresponding financial investments. Donor resources for disaster prevention and preparedness remain uneven and have not increased substantially since 2003.[29] Over the last decade in Asia and the Pacific less than 1 per cent of total development assistance, and only around 10 per cent of humanitarian assistance, was spent on disaster preparedness and prevention.[30] Generally, donor funding for disaster risk reduction also remains heavily concentrated on a few countries.

Economic benefits of early warning

Often, the costs of early warning systems are outweighed by the economic benefits especially for hydrometeorological hazards such as floods. According to World Bank research, investments in hydrometeorological warning services in developing countries could have a benefit-cost ratio of between four and 36, with substantial benefits for weather-sensitive sectors such as agriculture and energy.[31] Much of the investment required is in people – specifically the technical staff of NMHSs, in order to make forecasts more accurate and user-friendly and to increase warning lead times.

This is confirmed by research by RIMES which suggests considerable economic benefits from investments in local and national warning systems for high-frequency, low-impact hazards, such as storms and floods (Table III-4). However, for low-frequency, high-impact hazards, such as tsunamis in the Indian Ocean, it would be more economical to take a regional or a collective approach.[32]

In Bangladesh, for example, RIMES found that for every $1 invested in increasing the accuracy and lead-times for cyclones warning, there would be a return of $41 in benefits.[33] This study assumed a major cyclone every five years but economic benefits would be considerable even over a longer return period. As stated above, an

TABLE III-4

Cost effectiveness of early warning

Country	Hazard	Benefit-cost ratio
Bangladesh	Cyclones	40.9
Sri Lanka	Floods	0.7
Bangladesh	Floods	447.1
Thailand	Floods	1.8
Viet Nam	Hydro-meteorological	10.4

Source: Subbiah, Bildan and Narasimhan, 2008.

initiative in the same country to increase the lead time for flood forecasting up to ten days has also shown promising economic benefits.

For the Indian Ocean region as a whole the greatest potential economic benefits from forecasting would be for cyclone, floods and volcanic eruptions. This is because, except for flash floods, these hazards can be predicted fairly accurately – making it possible to evacuate people and reduce damage to property and livelihoods.[34] The benefits can be lower from tsunamis which, although they can be very destructive occur less frequently.

These benefits will only be realized, however, if the investments are well directed.[35] A World Bank report cautions against over-reliance on expensive technologies with high operating and maintenance costs. Instead, the report suggests addressing practical needs – such as estimating and calibrating models, carrying out hazard analysis, digitizing past data and improving data from ground observations.

Innovative funding models

Given the resource constraints, the best way to maximize the impact of finance, especially donor funds, is through pooled funding. Multiple partners can coordinate their investments and thus reduce the risk of duplication. One example, established after the 2004 Indian Ocean tsunami, is the ESCAP Multi-donor Trust Fund for Tsunami, Disaster and Climate Preparedness (Box III-4), which applies a regional approach focused on South-South cooperation. An independent evaluation found that the fund had helped significantly strengthen early warning systems, especially by helping establish the IOTWS and RIMES, and also by providing dedicated support to high-risk, low-capacity countries.[36]

An example of a large-scale pooled fund is the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR). By the end of 2013, GFDRR's global portfolio consisted of 226 grants worth $156 million.[37] This included 45 grants worth $34.8 million in East Asia and the Pacific, and 30 grants financed with $13.6 million in commitments in South Asia. Among the valuable early warning activities supported at the country level were participatory risk mapping in Indonesia, integrated flood risk management in the Philippines, and community resilience in Viet Nam.

BOX III-4

ESCAP Multi-donor Trust Fund for Tsunami, Disaster and Climate Preparedness

The Trust Fund was established in 2005 following the devastation wrought by the Indian Ocean tsunami. Its original mission was to support tsunami early warning systems in Indian Ocean and South-East Asian countries. In 2010, following an independent review, the member States and ESCAP expanded the thematic scope of the Trust Fund to include overall disaster and climate preparedness, while retaining a focus on end-to-end early warning for coastal hazards. In 2015, the geographic scope was expanded to include small island developing States in the Pacific.

The Trust Fund supports the strengthening of early warning for coastal hazards such as tsunamis, typhoons and storm surges, while applying a regional approach. It contributes to the narrowing of capacity gaps through regional and South-South cooperation, sharing of resources and the development of an integrated regional warning system comprising a network of collaborative centres.

The strategy of the Trust Fund has three main pillars:

I. Regional intergovernmental mechanisms;
II. Specific country needs; and,
III. Civil society innovations and business sector initiatives.

As of July 2015, the Trust Fund had approved 26 projects with a combined budget of approximately $13.7 million, directly benefitting 19 countries. In particular, the Trust Fund has made important contributions to the establishment of a regional warning system for tsunamis and the provision of cost-effective warning products and services especially to low-capacity countries.

Another innovative pooled funding model that promotes coordination and synergies among multiple actors is the Global Initiative on Disaster Risk Management. This is coordinated by GIZ with financial support from the Federal Government of Germany. The initiative brings together a wide range of stakeholders from Germany, Asia and the Pacific and other regions – providing a forum for collaboration in disaster risk management between donors and implementing partners. One of the three main focus areas is early warning.

Sustainability

A major concern for investment in early warning systems is sustainability. Governments have many competing priorities and, over time, may come to question the value of relatively expensive systems, especially for infrequent hazards such as tsunamis. For this reason it is important to build multi-hazard systems whose value can be demonstrated more regularly. Early warning systems for geophysical and hydrometeorological hazards, for example, have many components that can be shared – both for technology and human resources (Figure III-4). Integration can not only reduce costs but improve performance.

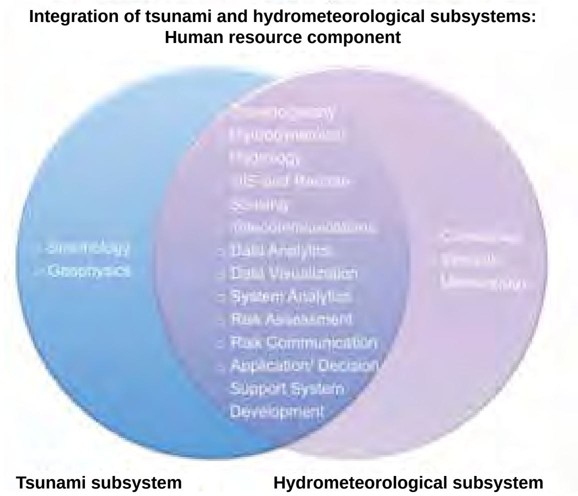
Sustainability is a priority for the IOTWS.[38] The initial investment was $300 million, mostly borne by the governments of Australia, India and Indonesia and their partners. As of 2014, the total annual cost to operate and maintain the IOTWS was approximately $90 million.[39] To make the IOTWS more sustainable the members are taking a multi-hazard approach and have recommended that governments enshrine their financial commitment in legal frameworks and long-term policies.

FIGURE III-4

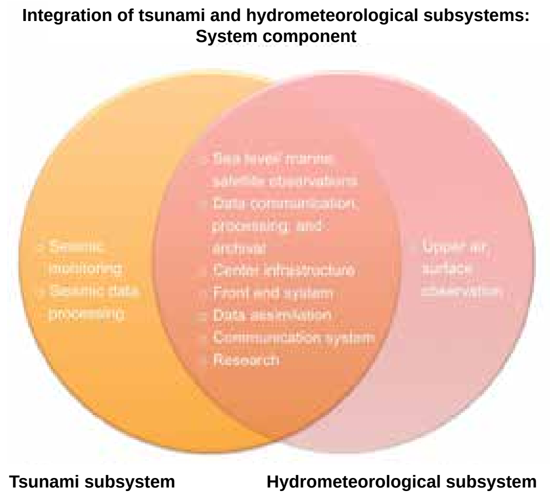
Potential integration of tsunami and hydrometeorological warning systems

Integrating tsunami and hydrometeorological early warning systems into one multi-hazard system brings potential synergies and economies of scale, both in the human resource and the system components.

Human resources



Systems



Source: A.R. Subbiah, Lolita Bildan and Ramraj Narasimhan, 2008. "Background Paper on Assessment of the Economics of Early Warning Systems for Disaster Risk Reduction." Paper submitted to the World Bank Group Global Facility for Disaster Reduction and Recovery (GFDRR).

To further strengthen sustainability, it is important to avoid that early warning is seen as a science project that is taking place in isolation from society as a whole. Instead, whenever possible, early warning information should be made relevant to supporting livelihoods in multiple sectors of the economy, as seen in the example above regarding the monsoon forums. In this way, the early warning system can become an enabler for sustainable development, with clear economic benefits. Going forward, linking the early warning system to the needs of end users in various economic sectors can thus help make the case for sustainable funding for early warning.

In India, a good example is the information provided to small-scale fishermen by the National Centre for Ocean Information Services. These weather forecasts and fishing zone advisories enable fishermen to reduce their exposure to hazards, as well as cut their fuel consumption, as they spend less time searching for fish. Targeted weather and ocean forecast services have also provided benefits for other economic activities such as desalination and ornamental fishing.[40]

UNMET NEEDS IN INDIAN OCEAN AND SOUTH-EAST ASIAN COUNTRIES

New research by ESCAP highlights the unmet needs in early warning across Indian Ocean and South-East Asian countries.[41] Although it focuses on coastal hazards, the findings, outlined below, illustrate a state of affairs common across the Asia-Pacific region with respect to the four elements of early warning.

Risk knowledge

There are significant gaps for both the generation and dissemination of risk information (Box III-5). For generation, the priority should be to improve data gathering on hazards, exposure and vulnerability, and to develop hazard and risk maps at smaller scales that can guide local efforts at risk reduction and preparedness. There is also a lack of regional-level multi-hazard risk maps including for transboundary hazards. The production of such maps should not however be seen as one-off efforts but rather as continual processes to understand the dynamic nature of hazards and vulnerabilities. For this purpose and to ensure local ownership it is vital to involve local communities in gathering data.

For knowledge dissemination, the key task is to develop user-friendly ways of communicating, especially to local disaster managers, other government officials and the population. It is thus essential to bridge the gaps between scientists and disaster managers.

Monitoring and warning services

Many Asia-Pacific countries have successfully applied new advances in science and technology to enhance observation networks. But a number of least developed countries have limited capacity to take advantage of these advances (Box III-6). Such countries can benefit greatly from regional cooperation – which can offer them better access to information and expertise. Communities too can make a valuable contribution – for example by complementing technological data with traditional risk indicators such as changes in animal behaviour or vegetation.

For issuing warnings it is important to balance the accuracy and timeliness of the information, and frequently update SOPs at various levels. Even the most technologically advanced countries can struggle with this.

Another problem is that vital parts of early warning systems, such as weather stations, may themselves be damaged during disasters. In 2013

BOX III-5

Main unmet needs in risk knowledge

Knowledge generation

- Improving international exchange on assessment methodologies and harmonization.
- Producing more hazard and risk maps down to scales of 1:5,000/1:10,000 when possible.
- Improving data gathering on hazards, exposure and vulnerability using scientific methods as well as indigenous knowledge and community-based methods (e.g. crowdsourcing).
- Reviewing coastal inundation, storm surge and tsunami hazard maps (including more detailed bathymetry) and considering developing multi-hazard maps for “big ocean waves”, which could include both tsunami and storm surge.
- Including climate change related information in risk assessments (priority on precipitation, sea level rise and severe winds), in addition to disaster information parameters.

Knowledge dissemination

- Assessing the risk information needs of local disaster managers and developing more user-friendly ways of presenting data to this target group.
- Communicating the inherent uncertainties in risk information to the end users.
- Improving the sharing of good practice examples of educational materials related to early warning.

BOX III-6

Main unmet needs in monitoring and warning services

- Balancing the accuracy and the timeliness of alerts in order to avoid many false alarms.
- Incorporating information from citizens for warning purposes.
- Improving rain forecasting to enhance the reliability of the forecasting of fresh water coastal floods.
- Further developing and expanding the coverage of the direct observations of wave heights of storm surges, tsunamis and swells (e.g. using coastal radar, pressure-type sensors, satellite-based altimeters, observation of cyclone by airplanes).
- Improving indirect methods of tsunami observation using more specific earthquake data (e.g. focal mechanisms) with GPS data and faster computers.
- Regularly updating international/regional SOPs that are in place for status communication and information on hazardous events (probably every five years and after significant events).
- Formulating national SOPs in countries where these are missing, and implementing existing SOPs more diligently in many countries.

typhoon Haiyan partially or completely destroyed 12 weather stations in the Philippines – at an estimated replacement cost of $1.63 million.[42] Post-disaster needs assessments and recovery plans should thus incorporate reconstruction needs for damaged early warning systems.

Communication and dissemination

Warning information and alerts should be formulated such that the end user understands them and knows how to respond. In some cases, the message may have to be very direct, such as “Evacuate now to save your life”. In others, the message may be subtler and contain less urgency. Either way, a common pitfall is that the warning information becomes too technical and complicated.

In many countries, there are also gaps in communications channels and networks (Box III-7). As a result, vulnerable and remote populations may not receive warnings. This may be a matter of geography as for small island developing States. In other cases the barriers may be social – in countries, for example, that have large and diverse populations, with a variety of languages.

An important way of reaching many people quickly is through the broadcast media. These should be incorporated into warning chains – both to take advantage of their reach and to ensure that they do not spread inaccurate or exaggerated information. In two projects supported by the ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness, the Asia-Pacific Broadcasting Union has developed guidelines and other warning tools for broadcasters. However, in order to be effective in an emergency the broadcast media need a formal role in the warning chain – established through SOPs.

A related issue is the contribution of social media – which can disseminate accurate warnings but may spread false alarms, rumours and misinformation. Rather than let misinformation pass unchallenged, the authorities are usually better off monitoring the social media and themselves using these platforms to reach the public with the correct information.

BOX III-7

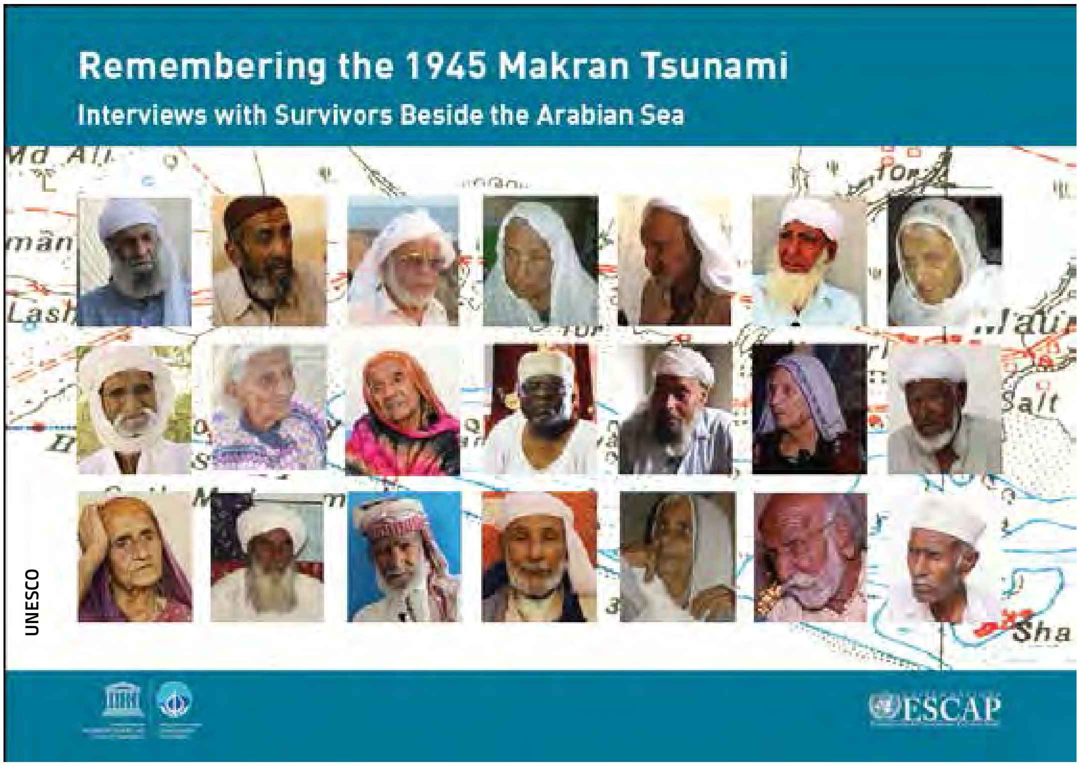
Main unmet needs in communication and dissemination

- Reviewing and adjusting warning messages, alert levels and educational materials if they are found to be too complicated or the language is not well adjusted to the target population.
- Investing additional effort in reaching populations at the 'last mile'. Technical means of spreading alerts are available but have to be used in a more widespread manner.
- Integrating the broadcast media, including TV and radio, more thoroughly into the early warning chain and discouraging unauthorized warnings. Short and frequent updates from warning authorities during emergencies are recommended.

Having reliable information corroborated through diverse channels can prevent panic and false alarms that can undermine public confidence, breed mistrust, dilute the impact of official alerts and reduce the credibility of future warnings. In 2007, in Aceh, Indonesia a local tsunami siren went off by mistake causing mass panic and injury as residents fled. Anger led residents to later disable the tsunami warning system, causing unnecessary vulnerabilities and long-term risk.[43]

Response capability

Warnings are only useful if they reach the last mile and people are capable of acting on them. There thus needs to be constant attention to



Cover page of educational booklet on the 1945 Makran tsunami, produced by UNESCO with financial support from the ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness.

the linkages between the warning system and the communities at risk (Box III-8). Risk maps and contingency plans, for example, require continuous updating to match changes in population and land use patterns. Proper signage and evacuation centres need to be maintained. These activities should be accompanied by sustained education and outreach to maintain risk awareness among local communities and government officials.

Regional warning mechanisms also need to be tested down to the local level (Box III-9). Currently, local exercises and drills tend to be ad-hoc and not linked to the revision of SOPs, leading to missed opportunities for learning and for system improvement.

Cross-cutting issues

Beyond the unmet needs within the four elements of early warning, there are a number of cross-cutting issues (Box III-10). Most of the gaps here – such as improving communication among key actors, participation of local communities and performance assessments – relate to good governance. Countries generally have national legislation on specific mandates for early warning

BOX III-8

Main unmet needs in response capability

- Identifying evacuation routes and evacuation centres with proper signs.
- Conducting frequent drills at the community level and simulation exercises for disaster managers (e.g. once a year).
- Ensuring that disaster managers pay attention to the type of expected hazard and the evacuation routes and places that are appropriate for the respective hazard.
- Designing and constructing evacuation centres to withstand common hazards (e.g. severe winds or ground shaking).

BOX III-9

Testing warning systems, end to end

A broader challenge in Asia and the Pacific is to ensure that regional systems are tested end to end. The IOTWS, for example undergoes communications tests every six months and large-scale exercises every two to three years. In general, recent tests and exercises have been successful and shown that the regional system performs well but have not been linked effectively with local-level drills and exercises. At the 2014 region-wide exercise (IOWave14) only three out of 24 participating countries (India, the Seychelles and Timor-Leste) conducted public evacuation drills. As a result, the ability of the regional warning system to trigger local life-saving action was not fully tested. The 10th Session of the Intergovernmental Coordination Group for the IOTWS in 2015 recommended future region-wide exercises to make such public evacuation drills a priority.

Source: IOC-UNESCO, 2015. Exercise Report, IOWave 14.

BOX III-10

Main unmet needs regarding cross-cutting issues

- Ensuring adequate in-country information sharing and coordination.
- Improving the communication between technicians/scientists and other groups using the risk information (e.g. communities, businesses, politicians).
- Integrating various early warning systems to establish multi-hazard systems, as many systems currently only deal with one hazard type.
- Improving the participation of local communities in early warning.
- Addressing the warning needs of people with disabilities and older persons, e.g. by identifying those receptive impaired who live alone and need special arrangements to alert them and assist them in preparations. Gender issues as well as the special needs of other vulnerable groups such as pregnant women and older persons also need to be taken into account.
- Given growing international migration and tourism, integrating non-permanent residents into the early warning system. International standards proving common alert levels and colour codes in a multi-hazard approach could help facilitate this.
- Exploring mechanisms on how to improve the sustainability of early warning systems.
- Improving cost-benefit analysis of early warning, especially for political decision makers and private companies.
- Developing and testing different approaches for assessing the performance of early warning systems (e.g. with success indicators).

roles and responsibilities. But it is important also to build the political will and institutional commitment to ensure the necessary resources and coordination.

To meet the needs of the most vulnerable people, early warning systems must reflect gender considerations and provide for the needs of especially vulnerable groups such as those with disabilities, pregnant women and older persons, who are likely to require extra assistance in the case of an emergency. ESCAP has supported the development of guidelines on early warning for people with disabilities.[44]

FUTURE PRIORITIES

For the global target of the Sendai Framework to be reached by 2030, early warning systems and services must be considered public goods that should be widely available and adequately financed by public investment.[45] Such investments have high returns for society as a whole – building resilience, minimizing loss of life and preparing for an accelerated recovery.

Recommendations:

1. Integrate the concept of 'early warning as a public good' into national planning, policy and decision-making.
2. Strive to make early warning systems multi-hazard and people-centred, keeping in mind the response requirements at the local level ('the last mile').
3. Ensure that forecasters are mindful of the specific needs of the end users of different types of warning information, and tailor products and services accordingly.
4. Seek effective communication channels with the people at risk, including by integrating the broadcast media into the early warning chain.

5. Link SOP development/revision with operational tests, including local evacuation drills.
6. Strengthen regional cooperation in early warning, going beyond coastal hazards to include hazards such as transboundary river basins floods.
7. Concentrate external assistance on low-capacity, high-risk countries.

Early warning systems are essential for reducing disaster risks and building greater resilience. But they should be part of coherent framework for disaster risk reduction and have clear institutional arrangements.

ENDNOTES

1 IFRC, 2013.

2 World Bank, 2010b.

3 UNDP, 2010a.

4 Zurich Insurance Group, 2014.

5 OCHA, 2015c.

6 Vanuatu, 2015b.

7 Australian Red Cross, 2015.

8 Coates and Feast, 2015.

9 A ‘storm surge” is a rising of the sea as a result of atmospheric pressure changes and wind associated with a storm.

10 GIZ, 2014.

11 The Guardian, 2015.

12 WMO, 2015b.

13 UNISDR, 2006.

14 ESCAP/WMO Typhoon Committee and WMO/ESCAP Panel on Tropical Cyclones, 2015.

15 ESCAP and UNISDR, 2012.

16 ESCAP, 2010.

17 Tsunamigenic refers to those earthquakes, common along major subduction zone plate boundaries, which can generate tsunamis.

18 UNESCO, 2014.

19 Teisberg, 2011.

20 Weinstein, 2014.

21 United Nations News Centre, 2015.

22 Xing, Wood and Ma, 2015.

23 Deltares, 2014.

24 National Meteorological and Hydrological Services

25 ADPC, 2006.

26 *Dzud* is a Mongolian term for a severe winter in which a large number of livestock die, primarily from starvation or directly from the cold.

27 Eldev-Ochir Erdenebat, National Agency for Meteorology and Environment Monitoring of Mongolia, “Early warning system: Status and Priorities”, presentation given at the 6th RIMES Council Meeting, Bangkok, Thailand, 29 May 2014.

28 Golnaraghi, 2012.

29 Kellett and Caravani, 2013.

30 See Chapter 1 of this publication.

31 Hallegatte, 2012.

32 Subbiah, Bildan and Narasimhan, 2008.

33 Ibid.

34 Teisberg and Weiher, 2009.

35 World Bank, 2010b.

36 Aysan, 2011.

37 Available from https://www.gfdrr.org/our-portfolio

38 Jaksa, Kumar and Wandono, 2014.

39 Ibid.

40 India, 2012.

41 ESCAP, 2015g.

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44 ADPC, GAATES and ABU, 2014.

45 United Nations, 2015.


NDRCC

4

RIGHT INFORMATION, RIGHT PEOPLE, RIGHT TIME

CHAPTER 4 RIGHT INFORMATION, RIGHT PEOPLE, RIGHT TIME

"We must address gaps in our knowledge if we are to design policies to avert, or at least mitigate, the impact of this and future crises. We must obtain real-time data that can be easily analyzed across sectors and address the policy questions that need answering. We must further improve our methodologies....The voices of the vulnerable should compel us to act with urgency."

Voices of the Vulnerable, p.4.[1]

A critical part of disaster risk management is managing the flow of information. Getting the right information to the right people at the right time saves lives and reduces losses, while also strengthening people's resilience to disasters. Some Asia-Pacific countries now have state-of-the-art disaster information management systems, but others have major gaps in data and analysis.

This chapter presents the case for effective information management in two broad sections. The initial sections focus on 'soft' issues, including data, modelling and decision support. Subsequent sections cover emerging ICT technologies and the need to build critical 'hard' information infrastructure.

Right information

Nowadays for disaster risk management there are many more sources of information, with multiple global and local data sets, some free and some commercial. Often these originate in the developed countries. In the US, for example, the National Oceanic and Atmospheric Administration has made earth observation data more accessible to the public.[2] Other US organizations will also release data on request for purposes of disaster risk management.[3]

Nevertheless range and coverage of these data sets are limited and governments in many countries do not have access to good information at the national or regional level.[4] Even when they have access to the data, they may not be able to use it.[5]

Right people

Many people are involved in disaster management – at the international, regional, national and local levels, each with their own mandates, priorities and areas of interest. Organizations and governments have attempted to take stock of the various actors. In India, for example, the Government publishes a 'Directory of institutions and resource persons in disaster management', and in Indonesia, the Government publishes the 'Profile and directory: disaster risk reduction organisations in Indonesia'.[6] There are also directories at the international level, maintained, for example, at preventionweb.net.[7]

Some institutions are both users and producers of disaster risk knowledge and they differ greatly in knowledge and capacity.[8] Given their diversity, there are often problems of coordination. Disaster management frameworks often assume that all actors need information in order to act and that there is coordination between them.[9]

Right time

Information on disasters should arrive at the appropriate time though that period will vary considerably. During or immediately after a disaster, for example, this could be within 12-48 hours, up to 72 hours, one week, two to three weeks, or four to six weeks.[10] For the post-disaster phase, for 'building back better' the information flow could take place over many years.[11] Again, however, there are considerable differences between developed and developing countries. In the US the Federal Emergency Management Agency can respond quickly using satellite imagery and geospatial information, along with mobile applications and innovative technologies.[12] In many Asia-Pacific developing countries, however, information is much scarcer and many communities do not know where to get timely information or know how to act on it.[13] For effective information management, it is important to improve 'situational awareness' – knowing what is going on in the immediate environment.[14]

Decision makers need precise disaster risk models and comprehensive impact profiles that are based on systematic and dependable data. They can get the basic information from global data sets and analysis and then combine these data with those from other sources, historical analysis, GIS mapping and local knowledge and foresight, to identify the timing and pathways of impact, and recommend action for businesses, citizens and communities.[15]

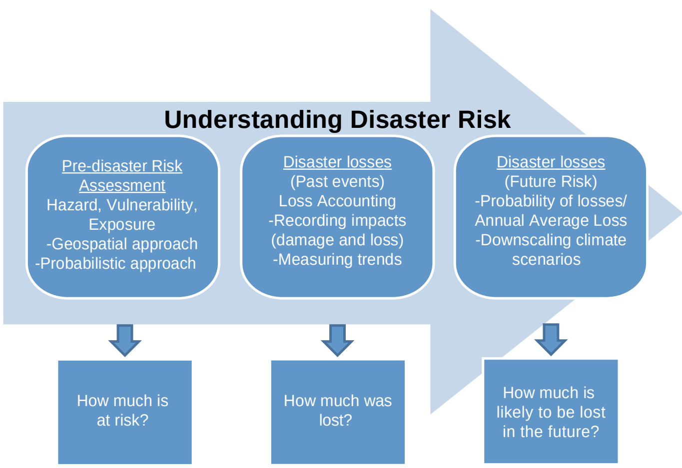
The Sendai Framework for Disaster Risk Reduction sets as one of its targets "Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030." The first priority action for the implementation of the Framework is "understanding disaster risk".

INFORMATION MANAGEMENT PRACTICES

Disaster information management practices in the region have evolved with the growing understanding of disaster 'risk' – which involves the interaction between hazard, vulnerability and exposure (Figure IV-1). In the pre-disaster phase

FIGURE IV-1

Information management practices for understanding disaster risk



technical staff can use probabilistic modelling and geospatial approaches. In the post-disaster phase, they can also use field-based methods to estimate damage and losses.

PRE-DISASTER RISK ASSESSMENT

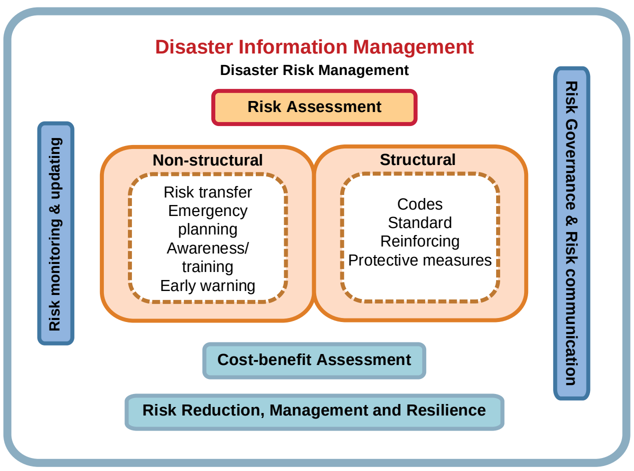
It is important to prevent development investment and activities that exacerbate existing risks or create new risks. Pre-disaster risk assessment, or to be more precise, the use of information in 'normal' times, is thus needed to generate risk awareness for development planning purposes. This assessment can guide DRR policies, strategies and investment programmes.

Pre-disaster assessments will involve both qualitative and quantitative methods. The qualitative approach is useful as an initial screening process. Typically this will combine hazard maps with qualitative judgments of vulnerability and exposure to build a simple risk matrix.

Quantitative methods combine data from multiple layers of geospatial data including satellite images, with socioeconomic indicators and detailed census and survey data to create a more comprehensive assessment. This information can feed into a framework that takes account of structural and non-structural factors (Figure IV-2). This can facilitate risk-sensitive decision-making and strengthen risk governance. It can also be used for cost-benefit assessments that can be embedded in comprehensive long-term planning processes.

FIGURE IV-2

Conceptual framework for disaster information management

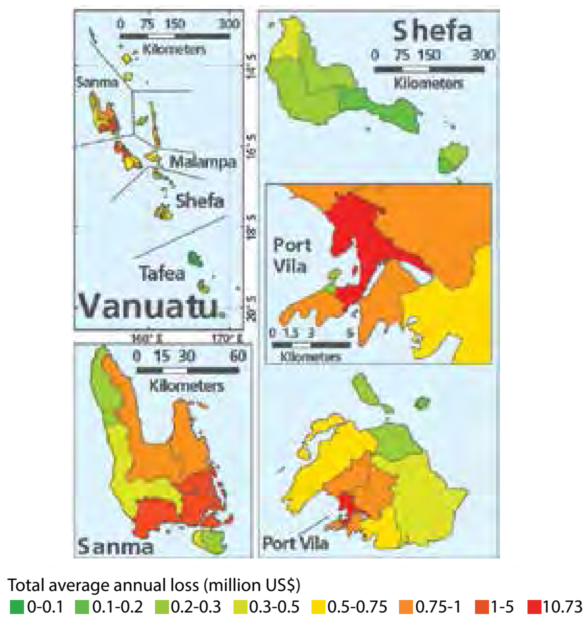


Source: Concept from Van Westen, 2013.

A number of countries have carried out pre-disaster risk assessments. Vanuatu, for example, has combined data on earthquakes and tropical cyclones with information on exposure and vulnerability and then used a probabilistic risk assessment model to estimate total average annual losses (Figure IV-3). This was used to identify high-risk areas, for appropriate development plans and interventions.

FIGURE IV-3

A multi-hazard risk map in Vanuatu



Source: Pacific Catastrophe Risk and Financing Initiative – Country Risk Profile Vanuatu. Available from http://pcrafi.sopac.org.

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The Philippines has also used multi-hazard risk information, in this case to make buildings more resistant to earthquakes and typhoons. For earthquakes the National Structural Code divides the country into four zones. Most land is in seismic zone 4, where high ground motion is expected. For typhoons, the country is divided into three zones according to expected wind speeds (Figure IV-4).

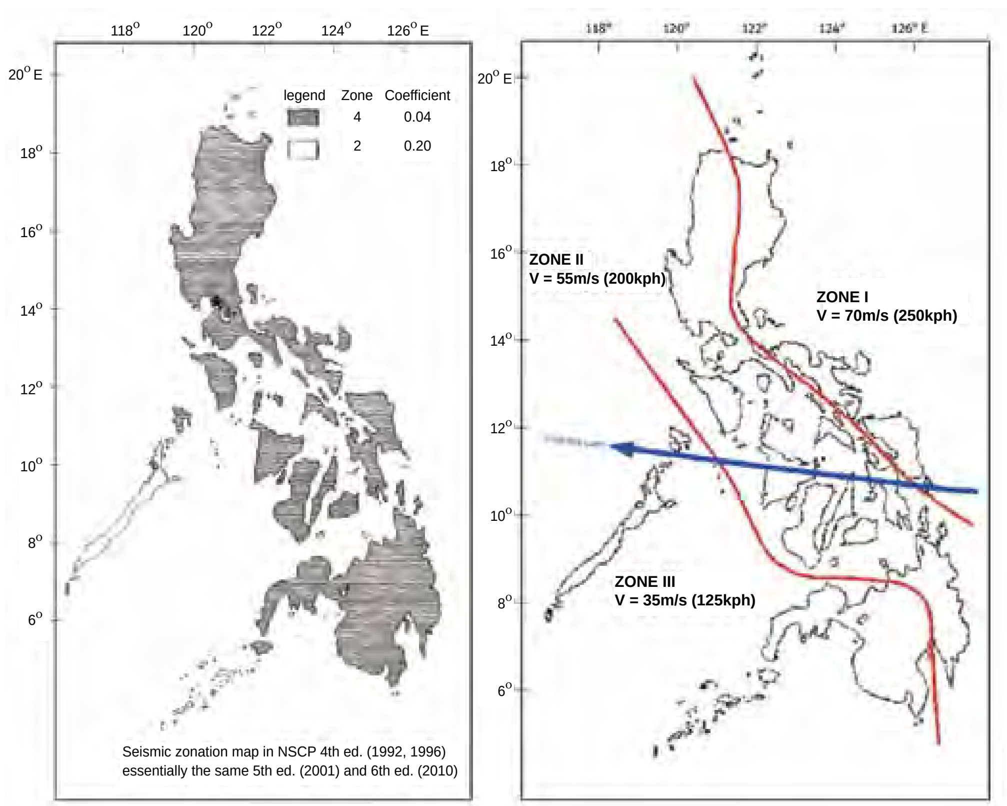
Customizing information

The production of risk information should be an interactive two-way process with an exchange of information between risk assessors, managers, interested groups and the general public. Each of these stakeholders, whether individuals, businesses, organizations or governments requires customized information. Thus the general public might need simple maps of neighbourhoods while technical staff in local government will need more detailed information and statistical data for specific purposes. The range of potential information is indicated in Table IV-1.

One important use for disaster risk information is insurance. The Japanese Government, for example, has since the 1960s provided earthquake insurance. These schemes have been operating jointly by the public sector and the private

FIGURE IV-4

Multi-hazard risk mapping in the Philippines



Earthquakes | Wind speed and the path of typhoon Haiyan

Source: DPWH (Philippines Department of Public Works and Highways and World Bank, 2014 – Field Investigation Report on the Impact of the Bahol Earthquake and Typhoon Yolanda on Building, Washington, DC, World Bank).

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

TABLE IV-1

Information needs of different stakeholders

Stakeholder	Purpose	Information
General public	General information on risks over large areas	Basic WebGIS application on which they can overlay the location of major hazard types with high-resolution imagery or topographic maps
	Community-based DRR projects	Simple maps of neighbourhood with risk class, buildings, evacuation routes, and other features
Businesses	Investment policies and location planning	General information about hazards and risks in both graphical and map format
Technical staff of (local) authorities	Land use regulation / zoning	Maps and simple legends in three classes: construction restricted, construction allowed, further investigation required
	Building codes	Maps indicating the type of buildings allowed (building type, number of floors)
	Spatial planning	Hazard maps, with simple legends related to probabilities and possible consequences
	Environmental Impact Assessment	Maps and possible loss figures for future scenarios
	Disaster preparedness	Real time simple and concise Web based information in both maps and graphical forms
Decision makers / local authorities	Decision-making on risk reduction measures	Statistical information, loss exceedance curves, F-N curves, maps
	Investments	Economic losses, projected economic losses for future scenarios
	Strategic environmental assessment	General statistical information for administrative units
NGOs	Influence political decisions in favour of environment and sustainable development	This can vary from simple maps to web-based applications, depending on the objectives
Scientists / technical staff of hazard data producers	Hazard information exchange to public and other agencies	WebGIS applications where they can access the basic information
	Exchange of basic information for hazard and risk assessment	Spatial data infrastructure / clearing house for exchanging information
Insurance Industry	Development of insurance policies	Loss exceedance curves of economic losses
Media	Risk communication to public	Animations of hazard phenomena that clearly illustrate the problem

Source: Van Westen, 2013.

sector, under the "Law Concerning Earthquake Insurance". For this purpose they have evaluated the potential earthquake risk of specific regions using relevant data – which includes the potential magnitude of earthquakes, the place of occurrence, geometry of earthquake source faults, types of land cover, the structure and age of buildings, time of day and population density.[16]

This information has been used, for example, since 2009 to create the National Seismic Hazard Map. Figure IV-5 shows an earthquake hazard map with 3 per cent probability of exceedance of earthquake within a 30-year period indicating that the greatest risks are for the east coast. This information is used by insurance providers to calculate potential damage and to formulate insurance coverage, premiums and estimated claims.

FIGURE IV-5

National seismic map for Japan

Hazard intensity map

Source: National Research Institute for Earth Science and Disaster Prevention, Japan, 2009.

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

Insurance companies in a number of countries have developed proprietary software for catastrophe modelling, for different types of hazards, though these customized products are often not available in the public domain. The insurance company Munich Re, for example, has a database for natural catastrophes on material and human loss events worldwide (NatCatSERVICE). The insurance company Swiss Re has a similar database (SIGMA).

Multi-tier mapping

Risk information is often customized according to scale. At the regional/national levels of planning, 'actionable' risk information commonly uses a mapping scale smaller than 1:1,000,000, while at the community municipality or provincial levels the scale can vary from 1:1,000,000 to 1:5,000. For project implementation at the field level, actionable risk information can use a scale of more than 1:2,000 (Table IV-2).

A number of Asia-Pacific countries have these multi-tier disaster risk information systems. Indonesia, for example, has an actionable multi-tier information system at national, provincial and district levels (Box IV-1). Similarly, India has a National Database for Emergency Management which is a GIS-based repository of data at varying scales which uses core data, hazard-specific data, and dynamic data in spatial as well as temporal form. The database includes national-level core-geospatial data at 1:50,000

TABLE IV-2

Risk information scale for policy planning and project implementation

Regional/national level – mapping scale (1:1,000,000 or smaller)

- Formulation of national disaster risk management strategy
- Inventory of major hazards in the country
- Identification of areas affected or threatened for an entire country

Provincial level – mapping scale (up to 1:1,000,000)

- Draft regional development projects or large engineering projects
- Utilized more for spatial analysis at this scale (mostly qualitative)

District level – mapping scale (1:25,000 to 1:100,000)

- Conduct the feasibility study of developmental projects
- GIS analysis capabilities are used extensively for hazard zonation

Municipality or community level mapping scale (1:5,000 to 1:25,000)

- Formulate projects at feasibility levels
- Generate hazard and risk map for existing settlements and cities
- Planning disaster preparedness and disaster relief activities

Project level very high resolution large mapping scale (1:2,000 or larger site)

- Planning and design of engineering structure and in detail engineering measures to mitigate natural hazards
- Data management and 3D visualization

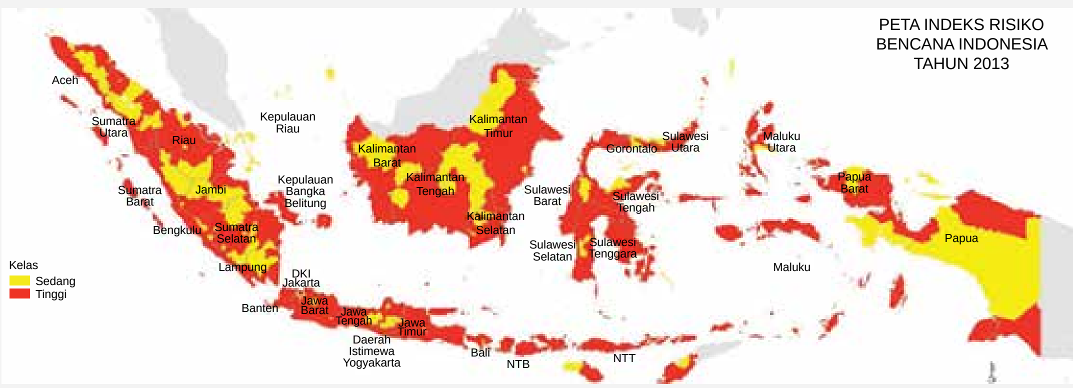
Policy Planning

Project Implementation

BOX IV-1

Indonesia disaster risk index

In 2011 to assess vulnerability in each region, Indonesia's national disaster mitigation agency (PNPB) developed the Indonesia disaster risk index (IRBI). This is based on an inventory of hazards and vulnerabilities, taking into account the frequency and intensity of hazards, including floods, landslides, earthquakes and tsunamis. Vulnerability is quantified using socio-cultural, economic, physical, and environmental parameters. It also takes into account the regulatory and institutional capacities of local governments, as well as the effectiveness of early warning systems, vocational education system, and mitigation and preparedness systems. The IRBI, which is updated every two years, categorizes 497 districts as being at high, medium or low risk (see map below). These data can then be used to derive a risk index at the provincial level. The index is used to inform the planning and allocation of public DRR funds.



Source: BNPB, 2015. Geospatial Application in Indonesia Disaster Management Authority (BNPB). World Conference on Disaster Risk Reduction, Sendai 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.

scale, hazard-specific data for multi-hazard prone districts at 1:50,000 scale, data for multi-hazard prone cities and towns at 1:10,000 scale and data for major cities at 1:2,000 scale (Box VI-2). It also provides support tools for real-time decision-making.[17]

Such information is valuable for assessing the risks to large-scale infrastructure development particularly in high-risk areas. China, for example, has built the world's longest high-altitude plateau railway, the 1,956-kilometre Qinghai-Tibet railway which cost approximately $5.3 billion to construct. Of this, some 960 kilometres is 4,000 metres above sea level, reaching a peak at 5,072 metres. As it traverses the Tibet Plateau, the railroad is exposed to earth crust movements and a severe climate (Figure IV-6).[18] The construction therefore took into account both seismic and climate risk.[19] Despite frequent earthquakes, the railway is still operating safely.[20]

BOX IV-2

India's National Database for Emergency Management

India has a National Database for Emergency Management. This is a multi-scale GIS database which combines raster and vector images linked with non-spatial information. These include core data, hazard-specific data, corresponding attribute data, and live data from remote national locations. Core data sets include base, thematic, and infrastructure layers. Disaster-specific information pertains to floods, cyclones, forest fires, earthquakes, landslides and droughts.

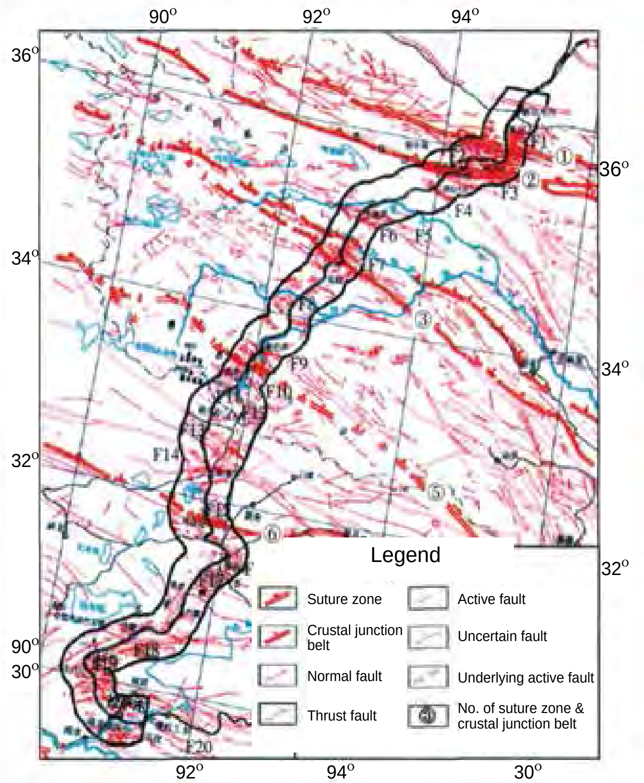
The database is organized and structured to provide the right information at the right time to the right people. For this purpose it has defined a series of standards covering such issues as coding, data management and dissemination.

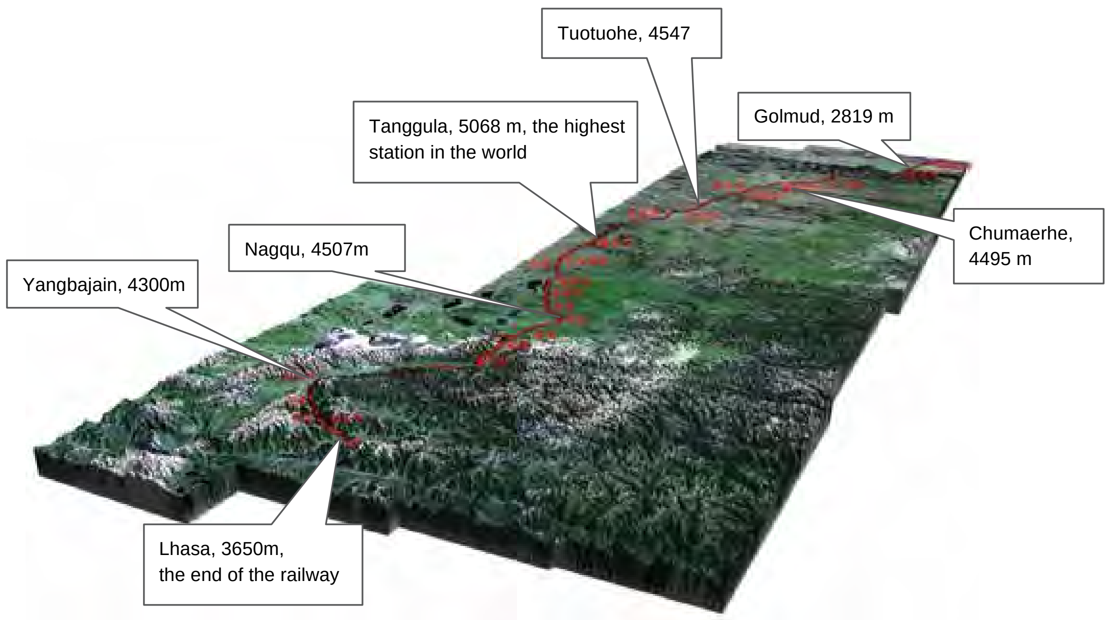
The database covers all of India at a 1:50,000 scale, multi-hazard prone districts at a 1:10,000 scale, and megacities at a 1:2,000 scale. The datasets are available to various end users through a virtual private network and geospatial web service providing services, data and visualizations.

Source: Bhanumurthy and others, 2014.

FIGURE IV-6

Qinghai-Tibet Railway seismic hazard map and 3D elevation, highlighting the risk scenarios





Source: Wang, 2006 and China, Centre for Resources Satellite Data and Application, 2009.

Crisis and operations centres allow dedicated monitoring and assessment of disaster situations.

POST-DISASTER ASSESSMENT

In the immediate aftermath of a disaster the international humanitarian community needs to coordinate many actors. For this it requires reliable, relevant and timely information. Disaster risk management activities that take place immediately after the onset of a disaster involve multiple agencies and are centred on emergency response and humanitarian relief. They are often sporadic and local responses which, over the course of hours and days after a disaster, evolve into more formal and structured responses. For example, from neighbours frantically clearing rubble to rescue those trapped, to people using lifting and digging tools from local construction sites, to heavy machinery brought in to clear rubble.

This type of response requires situation reports, also known as 'sitreps'. These operational documents may be created by a national disaster management authority, a UN agency, international or local NGOs, or regional institutions. Sitreps will include elements of rapid assessment and situation analysis – to establish what has happened, the nature of the existing response, and the people and areas in need of emergency aid and relief. OCHA, for example, generally starts with a daily situation report during the acute phase and subsequently moves as appropriate to weekly or monthly 'humanitarian bulletins'.[21]

Situation reports, can be combined with other sources of information to produce a multi-cluster initial rapid assessment (MIRA).[22] A MIRA can appraise the disaster situation, and consolidate information that is often scarce and incomplete. The MIRA, along with other situation reports and rapid impact assessments tools, can serve as the basis for quickly dispersing funds for relief and emergency responses. One example is a 'UN flash appeal', which is an initial inter-agency humanitarian response strategy and resource mobilization tool designed to cover the first three to six months. If humanitarian responses extend more than six months this can be followed by a 'consolidated appeal process'.

Situation reports require multiple sources of information. One of the most valuable is satellite imagery, which can provide a clear picture of the situation before and after a disaster, at different time intervals and for specific areas (Figure IV-7). When cross-checked and cross-referenced with other information the analysis of such images can indicate the extent and location of damage. In Asia and the Pacific, ESCAP, through its Regional Space Applications Programme for sustainable development (RESAP) network, helps provide satellite imagery, at no cost, to disaster-affected countries (Box IV-3). For example, during the 2015 Nepal earthquakes, RESAP received multiple images of sites in and around Nepal from different satellites administered by the region's spacefaring member countries. The material included raw images that officials within the Ministry of Home Affairs and other relevant national institutions could use to perform their own analysis and create mapping products. Globally, the International Charter on Space and Major Disasters provides an agreement between space agencies, aimed at creating a unified system for accessing and delivering fast and free satellite imagery and space data to countries affected by disasters.

Larger Asia-Pacific countries now have their own sophisticated systems for information management. In India, for example, following cyclone Hudhud in 2014, the State Government of Andhra Pradesh used geographic information systems, global positioning systems, and remote sensing technologies to assess damage and upload information onto a satellite map using geo-tagging.

In the Republic of Korea, the National Disaster Management Institute has developed a smartphone-based damage assessment system that can gather data from user measurements and transmit these to a mobile server that classifies and organizes the data and feeds it into the National Damage Management System. The system automatically calculates the expected damage value and dramatically reduces the time for damage assessment.

FIGURE IV-7

Before and after images of Kathmandu for 2015 Nepal earthquakes

Source: Provided to ESCAP by UNITAR UNOSAT, CNES and AIRBUS, 2015.

BOX IV-3

The Regional Space Applications Programme for Sustainable Development

ESCAP promotes the application of space technology for disaster risk reduction and sustainable development through RESAP. This unique regional cooperative platform, which has been running for 20 years, calls on all national space agencies in the Asia-Pacific region to work together to help disaster-affected countries. RESAP provides support for the use of satellite-derived data, products and services and enables countries without their own space programmes to have cost-effective access to space-derived data, products and services for disaster risk management.

Upon receiving requests from disaster-affected countries or early-warning alerts, ESCAP, in collaboration with its RESAP member countries and strategic partner UNOSAT, facilitates access to space-based data. In 2013 and 2014, for example, RESAP mobilized more than 218 satellite images and damage maps that contributed to preparedness, response, relief and damage assessment. In 2015, RESAP mobilized 150 satellite images and maps including in the aftermath of the Nepal earthquakes and the typhoon that struck Vanuatu. These images were provided free of charge by RESAP members and UNOSAT, and had an estimated monetary value of more than $600,000 USD. This service is of particular benefit to LDCs, LLDCs and SIDS, which otherwise would not have access to such critical and timely information or advanced technological capabilities.

Unmanned aerial vehicles

Another technology increasingly used in the aftermath of disasters is unmanned aerial vehicles (UAVs), also known as drones. UAVs can reach areas that are inaccessible or difficult to fly over with manned aircraft. For example, in 2013 after typhoon Haiyan hit the Philippines a UAV was used to choose where to set up a base of operations, and then to check if roads were passable. The UAV was then flown up the coast to evaluate damage from storm surges and flooding and to identify the villages most affected. China has also been using UAVs for landslide and earthquake related damage and impact assessment. The use of UAVs has, however, raised serious practical and ethical issues that humanitarian organizations must address.

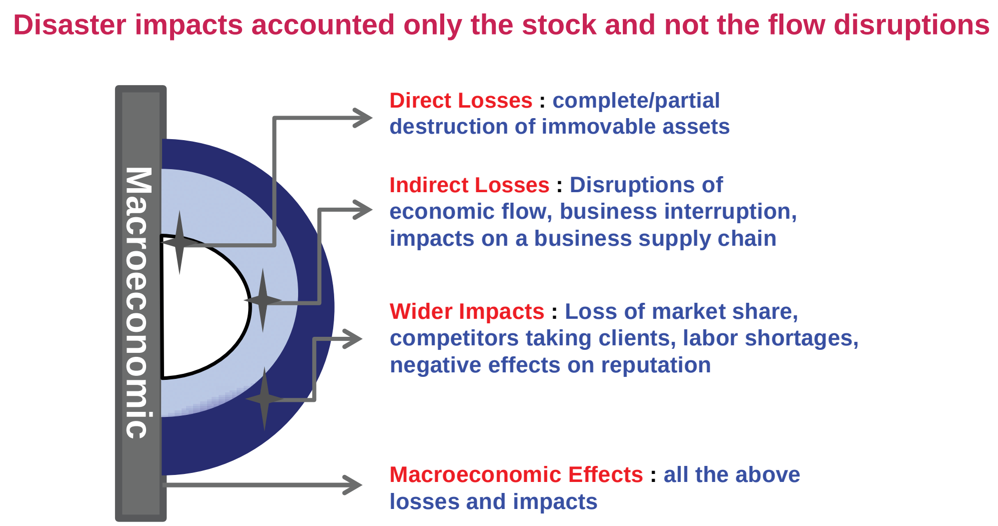
In response to the wealth of data coming from new technological sources, including UAVs, a group of non-governmental organizations have formed the Digital Humanitarian Network. This consortium aims to provide an interface between formal, professional humanitarian organizations and informal volunteer and technical networks. Following cyclone Pam in Vanuatu, for example, OCHA and the World Bank engaged the network for UAV imaging support.

DAMAGE AND LOSS ASSESSMENT

After disasters, governments as well as other institutions, public and private, need to estimate the damage. In the past such assessments have had a number of weaknesses. One is a lack of pre-disaster baseline information. Another is that the economic estimates cover only loss of stocks not flows. That is, they assess the destruction of assets but not the cost of flow disruptions such as the interruption of business and the shortages of labour, and other direct costs (Figure IV-8). As a result, according to the 2013 *Global Assessment Report*, close to 50 per cent of the economic impacts of disasters are not accounted for.

FIGURE IV-8

Economic losses from disasters



Source: UNISDR, adapted from PricewaterhouseCoopers.

To assist with a more complete overview of post-disaster needs, in 2013, the UN, the World Bank and the European Union produced guidelines for post-disaster needs assessment (PDNA). This has since been widely used – for the 2015 Nepal earthquakes, for example, and for the cyclone in Vanuatu. In March 2015 at the Sendai World Conference on Disaster Risk Reduction the World Bank, the GFDRR, the EU and UNDP jointly launched a guide to developing disaster recovery frameworks. This links the PDNA process with the 'building back better' approach.

The PDNA is a government-led exercise which covers economic damage and losses, and the recovery priorities, in a single consolidated report. This is used as a basis for developing a comprehensive immediate and long-term recovery framework and for mobilizing assistance from donors and development partners. One concern, however, is that the affected country may lack the capacity for institutionalizing the PDNA into the national disaster damage and loss assessment system.

Most disaster events in the Asia-Pacific region are small to medium scale, so may not require the deployment of international assessment teams, but instead can use home-grown methodologies. These can use the PDNA methodological framework, and retain a sound scientific base, but need to be downscaled to meet local needs. For this purpose countries at high risk and with low capacity will need a 'critical mass' of trained manpower.

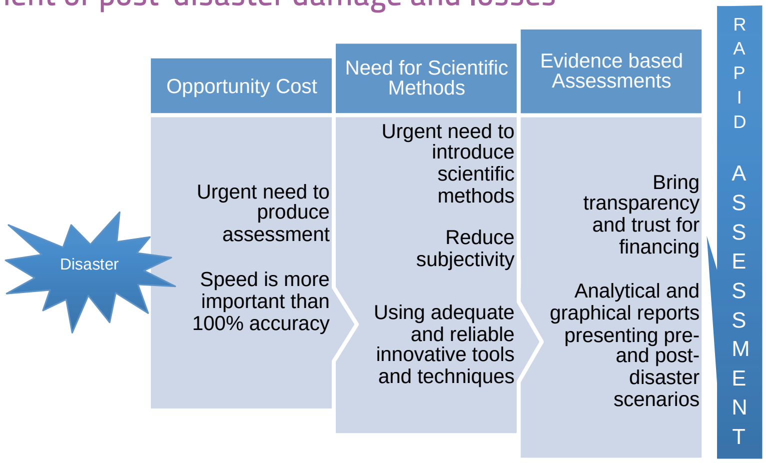
In recent years, to support the urgent political decisions on recovery and reconstruction, there has also been more emphasis on rapid assessments that are technology-based. These use satellite remote sensing, GIS, crowdsourcing and ICT applications. This was the case in the Uttarakhand flash floods in 2013, typhoon Haiyan in 2013, cyclones Phailin and Hudhud in 2014 and cyclone Pam and the Nepal earthquakes in 2015.

Rapid assessments enable faster and more accurate decision making (Figure IV-9). The key requirement is quick action based on the highest possible levels of accuracy. It is therefore critical that the estimation of post-disaster damage should be made in an objective and reliable manner with evidence-based quantitative information.

To assist in this process, and increase the speed of evidence-based assessment, ESCAP has produced a rapid assessment manual. This combines PDNA sectoral assessment methodology with the use of real or near real-time satellite data including geospatial solutions (Box IV-4). The methodology was pilot tested in the response to the 2015 Nepal earthquakes, and then adopted for capacity development training as a smart PDNA module. In South Asia, ESCAP is partnering with SAARC to customize the manual which will subsequently be rolled out in other subregions.

FIGURE IV-9

Rapid assessment of post-disaster damage and losses



BOX IV-4

Rapid assessment for resilient recovery

The SAARC Disaster Management Centre has put in place the South Asia recovery framework. The framework is supported by an important PDNA tool – Rapid Assessment for Resilient Recovery. The rapid assessment takes into account the damage and losses for selected sectors such as housing, infrastructure and agriculture, with disaster risk reduction as a cross cutting sector. ESCAP and SAARC Disaster Management Centre are jointly developing this manual on rapid assessment. This will be a step-by-step guide on conducting rapid damage assessments for the selected sectors using space, geospatial modelling, crowdsourcing and other web-based technology. The manual was pilot tested following the PDNA for the 2015 Nepal earthquakes and the methodology was reviewed by experts.

The manual should help make assessments more timely and evidence based and help users monitor the recovery process. It is targeted at managers and practitioners from government agencies that are responsible for post-disaster relief, response, recovery and reconstruction.

Comparing actual damage with pre-disaster risk assessments

A rigorous pre-disaster risk assessment can be compared with the actual outcome should disaster strike. This exercise has been carried out, for example, for the 2015 Nepal earthquakes. The pre-disaster assessment was based on the SEismic Loss EstimatioN model (SELENA) which was piloted by ESCAP in Nepal.[23] The model was run for future earthquakes at magnitudes from 5 to 8. The GDP loss per capita was anticipated to be greatest in the central hill and eastern mountain districts – which was confirmed by the actual outcome (Figure IV-10). A similar exercise for Vanuatu found that the pre-disaster risk assessment corresponded well with actual damage and loss from cyclone Pam in 2015.[24]

ESTIMATING FUTURE DISASTER LOSSES

There are two main approaches for estimating future losses. The first is probabilistic risk modelling to estimate average annual loss and the second is based on potential climate scenarios.

Average annual loss

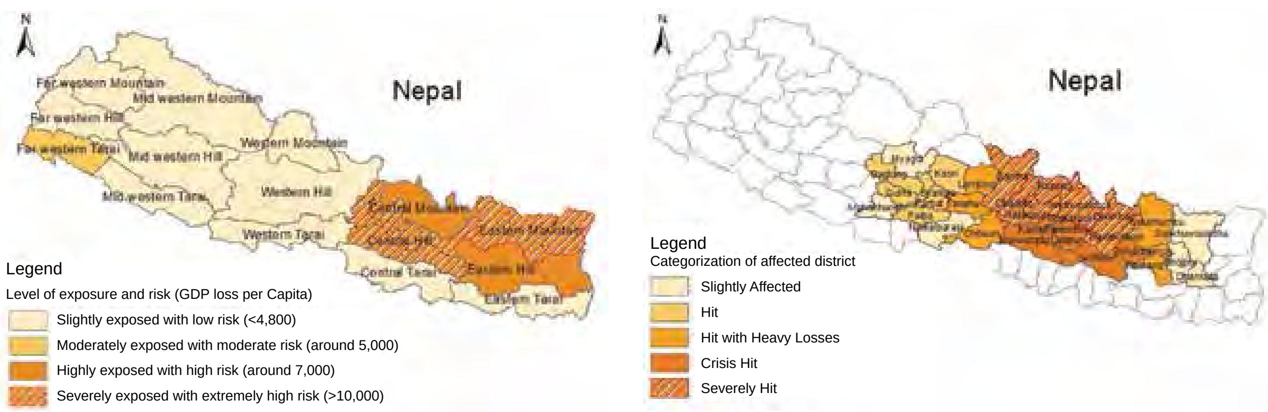
The *Global Assessment Report 2015* introduced the probabilistic risk assessment method and used it to estimate future losses, from earthquakes, tsunamis, floods, cyclones/typhoons and landslides. The estimate is a weighted average of the expected loss from every disaster event, given its probability of occurrence – the average annual loss (AAL). An AAL calculation involves three components: hazard modelling; exposure and vulnerabilities; and risk estimations. It uses both historical experiences and modelled predictions to give a comprehensive picture of what can be expected.

The AAL is considered one of the most robust probabilistic risk indicators - offering a quantifiable, and comparable assessment of future disaster losses by type and economic sector. Policymakers can use this for DRR financing budgets, designing risk reduction schemes and carrying out cost-benefit analysis for specific intervention proposals.

FIGURE IV-10

Modelled and actual earthquake damage in Nepal, 2015

Modelled impact | Actual impact



Source: Government of Nepal/Ministry of Home Affairs (accessed 21 May 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.

Disasters impact different countries in different ways, and the AAL can reflect this with detailed estimates at the national level. Figure IV-11 provides estimates for AAL for selected countries, by type of disaster and sector. This indicates that in large continental States including Bangladesh, China, Myanmar, Nepal and Pakistan, the main drivers of AAL are floods. It also shows that China, Nepal and Pakistan are at greater risk of losses from earthquakes, while Bangladesh is more exposed to cyclonic winds. For island countries like Vanuatu and the Philippines, the risks are much higher from storms and cyclonic winds.

The AAL also enables estimates by sector (Figure IV-11). For some countries, those worst affected are poor households – as in Myanmar, Pakistan and Fiji, where they experience around 40 per cent of the income loss. For others, the brunt of expected disaster losses, around 70 per cent, is felt in commercial and industrial sectors – as in Bangladesh, China, Nepal and Thailand.

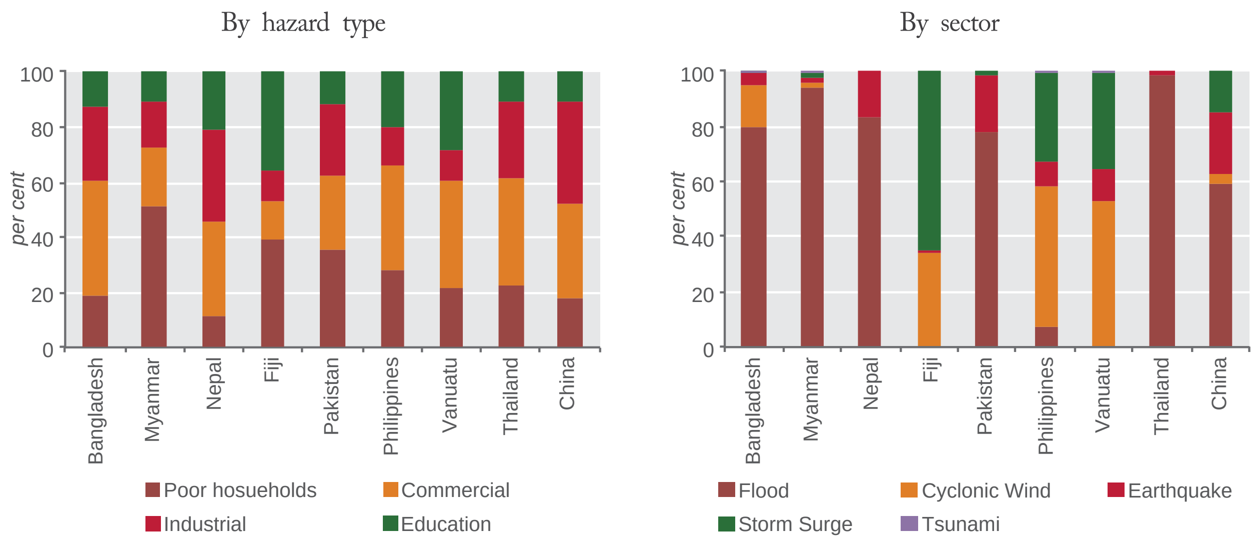
Climate risk assessment

Many countries in the region have been downscaling regional climate change scenarios to the national level, particularly for hydrometeorological hazards. The aim is to understand the scale and nature of the risks associated with climate change, as well as the impact on vulnerable sectors, along with the associated costs. This involves three steps: regional climate modelling, physical impact assessment and economic assessment.

The Asian Development Bank, for example, has examined the economic costs associated with climate change and adaptation in five countries: Bangladesh, Bhutan, India, the Maldives and Sri Lanka. This pioneering study predicts that climate change will cost these countries on average 1.8 per cent of their annual gross domestic products, rising by 2100 to around 8.8 per cent.[25]

FIGURE IV-11

Estimated average annual losses from disasters, selected countries



Source: UNISDR, 2015b.

A number of countries now have pilot programmes for comprehensive climate risk assessment – including Bangladesh, Cambodia, Nepal, Papua New Guinea, Samoa, Tajikistan and Tonga. These assessments are taken into account by climate investment funds/green climate funds for financing climate resilience projects. A number of innovative country-level initiatives have demonstrated the potential for climate risk assessment for resilient development planning (Box IV-5).

TRANSBOUNDARY CONCERNS

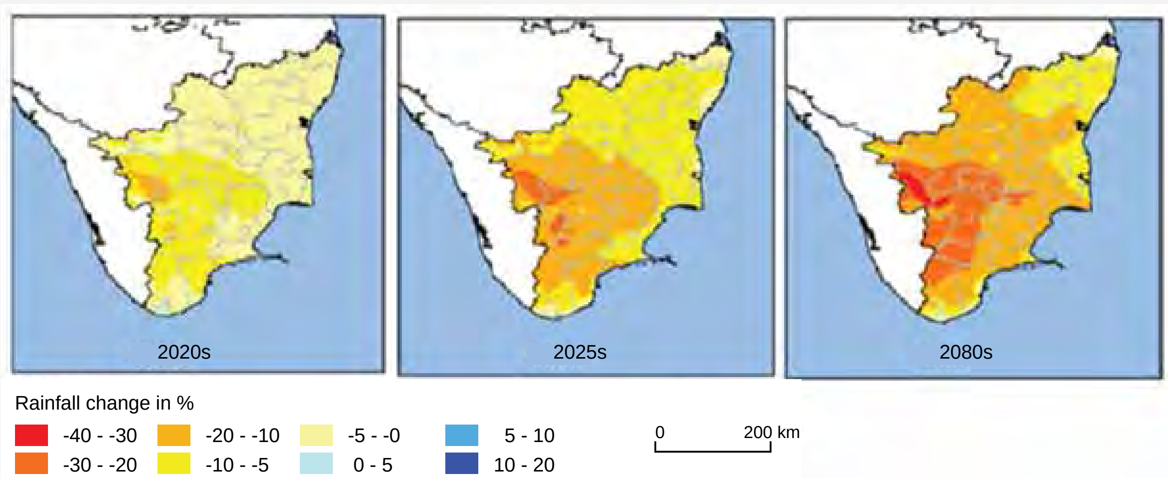
The impact of natural disasters often extends beyond the boundaries of a single country as weather and geographic topography do not stop at the boundaries of any one country, city or administrative boundary. Managing disaster risk thus also requires cooperation between neighbouring countries. The region's best practices in information sharing for disaster risk management include:

BOX IV-5

Climate risk assessment for resilient development planning – Tamil Nadu, India

Tamil Nadu in India is exposed to various climate-related risks including cyclones, heavy rainfall, floods, droughts and landslides. To ensure climate-sensitive planning and decision-making, government stakeholders have been encouraged to incorporate comprehensive climate risk management into development planning.

This has been used to calculate the effect of climate change on the agriculture sector. The assessment was based on high, medium, and low emission IPCC scenarios, for the 2030s, 2050s, and 2080s.[26] This indicated the associated temperature increases and likely declines in precipitation, as in the maps below.

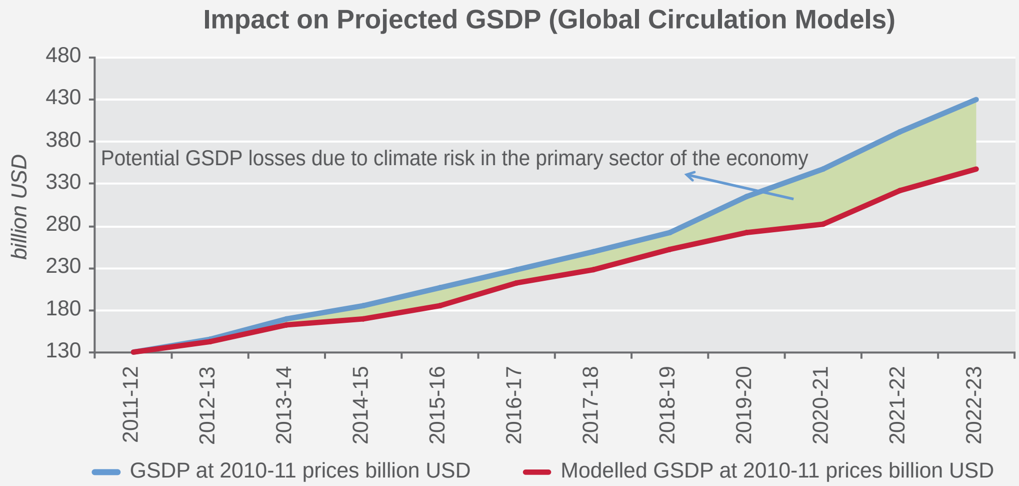


Source: UNDP, 2013b.

BOX IV-5 (continued)

Climate risk assessment for resilient development planning – Tamil Nadu, India

This was used to model the impact on the primary sector of the economy – on agriculture and on industry and service sectors linked to agriculture. The project impact on gross state domestic product (GSDP) is indicated below.



Source: UNDP, 2013b.

Flood management and mitigation in the Mekong river basin

The region's most established mechanism for managing a transboundary resource is the Mekong River Commission – which works directly with the governments of Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam on joint management of shared water resources in the Mekong river basin (MRB). The MRB has many potential flood areas and complex transboundary water relationships – particularly in the lower MRB – emanating from nature or human decisions and activities (Figure IV-12).[27]

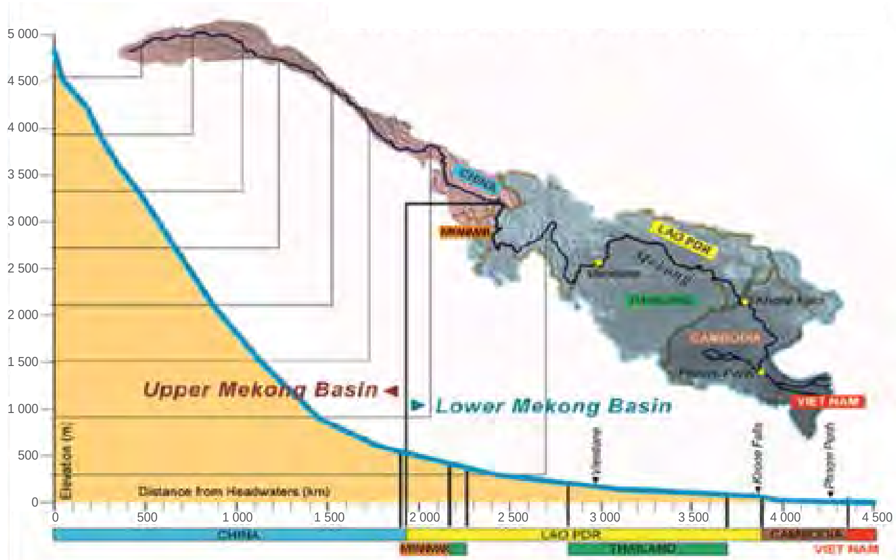
The Mekong has a predictable and regular pattern of seasonal flooding but the extent can vary significantly from year to year.[28] To address such issues the MRC has an Information and Knowledge Management Programme which makes flood forecasts via its Data Information Services Portal – keeping communities updated and helping them plan for crop irrigation, navigation accessibility and fisheries.[29]

Hindu Kush Himalaya regional flood information management system

The Hindu Kush – Himalayan region (HKH) comprises high mountains, valleys, and plateaus shared by Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. Rivers flowing through this region are vital for the survival and well-being of more than a billion people, most of whom live in the surrounding plains. The region is, however, vulnerable to geological and hydrometeorological disasters, particularly flooding.

FIGURE IV-12

The Mekong river profile from headwaters to mouth



Source: Mekong River Commission, 2011.

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 monitor these vital water flows, and ensure a timely exchange of flood data through an accessible and user-friendly platform, the International Centre for Integrated Mountain Development (ICIMOD), in collaboration with the World Meteorological Organization, has made efforts to establish the 'Regional Flood Information System in the HKH Region'.[30] This initiative has helped set up hydrometeorological stations across Bangladesh, Bhutan, Nepal and Pakistan. These stations collect real- or near-real-time data on river levels and rainfall and related issues – which is disseminated through a web-based platform. This Regional Flood Information System may now be integrated into the operational flood monitoring and early warning systems in the respective countries. For this purpose, there are two important enabling steps. The first is to fully understand the transboundary risk - from regional to local levels. The second is to establish a multi-stakeholder platform that will engage the disaster risk management community with other key stakeholders, including hydrologists and meteorologist. This twin-track strategy will ensure better linkages between the Regional Flood Information System and its operational applications so as efficiently support flood forecasting and early warning down the line.

Transboundary management of landslides

Landslides can also be transboundary. In 2014, for example, heavy precipitation in Tajikistan triggered a landslide that killed 431 people in the neighbouring region of Badakhshan in Afghanistan.[31] Due to the absence of a transboundary information sharing mechanism, it was not possible to issue an early warning.

If countries and communities are to mitigate the impacts of hydrometrological-related disasters they will need to scale up existing measures such as landslide hazard zonation, risk assessment and early warning. This requires a more in-depth understanding of numerous risk factors: terrain characteristics; weather patterns and severe precipitation events; vulnerable populations; exposure of settlements; and key infrastructure. This should be complemented with a transboundary information management system to deliver data to government agencies. By cooperating in this way at the regional level and local level they can share the risk information and allow for timely evacuation. Such transboundary information management also needs to be more comprehensive – integrating river-basin hydrology with climate risk scenarios, seasonal weather forecasts, monsoon variability analysis, terrain characteristics and information on land use and cover.

ESCAP is supporting this transboundary information management in various ways, including the development of regional land cover maps for better understanding of disaster risk. In addition, one of ESCAP's specialized regional institutions, the Asian and Pacific Centre for development of disaster information management (APDIM), is helping countries address critical gaps and strengthening the region's capacity for pre- and post-disaster risk assessment. APDIM takes a multi-hazard approach – focusing on earthquakes, tsunamis, floods, cyclones/typhoons and droughts. In this way it can address information gaps and promote South-South and regional cooperation.

ADDING VALUE TO INFORMATION

Information should not just be accurate it should also be actionable – allowing countries to assess trends over time, and between regions, and to set quantifiable targets for disaster risk management. They should be able to employ the data in their risk models and vulnerability analyses and use these as a basis for decision-making. For this purpose disaster data systems should use standard socioeconomic indicators and harmonized methodologies so that they can be interlinked.[32]

Geospatial information

Geospatial information is valuable for assessing a number of hazards. One study that assessed ten major geospatial information products found that for humanitarian purposes the most valued products were those related to earthquakes and floods.[33] For economic purposes, however, those of greatest use were for urban land use classification along with flood and landslide risk assessments (Figure IV-13).

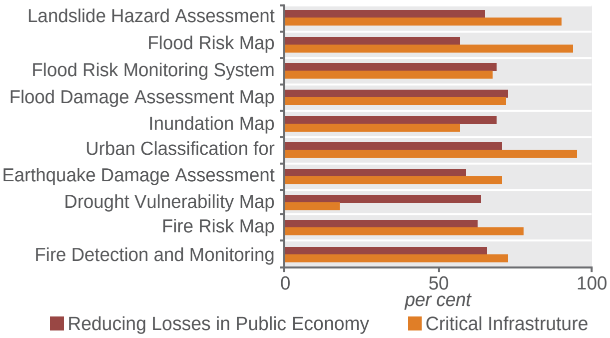
The study also considered the most useful mapping scales. Apart from drought vulnerability, where the data often need to be presented at a regional or global level, the most useful geospatial information should be on much smaller scales and at high resolution. Flood risk maps, and urban classification for earthquake risk mapping, for example, should be on scales of 1:2,000 to 1:10,000, with a spatial resolution of one to five metres per pixel.[34] Landslide hazard assessment mapping can be at a 1:50,000 scale, with a spatial resolution of 10 metres. Another issue is the frequency of updates which in both these cases might be every five years.

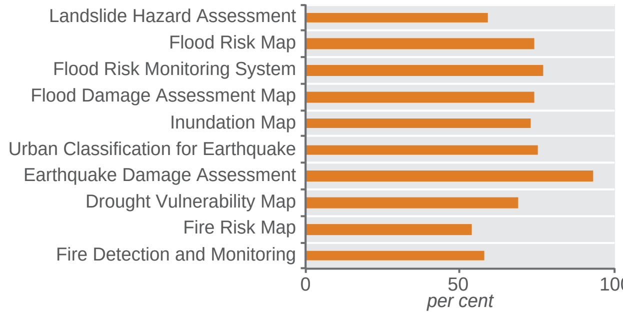
Geoportals

One of the most useful ways of sharing information is through web-based geoportals. These can collect information from diverse sources and offer customized presentation for specific types of user. Customization is organized according to 'access control' and 'workflow'. Access control means that different groups of users can be given privileged or limited access to certain areas of the system. Workflow involves

FIGURE IV-13

Views of the value of geospatial information





Source: UNOOSA, 2015.

Notes: Percentage of respondents rating the benefits as 'high'.

managing the flow of data between certain groups of users, depending on who needs to take action, who needs to stay informed, and who needs specific information. Another important issue is the aspect of time. Within geoportal systems timing can be managed through the use of alerts, notifications, and scheduled and automated updates and outputs.

ESCAP has worked with Countries with Special Needs to establish cost-effective, easy-to-maintain portals for geo-referenced information systems for disaster risk management (Geo-DRM). For this purpose ESCAP has been collaborating with UNOSAT, the Asian Institute of Technology, and the Applied Geoscience and Technology Division of the Secretariat of the Pacific Community. These portals, which have now been established in Bangladesh, Cook Islands, Fiji, Kyrgyzstan, Mongolia and Nepal, combine socioeconomic data with satellite imagery and other disaster-related data – providing the right information to the right people, at the right time. Countries that wish to implement their own geoportal can take advantage of open-source options (Box IV-6).

BOX IV-6

Open-source geo-referenced information systems

ESCAP has helped countries share geo-referenced information over the internet using the open source tools GeoNode (http://geonode.org/) and GeoNetwork (http://geonetwork-opensource.org/). These provide a single platform for accessing location-based information, using archived and up-to-date infrastructure, socioeconomic, meteorological, disaster and satellite-derived data. Responding to an ESCAP survey, national authorities and agencies said that Geo-DRM portals are essential tools for taking advantage of satellite imagery received from national, regional and international providers.

To control access, manage data, and maintain the consistency and authenticity of information, it is important that such systems be centrally managed by a national focal point, preferably a national disaster management authority. The focal point can work closely with national survey departments, BOX IV-6 (continued)

Open-source geo-referenced information systems

census departments and meteorological departments to upload and maintain data in their respective domains. For this reason, the Geo-DRMs have been positioned within the appropriate national authorities. During these tasks, ESCAP has also linked up with ministries and agencies working in similar fields and coordinated with on-going national efforts through existing United Nations and inter-agency initiatives.

- Cook Islands – the country has formed a taskforce consisting of GIS experts from various ministries. After fully mapping the island of Aitu, they officially launched the portal in August 2014.

- Mongolia – National Emergency Management Agency has established a Geo-DRM portal which is used for mapping resources, groundwater, land use, ecosystems, provincial borders, forests, soil, grasslands and special protected areas. Mongolia is currently utilizing natural and man-made disaster data and will connect the portal to the emergency operation and early warning centre.

- Nepal – The Ministry of Home Affairs has formally launched their portal and all stakeholders are using the system and continuously uploading disaster-related data. The geoportal was also used during the 2015 earthquakes as a repository for GIS and mapping data (http://drm.moha.gov.np/).

ESCAP has also launched an online learning platform for disaster risk management. The site provides instructions on how to set up and maintain such Geo-DRM portals, perform geospatial analysis and flood risk modelling. It also offers information on other disaster-related GIS skills and techniques (http://drmlearning.unescap.org/).

Source: ESCAP, available from http://drmlearning.unescap.org/.

The Asia-Pacific region has access to a variety of advanced subregional, regional and global geoportals. They include those developed by: the Indian Space Research Organisation (http://bhuvan.nrsc.gov.in); the Pacific Disaster Center (http://www.pdc.org); the International Centre for Integrated Mountain Development (http://geoportal.icimod.org); the Global Disaster Alert and Coordination System (http://www.gdacs.org); and ReliefWeb (http://reliefweb.int), a specialized digital service of OCHA.

THE RIGHT INFORMATION TO THE RIGHT PEOPLE AT THE RIGHT TIME

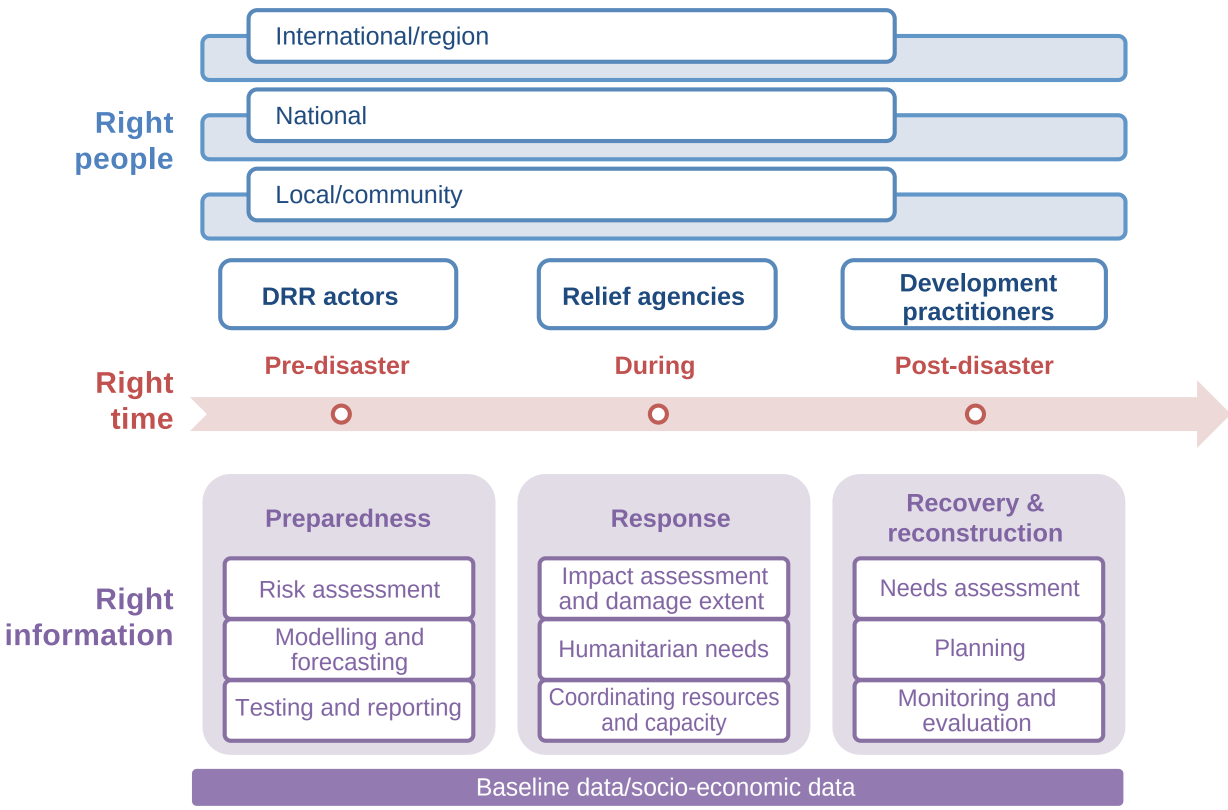
Effective information management provides the right information to the right people at the right time (Figure IV-14).

Right information – Each phase of the disaster cycle – preparedness, response and recovery and reconstruction has specific tasks. During the response period, for example, these include impact assessments, humanitarian needs assessments and the coordination of resources and capacity. Each has its own information requirements.

Right people – Each phase also has its own primary stakeholder groups. These include DRR actors, relief agencies and development practitioners who in turn may be operating at the international, regional, national and local levels. It is important to map these groups and understand their information needs and also the information they can generate to feed into the overall information management system.

FIGURE IV-14

Right information, right people and right time



Right time – There are windows of opportunity for providing information to each target audience and for collecting it from the various sources. This requires a degree of predictability through regular reporting structures, as well as elements of flexibility to fulfil ad-hoc information requests.

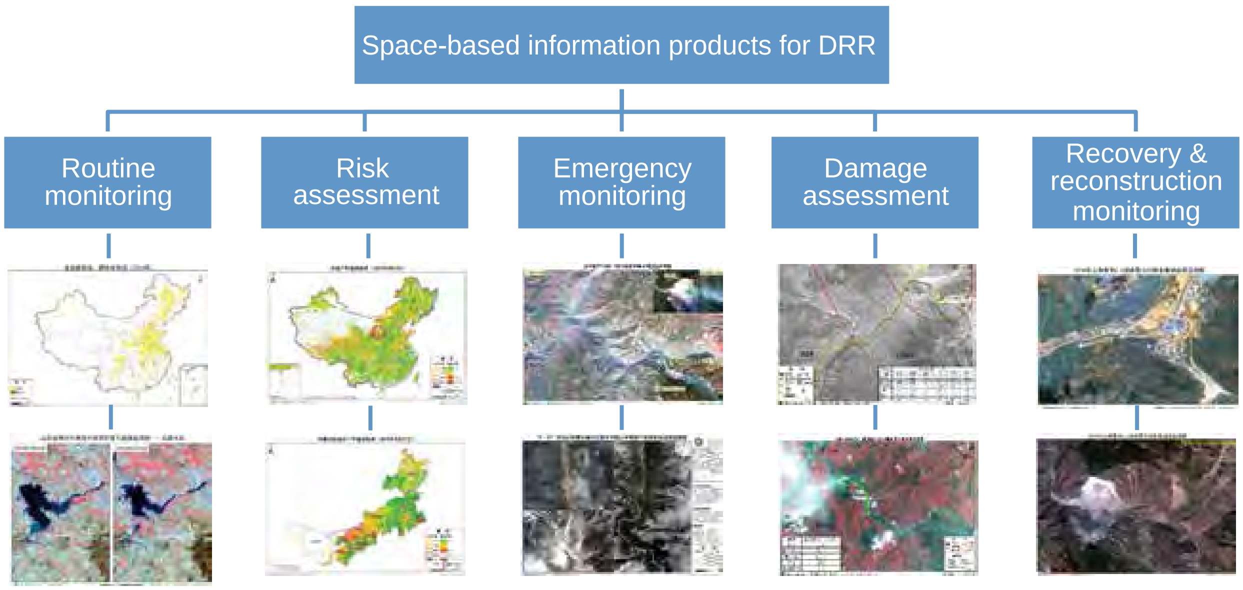
Each country will design its own information system. For example, the National Disaster Reduction Centre of China (NDRCC) has a range of operational information products (Figure IV-15). In this case, for example, the 'routine monitoring' and 'risk assessment' components correspond to the 'pre-disaster' right time period of Figure IV-14. While the 'Emergency monitoring' and 'Damage assessment' components correspond to the 'during' period. Pre-disaster products, for example, cover applications for providing advice and sending messages through mobile phones and other devices. During-disaster products include applications for disaster situation briefings, aerial imagery, geological hazard monitoring, flood inundation, monitoring structural integrity and monitoring damage to key roads, infrastructure and residential sites.

MAKING ICT SYSTEMS RESILIENT

During disaster events, information management systems are themselves vulnerable. It is important therefore that they are grounded within resilient infrastructure such that they can absorb shocks and maintain services when faced with limited connectivity or increased volume of traffic. Such resilience requires network diversity, redundancy and proactive investment. In an effort to understand how these considerations affect the communications networks in the region, ESCAP and ITU have partnered to create a regional map of the terrestrial fibre optic backbone. This map makes it easier to identify weaknesses in

FIGURE IV-15

Disaster information products in China



Source: Provided to ESCAP by NDRCC, 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.

the regional connectivity infrastructure and to target infrastructure investment opportunities.

ESCAP's Asia Pacific Information Superhighway[35] (APIS) initiative tackles these issues by addressing missing links at the national and subregional levels. APIS promotes resilient infrastructure backbones that have a balance of terrestrial and submarine fibre optic connectivity. Investments in this type of infrastructure, together with improvements in internet traffic management, and mechanisms for regional cooperation, will make networks more resilient to disruption by disaster events and easier to restore if damage occurs.

Japan, for example, has ensured that its disaster management communications are resilient by basing them on a decentralized 'mesh' architecture. Networks and relevant buildings each have their own receiving stations and radio masts, supplemented by mobile equipment, while all are linked to an overarching communications satellite (Figure IV-16).

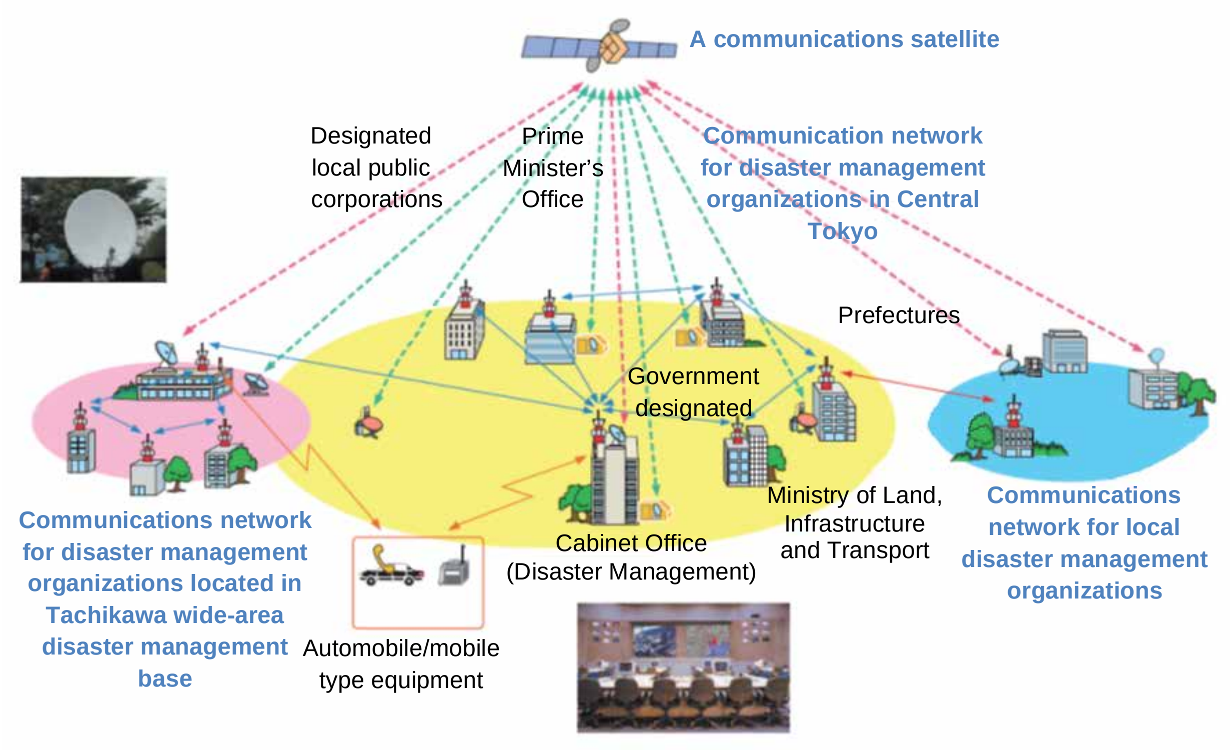
SCADA systems

Individual items of energy and transport infrastructure, such as bridges or electricity substations, are typically monitored remotely by centralized systems over communications networks – using SCADA (supervisory control and data acquisition) systems. Such systems generally work well, but from the perspective of disaster management have a number of limitations. One is that they are usually proprietary and differ from one application and enterprise to the next. Another is that these 'black box' systems are not interoperable or interconnected.

For example, Thailand's Flood Control Center, established in 1990, monitors 69 remote SCADA units that measure hydrological data such as

FIGURE IV-16

Central disaster management radio communications system in Japan



Source: Provided to ESCAP by Japan Aerospace Exploration Agency, 2014.

rainfall, water levels and quality, as well as flood damage for processing and analysis.[36] But the only way to collect the data is to physically visit the installations.

Nowadays due to increasing automation and integration of these technologies, it is necessary to view them as interconnected and interdependent parts of a critical network. For this purpose it will be important to move from proprietary systems to open standards. This helps promote systems integration, and empowers end users to identify problems and respond to them. Such systems should also be regularly tested. At the regional level stakeholders can create working groups to focus on specific activities, and collaborate on sharing information for disaster preparation and response.[37]

CELL PHONES

The latest smart-phones have embedded sensors that enable them to collect large amounts of incidental data, from electronic transactions, for example, and social media. Analysis of this 'big data' can, give immediate indications of population movements, for example, or other behaviour that can be useful before and after disaster events. Cell phones can also be valuable for general disaster management – receiving text messages and warnings of incoming disasters, and also transmitting crowd-sourced imagery of damage and impact.

The rapid advances in technology offer great opportunities. But taking full advantage of these is difficult for governments. While the technology for standard cell phone calls and text messages has remained relatively unchanged for many years, user behaviour changes very quickly. A specific application might only have a lifespan of five to ten years. This is a reasonable period for consumer technology, but far shorter than that typically required for government investment programmes and products.

These applications depend on collecting large amounts of user data, so they rely on a resilient network that can withstand large-scale disasters. To make realistic use of these tools, governments should therefore focus primarily on maintaining the infrastructure – ensuring, for example, that commercial telecommunications networks can cope with disruptive events and handle high usage spikes.

At the same time governments need to remain sufficiently agile to identify and utilize emerging technologies – and be in as strong position to collect, curate and take action on this data. For developing countries in particular this is generally an expensive prospect so governments should carefully consider which aspects of the technology they can afford or sustain.

Relying on mobile phones as data conduits also confronts a classic problem in the use of ICT – the tendency, particularly in developing countries, to empower the connected and further disenfranchise the more marginalized communities. There can also be gender implications, as women in some poorer communities are less likely to have mobile phones. Even in these circumstances, however, disseminating disaster warnings by text message is likely to be effective since the news will be passed on rapidly through communities and households. Nevertheless, when promoting these tools governments should be more sensitive to issues of access and marginalization.

Hardening networks

During disasters, there are two major causes of communications disruption. One is physical damage or loss of power. The other is sudden network congestion as governments, emergency responders, and citizens all start using their handsets.[38] To reduce the probability of service outages, countries should frequently stress test their networks and where necessary take steps to 'harden' the weaker components.

Two indicators of the health of a national communications system are 'packet loss' (the percentage of information packets that are lost in transmission) and 'network latency' (the time it takes for a packet of data to get from one designated point to another). Based on information from around 90 countries, the mean rate of packet loss globally is 1.68 per cent and the mean latency globally is 107.31 milliseconds. In the Asia-Pacific region performance on these indicators varies greatly. Latency in Nepal, for example, is significantly higher than in Singapore (Table IV-3).

Ensuring that networks are sufficiently robust during disasters is made more difficult by continuing increases in consumer demand. Countries that are not increasing their network capacities accordingly risk having them falter during disaster events.

One way of extending networks through fibre optic cables at lower cost is to co-locate these with existing or new energy or transport infrastructure. It may also be possible to use untapped fibre capacity in existing SCADA systems.[39] Such co-location also makes it simpler to repair damaged infrastructure.

TABLE IV-3

Network reliability, selected Asia-Pacific countries

Country	Year	Mean packet loss (%)	Mean latency (milliseconds)
Azerbaijan	2013	0.32	83.96
Russian Federation	2014	0.83	72.09
Hong Kong, China	2014	1.00	72.13
Singapore	2014	1.40	64.49
Kazakhstan	2010	1.26	92.35
Nepal	2012	1.85	92.65

Source: Speedtest.net (retrieved June 2014) and analysis by ESCAP.

Recent disasters in the region have demonstrated that while a fibre optic backbone can be quite disaster resilient, it is more difficult to deliver reliable communications over the 'last kilometre'. In Nepal, for example, during the 2015 earthquakes the national core telecommunications backbone, which had benefitted from significant investment, stayed functional. But other components of the network, such as cell phone towers, suffered significant impacts, making it difficult to restore communications to hard-hit areas. This experience illustrates the value of investment, but also the need to consider the complete service delivery chain.

RESTORING COMMUNICATIONS AND E-RESILIENCE

The first 72 hours after a disaster are crucial.[40] During this period, the most critical response teams can be equipped with dedicated communications networks such as terrestrial trunked radio. However it is also vital to restore the communications infrastructure as a whole. Indeed it may need to be enhanced, given high data traffic following disasters – for sharing high-resolution GIS maps, for example, streaming video, or large amounts of voice communication.[41]

Resilience via internet protocols (TCP/IP)

Voice information on a telephone call is transmitted using a circuit-switched network which is prone to overload as multiple callers vie for the same communication pathways. The internet, however, operates on the principles of packet-switching in which individual packets of information that make up a message can take any one of multiple routes according to availability. This level of redundancy makes it inherently more flexible and resilient. In the wake of the Japan earthquake of 2011, for example, NTT DoCoMo, Japan's largest mobile phone operator, created an application called Disaster Kit. This allowed users to communicate with their friends and family via voice messages through a packet-switched data network rather than adding to the load on the circuit-switched voice network.[42]

Mobile base stations

Mobile networks can also offer a degree of redundancy. Should one cellular base station fail, some service to the affected area can be provided by a neighbouring node. And in the case of disaster it is also possible to quickly add mobile base stations or 'cells on wheels'.[43]

Even so, these will all need power supplies. One problem following the Japan earthquake of 2011, was insufficient power for base stations. In response, companies have introduced new designs featuring longer-lasting fuel cell technology.

Mobile base stations were deployed, for example, in the US in 2005 in the aftermath of Hurricane Katrina in New Orleans to provide cellular connectivity for first responders. ViaSat and Qualcomm staff transported mobile base stations that allowed for communications both within and outside the network. For best coverage such stations should be located on high vantage points. In New Orleans, they could be placed on high-rise buildings.[44] But this may not always be possible, particularly in rural areas, or in urban settings affected by floods or earthquakes. In such cases, ground-based systems can be supplemented with airborne antennae.

Airborne base stations

Another option is to have the whole base station airborne on a UAV.[45] Individual UAVs, using miniaturized cell phone technology, might be able to service only a limited area, but connected with a base station they can also be linked in chains. These have the advantage of flexibility since they can be moved as required. They are also relatively inexpensive.

Internet services can also be offered from balloons. In 2013, the internet company Google announced Project Loon. This project has now reached the stage where a single balloon can stay aloft for more than six months and when linked with an upstream telecommunications network can provide cellular service for an area of around 3,000 square kilometres. While originally intended to extend services generally in developing countries this also has considerable potential for more specific use during disasters.[46] Motorola is also developing lighter-than-air platforms to deploy communications services rapidly when terrestrial infrastructure has been damaged.

A ROADMAP TO EFFECTIVE AND RESILIENT INFORMATION MANAGEMENT

Providing the right information to the right people at the right time, involves five principal steps. These are: 1) understanding risk; 2) having data and information sharing policies; 3) generating actionable information; 4) customizing information and reaching out to people at risk; and 5) using real-time information.[47]

Taking these steps depends on three key 'enablers': capitalizing on innovative technology, achieving international and regional cooperation, and developing capacity through South-South and Triangular cooperation to share knowledge and good practices[48]. These principal steps and key enablers all depend on critical ICT infrastructure which need to be protected to underpin their functioning.

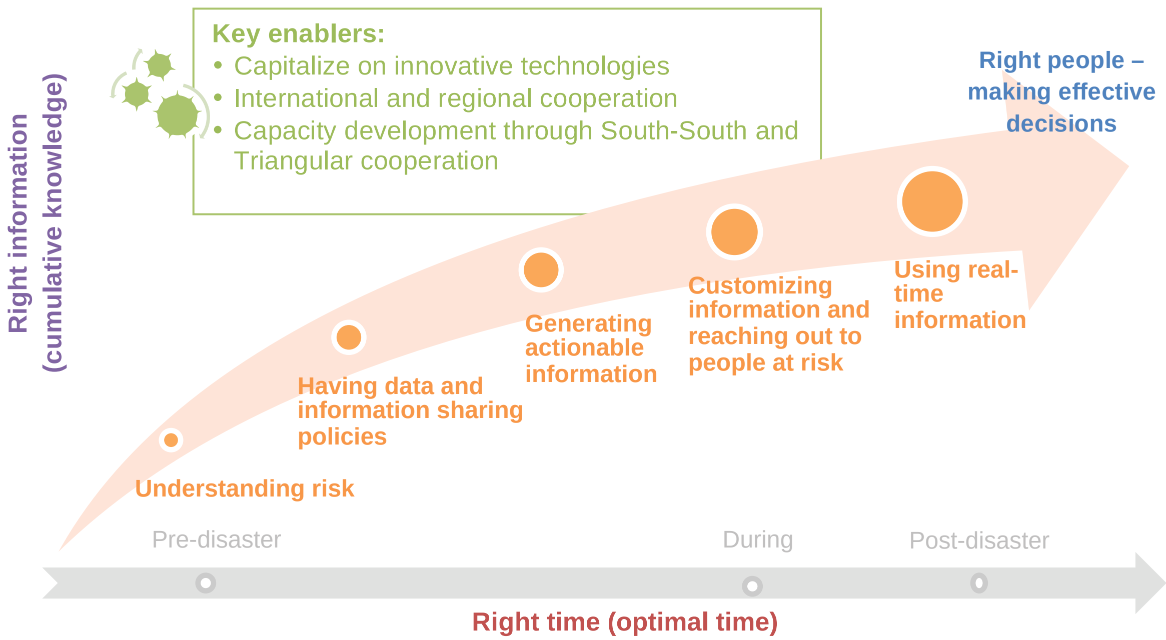
Step 1 - Understanding risk

Understanding risk is best addressed during the pre-disaster phase. This involves assessing risks in qualitative and quantitative terms, where possible modelling them with available data, while considering issues of financing and insurance. It also means taking into account the culture and psychology behind risk, and creating partnerships for building resilience (Box IV-7).

One issue is that information collected from various sources may not be in a standardized form. It may also have coverage biases: information

FIGURE IV-17

A roadmap to disaster information management



from insurance companies, for example, will largely refer to events that might be covered by insurance. Disaster information collected at the local level (e.g. DesInventar) is likely to be more complete for specific disaster – since it will include small magnitude and high-frequency events (Box IV-8). But it only covers those disasters that are entered into the system. Learning from the DesInventar experience, the Government of Indonesia has been working with UNDP to create Disaster Data and Information of Indonesia – a comprehensive disaster loss database that will guide the development of a national DRR plan and can be used to monitor the impact of disasters on poverty at the community level.

Step 2 – Data and information sharing policies

In many cases individuals and organizations create data for their own purposes, but it is not clear who is responsible for sharing it more widely. Everyone assumes that some responsible authority must be managing and coordinating information, but this may not be the case.[49] Data sharing may also be hampered by policies for data privacy and data protection.

It is imperative therefore that policies on data sharing are clearly established before disasters strike. Otherwise any sharing is likely to be ad hoc and sporadic based on personal relationships and informal networks.[50] Many countries have addressed this delicate policy balance through ministerial or parliamentary directives that override existing policies during emergencies. Or they may allow for exceptions where, under certain conditions, one policy takes precedence over another. Such policies can be broad, at the national and regional levels, or they can be specific or bilateral, between agencies and line ministries. Policies can also cover technical issues

BOX IV-7

Open-source risk assessment tools

Some tools for risk assessment have been developed by the private sector, usually by insurance companies for catastrophe modelling. However, there are also many open-source options developed by governments and international agencies.

One of the earliest, was the Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters (RADIUS).[51] This allows users to perform aggregated loss estimation using a mesh grid. Another is HAZUS ('Hazards US') which was developed using public domain software by the US Federal Emergency Management Agency for performing loss estimation. Several other countries have adapted the HAZUS methodology for their own needs.

The Central American Probabilistic Risk Assessment (CAPRA) initiative utilizes geographic information systems, Web-GIS and catastrophe models for disaster risk assessment within an open platform.[52] CAPRA's main product is the software tool CAPRA-SIG, which combines hazard scenarios, and exposure and vulnerability data to calculate loss exceedance curves. The RiskScape methodology for multi-hazard risk assessment is a comparable initiative in New Zealand.[53]

Additional methodologies and tools include Vulnerability and Capacity Assessment by the International Federation of the Red Cross and Red Crescent Societies, Community based disaster risk Management by the Asian Disaster Preparedness Center, and Natural Disaster Hotspots by the World Bank.

BOX IV-8

Databases and resources for understanding risk

The Emergency Events Database – Administered by the Centre for Research on the Epidemiology of Disasters, EM-DAT, records disasters based on threshold criteria: at least 10 fatalities; 100 or more people affected; a declaration of emergency; or a call for external assistance.[54]

GLIDEnumber – The Asian Disaster Reduction Center assigns each disaster a unique identifier and a number of relevant attributes.[55]

DesInventar – Disaster Information Management System. This is a disaster loss database that allows local authorities, communities, and NGOs to collect disaster information at the local level to feed into an online database.[56] It is an initiative of UNISDR, the European Commission and UNDP.

DisDAT – This is a service of the Global Risk Identification Program and the Centre for research in Epidemiology of Disasters. It brings together all publicly available disaster databases from different countries.[57]

INFORM – This is a global, open-source risk assessment for humanitarian crises and disasters. It is a collaboration of the Inter-Agency Standing Committee Task Team for Preparedness and Resilience and the European Commission. Available from http://www.inform-index.org.

such as standardization and formats, platforms, procedures and protocols, timeframes, naming conventions, authorization and classification.[58]

Integrating geospatial information in particular relies on robust spatial data infrastructure (SDI) – a framework for policies, resources and structures. At the global level the United Nations Spatial Data Infrastructure (UNSDI) promotes the development of a framework for sharing, processing, applying, and maintaining spatial data sets within an environment of agreed technologies, policies, and standards.

It is also important to combine global and national data infrastructure – to allow for the sharing of maps through inter-operable formats. For this purpose, the United Nations initiative on Global Geospatial Information Management (UN-GGIM) is setting the agenda for the development of global geospatial information, and monitors the SDI status for all countries.[59] Asia-Pacific countries that have their SDI details listed include Australia, China, India, Japan, Republic of Korea and Malaysia.

Step 3 - Generating actionable information

While it is relatively easy to generate vast amounts of data it is more difficult to ensure that this information is actionable. Earlier sections have indicated what this implies during the pre-disaster phase. But actionable information is needed throughout the disaster cycle. For this purpose, it is important to establish a classification system for information types, along with the implied actions. This system can then be used for information filtering. As information comes into a disaster risk management system it can be assigned to an appropriate action.

Step 4 – Customizing information and reaching people at risk

Information should be customized to the needs of stakeholders. This requires location-based information services and decision support tools that can reach out to people at risk. It also means establishing strong institutional links for coordination between developmental and planning actors so that risk reduction is integrated into development plans. Normally such integration should be carried out as part of their regular functions by planning ministries.

Step 5 - Using real-time information

A well-informed situation analysis requires real-time data. Nowadays this can come from local information complemented with satellite imagery, geospatial information, crowdsourcing and UAV images. However, to work smoothly this requires considerable coordination. For example, if a disaster has transboundary origins, then gaining access to real-time information requires regional and international cooperation. An important agreement in this respect is the International Charter on Space and Major Disasters (Box IV-9). At the regional level, in Asia-Pacific, access to satellite images is facilitated by ESCAP's RESAP network and Sentinel Asia.

Protecting ICT infrastructure

Disaster management planning depends on effective communications networks. Since these networks are also heavily embedded in a variety of other infrastructural components, such as management of the electrical grid, it is important to take an integrated approach.

BOX IV-9

The International Charter on Space and Major Disasters

The International Charter on Space and Major Disasters (International Charter) is a global agreement between space agencies, aimed at providing a unified system for accessing and delivering fast and free satellite imagery and space data to countries affected by natural or man-made disasters. Although the International Charter can only be activated by authorized members during emergencies, it can be activated for disasters in any country for acquisition and dissemination of space data to share with relevant national authorities.[60] For the Asia-Pacific region, the International Charter was activated on average for 14 per cent of disaster events – 15 times in 2012, 25 in 2013, and 20 in 2014 – more than half of global activations in those years.

Critical infrastructure should be planned and designed with disaster management in mind. This enhances the capacity to restore systems to functionality. By contrast, retrofitting such capabilities into existing systems is expensive and time-consuming.

In many developing countries, however, the commercial telecommunications network may not yet be sufficiently resilient – and thus can be unreliable for critical first-responder communications, especially in the initial hours after a disaster. Countries should therefore consider additional forms of connectivity. For example, first responders may be provided with subscriptions to terrestrial trunked radio networks, which are not connected with public networks and can accommodate sudden high-volume use.

ENDNOTES

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9 Greiving and others, 2012.

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34 If a sensor has a spatial resolution of 20 metres and an image from that sensor is displayed at full resolution, each pixel represents an area of 20m x 20m on the ground.

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47 Figure IV-17 can be adapted to create a more robust information management strategy, so that the five steps are cyclical and can be applied within each phase of the disaster cycle, in addition to different steps corresponding to different phases of the disaster cycle, as currently illustrated.

48 Triangular cooperation typically involves a traditional donor, a donor from the South, and a beneficiary country in the South.

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5

AT THE HEART OF SUSTAINABLE DEVELOPMENT

CHAPTER 5 AT THE HEART OF SUSTAINABLE DEVELOPMENT

"Sustainability starts in Sendai."

Ban Ki-moon, Secretary-General of the United Nations
at the opening of the Third UN World Conference on Disaster Risk Reduction,
Sendai, Japan, 13 March 2015

Disaster risk reduction cannot be confined to one or two government departments. Rather it is a responsibility for every part of government – from education to health to transport to social protection. Just as every sector can be affected by earthquakes or floods or cyclones, so every sector needs to consider how to make its activities disaster resilient.

Disaster risk reduction is an essential component of sustainable development. Measures to reduce the impact of disasters – building stronger infrastructure, for example, or better housing, or better organized communities – also support development in general. But the process works both ways, because countries with higher levels of development are also better able to defend themselves from disasters: as their economies grow, infrastructure becomes more robust and governments that have more resources can provide stronger systems of protection. Sustainable development thus reduces vulnerabilities and makes countries more resilient to disasters.

Disaster risk management should thus be closely integrated with development planning and programming. However in the Asia-Pacific region, there is still a long way to go in achieving this in an inclusive manner in all development sectors, and at all levels.

THE SUSTAINABLE DEVELOPMENT GOALS

The world has increasingly recognized the importance of integrating disaster risk reduction into every development activity, an understanding that has evolved over the years – from the 1987 World Commission on Environment and Development to the 2015 Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) (Box V-1). Disaster risk reduction is also central to the proposed Sustainable Development Goals (SDGs) which address this priority in a number of goals, including those on poverty eradication, food security, infrastructure, cities and human settlements, climate change and ecosystems (Table V-1).[1]

The SFDRR is thus integrated with the SDGs– horizontally across development sectors and

BOX V-1

Disaster risk reduction in the global development agenda

Global understanding on the importance of disaster risk reduction for sustainable development has evolved over recent decades.

1987 – World Commission on Environment and Development – This made the first global assessment of disasters, pointing out their devastating effects on development.[2] The United Nations General Assembly responded by designating the 1990s as the International Decade of Natural Disaster Reduction and adopted an international framework of action that called upon all governments to 'formulate national disaster-mitigation programmes, 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 programmes'.[3]

1994 – The World Conference on Disaster Reduction – Its 'Yokohama Strategy and Action Plan for a Safer World' reiterated that 'disaster prevention and preparedness should be considered integral aspects of development policy and planning'.[4] A review of the Yokohama Strategy pointed out that 'ensuring an established disaster reduction strategy that is linked to individual sectoral interests and integrated into national and local development planning and objectives' remained one of the most critical gaps in the strategy and plan of action.[5]

2005 – Hyogo Framework of Action – The HFA tried to address this gap by recognizing that 'effective integration of disaster risk reductions into sustainable development policies, planning and programmes at all levels' would be one of the strategic goals. And addressing the underlying risk factors across all sectors of development would be one of its five priorities of action. However, progress in this regard has been slow. The public investments for disaster risk reduction have been inadequate, as there was very little appreciation of the costs and benefits of risk reduction among the agencies responsible for planning and financing of development. Thus, disaster risk management has been skewed towards disaster response.

2015 – Sendai Framework for Disaster Risk Reduction – The SFDRR identified these critical gaps and substantially broadened the scope and purpose of the global framework of disaster risk reduction. The expected outcome and goals of the framework focused on implementation of 'integrated and inclusive' risk reduction with various measures – economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional'. The SFDRR has been carefully aligned with the SDGs: its period of action 2015-2030 is coterminous with that of the SDGs and its progress indicators are being developed by an intergovernmental working group in conjunction with the inter-agency expert group on indicators for sustainable development.

TABLE V-1

Resilience to disasters as a cross-cutting issue in the Sustainable Development Goals

SDGs	Main DRR linkages	Examples
Poverty eradication and economic growth	• Disasters tend to have the greatest long-term impacts on those people in the poorest income quartile or quintile, although lack of data and research on long-term effects of disasters at household level makes analysis of the complicated linkages between disasters and impoverishment difficult • Impoverishment is linked to lack of access to markets, capital, assets, and social security and insurance mechanisms that can help people to cope and to rebuild • Disasters affect disproportionally the poor in Asia-Pacific; and LDCs in the region have reported annual damage close to 1% of their GDP since 1970, which is significantly higher than the rest of countries (Chapter 1, "Countries with special needs") • Taking on risks and proactively managing them is a natural element of development and economic growth, and risk assessment and DRR planning should be integrated in investment planning at all levels	• There are over 500 million poor people, in 17 Asia-Pacific countries, who are living under medium or higher disaster risk (Chapter 1) • In rural Andhra Pradesh, India, drought was reported as the single most important factor contributing to impoverishment (Chapter 1)[6] • In the Indian states of Jharkhand, and Odisha (formerly Orissa) and Chattisgarh, drought-related income losses were close to 80 per cent[7] • In the aftermath of the Nepal earthquakes in 2015, poor households in rural areas were more adversely affected than those who lived in cities. The earthquakes are expected to have pushed 2.5 to 3.5 per cent of the population into poverty–around 700,000 people (Chapter 1) • After the earthquake in Sichuan, China in 2008, the proportion of the province's population covered under the 'basic provision protection' scheme rose to more than 50 per cent. Five years after the earthquake, this had not returned to the pre-disaster level (Chapter 1) • Globally, the expected annual average loss from natural disasters is $415 billion – of which 40 per cent is likely to come from 50 countries in Asia and the Pacific. In Myanmar, the annual average loss represents 30 per cent of its annual capital investment. In the Philippines it is expected to be 14 per cent and in Cambodia 10 per cent (Chapter 1)
Food security, sustainable agriculture	• Disasters destroy critical agricultural infrastructure and assets, and they cause losses in the production of crops, livestock and fisheries, causing serious damage to livelihoods and food security of millions of small farmers, pastoralists, fishers and forest-dependent communities in developing countries • Increasing demand for farmland can increase the risk of hazards through environmental degradation. For example, landslides can increase when vegetation is cleared for agriculture on steep slopes • The agriculture-food-nutrition sector is challenged to move towards resilient sector specific DRR measures, technologies and practices which raise yields and increase resilience against production failure, as well as towards a more sustainable use and management of vital resources	• A heat wave in the Russian Federation in 2010 led to the worst drought in nearly 40 years. Added to this were historically severe floods in Pakistan, which led to significant drops in global food supplies[8] • In 2010, following a *dzud* drought event in Mongolia, more than 8.4 million livestock died, affecting more than 770,000 herders. Among them, 164,000 herders lost more than half their livestock and 43,500 were left without a single animal[9] • Estimates from India suggest that drought reduces agricultural production by 12 per cent, compared with floods, which reduce production by 5 per cent (Chapter 2). In the state of Rajasthan, regular droughts have led to forced migration, unemployment, increased debt and reduced food consumption • In South-Western China the Grain for Green Program bans logging and agriculture on steep slopes and prohibits forest clearing. In exchange, the local communities receive grain and cash subsidies as well as protection against flooding events • The 2010-2011 floods in Australia led to the loss of $1.6 billion worth of crops, reducing wheat exports by 1.5 million tons and causing increases in world commodity prices[10] • Typhoon Ketsana hit Lao People's Democratic Republic in 2009, inundating 28,500 hectares of rice and crop planted areas. Five of the affected provinces were responsible for around half of domestic rice production[11] • A severe drought in Afghanistan in 2008 and 2009 led to an acute food supply crisis. Wheat production, at 1.5 million tons, was 60 per cent lower than previous years[12] • A severe drought in 2000 and 2001 in Tajikistan and Uzbekistan cut the availability of drinking and irrigation water and led to slow, chronic forms of malnutrition as households eliminated meat and dairy products from their diets

Health and education	• The Asia-Pacific region accounted for 60 per cent of all deaths in disaster events globally since 2005. A person living in the Asia-Pacific region is twice as likely to be affected by a natural disaster as in Africa, and 6 times more likely compared to someone living in Lain America and the Caribbean[13] • Disasters destroy and disrupt service in health and education facilities • Outbreaks of communicable diseases are often linked to the displacement of people in post-disaster situations, and can further hamper disaster relief • Disasters hamper countries' ability to invest in social development • Education can also greatly contribute to preparing communities and building inclusive, disaster resilient societies, as was acknowledged in the HFA	• In the 2015 Nepal earthquakes, more than 460 public and private health facilities were completely destroyed, almost 7,000 schools were completely or significantly damaged (Chapter 1)[14] • In China's 2008 earthquake, almost 5,400 children died or went missing, 4,500 classrooms were completely destroyed[15] • In Pakistan, the 2005 earthquake, 2007 cyclone and 2010 floods all led to drops in net primary school enrolment[16]
Water and sanitation	• Earthquakes, tsunamis, floods and storms were responsible for around 92 per cent of the total damage in Asia-Pacific since 1970[17] • Lack of basic services and sanitation combined with disasters can also create new risks, for example by turning a heavy rain into disastrous flood with the spread of disease • Disasters, particularly localized, small-scale events, hinder progress in achieving universal access to water and sanitation by damaging sewerage and water supply infrastructure	• As a result of floods in Solomon Islands in 2014, more than 1,000 shallow unprotected wells were contaminated, and flood-induced landslides damaged dams, pipelines and water tanks. This resulted in losses of $2.2 million (Chapter 1)[18] • Globally, a survey of 65 countries and two states found that more than 90 per cent of all damage and losses of water and sanitation facilities were from disaster events[19] • In 2015 cyclone Pam in Vanuatu damaged a total of 65,000 metres of electric transmission and distribution lines, affecting 12,000 people. Relatively few resources have gone into restoring the energy sector due to urgent needs in other priority areas, such as food, water and shelter[20] • The 2012 typhoon Evan caused widespread damage in the Western division of Fiji which experienced damage to power poles, power lines and transformers. The provision of electricity was seriously hindered and it took more than four weeks to restore power[21]
Gender equality and women's empowerment	• Due to existing socioeconomic conditions, cultural beliefs and traditional practices, women and men are affected differently by disasters • Productive resources tend to be owned by men, and losses in the informal sector and subsistence farming, dominated by women, are not often recorded at all • Despite being disadvantaged by economic, social and cultural factors, women can serve as agents of change and their role in disaster preparedness and relief both at family and community level is well documented	• Women represented an estimated 61 per cent of fatalities in Myanmar after cyclone Nargis in 2008 and 70 per cent after the 2004 Indian Ocean tsunami in Banda Aceh • The 1991 cyclone Gorky in Bangladesh killed 140,000 people. Within the age group 20-44, the female death rate was 71 per 1,000, compared to 15 per 1,000 for men • Following the 2010 floods in Pakistan, women were either overlooked or were unable to be reached because their mobility was restricted[22]
Inequality	• Low-income households suffer a dispro-portionate share of disaster impacts and people living in multidimensional poverty are likely to live in hazard-exposed areas and are less able to invest in risk-reduction measures • Disasters hit hardest the most marginalized, notably children, older persons and persons with disabilities • Extensive risk particularly affects areas already characterized by social inequality and exclusion, where a deficit of infrastructure is an underlying source of vulnerability and loss of this further aggravates the situation	• In villages affected by the 2004 Indian Ocean tsunami the death rate was highest for young children and older persons, and was 40 per cent higher for women than for men • Following the earthquake in Japan in 2011, the death rate in Miyagi region amongst the total population of the coastal area was 0.8 per cent, while it reached 3.5 per cent among persons with disabilities • When tropical storm Washi hit Mindanao in the Philippines in 2011, informal communities were hit the hardest[23]

Sustainable cities and resilient infrastructure	• Up to 742 million people, or 60 per cent of Asia-Pacific city dwellers, are exposed to levels of either 'high' or 'extreme' multi-hazard risk (Chapter 1) • More than 60 per cent of the area projected to be urban in 2030 has yet to be built; this poses significant challenges but also opportunities to properly integrate DRR in long-term planning • Hazards provide opportunities for major advancements in DRR with focus on building back better; it should not be limited to structural improvements in buildings or to specific elements of infrastructure without adequate focus on underlying drivers • Those living in informal settlements are most vulnerable to disasters, and many have migrated to slums due to disasters in their original settlements • Extensive risk is characteristic of informal urban settlements and low-income rural areas, where poverty forces low-income households to occupy areas of low land value that may be exposed to floods, landslides and other hazards	• Jakarta's plan for 2010–2030 calls for incorporating risk reduction activities into long-term spatial planning for the city. This includes: restoration of mangrove forests; improvement in public facilities and mass transit; refinement of building and environmental regulations that consider hazard risk; redesign of technology and engineering in disaster areas; and improvements of provision of open space for anticipated increases in intense rainfall • Slum populations and their increase in metropolises such as Dhaka or Manila are significantly augmented by migration related to floods, storms and droughts • In 2014, heavy rainfall in Nepal caused severe landslides at Jure village in Sindhupalchowk district, completely obstructing the Arniko highway, part of the Asian Highway network connecting Nepal with China. Importers faced significantly higher costs of transportation from taking alternative routes (Chapter 1) • The 2010 - 2011 floods Australia damaged more than 9,100 kilometres of roads 4,700 kilometres of rail networks. Power to 480,000 homes was disrupted and more than 50 coal mines were damaged on disrupted[24] • The 2011 Typhoon Haima in Lao People's Democratic Republic led to continuous rain, which caused landslides and blocked national, provincial and tertiary roads. (Chapter 1)[25] • After the 2015 Nepal earthquakes, half a million houses collapsed or were damaged beyond repair; more than 250,000 houses sustained damage. (Chapter 1)[26] • In 2015, cyclone Pam in Vanuatu destroyed 15,000 homes and affected 60 per cent of the population, setting the country's development by years (Chapter 1)[27] • In Dhaka, Bangladesh,vegetation cover has been reduced by more than half. This has depleted environmental barriers, increasing the potential impact of cyclones, floods and drought events (Chapter 1)
Climate change	• Many parts of the world are witnessing an increase in extremes of climate, such as greater extremes of temperature, heavier rainfall, or higher maximum wind speed of storms. This can result in an increase in natural hazards such as flash flooding, drought, landslide, and storm surge • In most countries, the predicted annual average loss increases under climate change scenarios. But affects will differ country by country • Drought and flood hazards are among the most potent causes for long-term impoverishment, particularly in rural areas	• In Asia and the Pacific, 80 per cent of disaster events reported since 1970 have been hydrometeorological-related events such as floods, storms and droughts. These have affected 5.8 billion[28] • Maldives is on average 1.5 metres above sea level. 80 per cent of the land area are less than one metre above sea level. A slight sea level rise will have devastating consequences. Some states, such as the island of Male, risks complete inundation by the end of the century[29] • Afghanistan, parts of China and India and countries in Central and South Asia, rely heavily on water from mountain glaciers and snow melts. A year with limited snow in winter will affect water resources during the growing season (Chapter 2) • Glaciers are retreating at an alarming rate and extreme climate events may become more intense. In particular, heat waves can seriously impact many countries (Chapter 2)
Ecosystems	• Environmental degradation is one of the main drivers of disaster risk • Natural ecosystems can reduce vulnerability to natural hazards and extreme climatic events and complement, or substitute for, more expensive infrastructure investments • Communities dependent on fragile or degraded landscapes – such as overgrazed, heavily deforested or severely eroded lands – are often the most vulnerable to losses from natural hazards • The effects of land degradation are often irreversible	• The 2004 Indian Ocean tsunami damaged coral reefs in Indonesia, Thailand and Sri Lanka. Damage was greatest in reefs that had previously suffered destructive fishing practices (Chapter 1)[30] • In Pakistan,high rates of deforestation have increased susceptibility to floods and landslides during heavy rainfall (Chapter 1)[31] • Mangrove ecosystems reduced the impacts of the Odisha cyclone on coastal communities in India in 1999 (Chapter 1)[32] • Around 1,400 million hectares of land are affected by desertification across Asia, more than any other region in the world. In China and Pakistan, almost a third of productivity gains were negated by soil and water degradation (Chapter 2) • Ecosystems in 32 of 34 Asia-Pacific countries, are experiencing 'medium' to 'strong' degradation (Chapter 1)

		• Some countries have been strengthening the disaster resilience of ecosystems. Since the 1970s India has taken a watershed development approach to agricultural production. It has, over the years, improved and reforested more than 10 million hectares of degraded land (Chapter 2)
Governance and peaceful societies	• Governance arrangements adopted by many countries, relying heavily on specialized emergency management organizations, are not always appropriate to address disaster risk • Disaster risk governance (DRG) often mirrors the challenges, restrictions, blockages and obstacles that exist within the overall governance arrangements, but DRG can also support good governance • Conflict and fragility can increase the impact of disasters, and disasters can exacerbate conflicts	• In India, following the earthquakes in Maharashtra (1993) and Gujarat (2001), housing records were digitized and land titles that were traditionally only recorded under the name of the male head of household for the first time also included the female head of household. This practice was institutionalized and transformed the general practice of social housing in these states
Means of implementation, renewed global partnership	• International cooperation has heavily concentrated on emergency-relief and reconstruction instead of preventive DRR • Funding for DRR is strongly concentrated in just a few recipient countries, with all but one (Bangladesh) of the top 10 recipients of financing being middle-income countries • Capacity building will be crucial, and there exists a need for closer coordination between DRR and climate change adaptation; lack of coordination on technology transfer has led to fragmented implementation	• Globally for every $100 spent on development aid, just 40 cents has been invested in defending that aid from the impact of disasters • In Bangladesh for every $1 invested in storm, cyclone and flood warning prediction systems, the estimated return is between $8 and $500 over a ten-year period. According to research undertaken by the World Bank, investments in hydrometeorological warning services, in developing countries, have a cost-benefit ratio between 4 and 36 (Chapter 4) • International assistance focuses primarily on disaster response and recovery while giving less priority to prevention and preparedness. In the Asia-Pacific region, over the past decade total aid from the international community was $438 billion, however only $2.85 billion was allocated for disaster prevention and preparedness (Chapter 1)

Source: ESCAP based on UN-DESA, 2015.

vertically through the focus on implementation at all levels: global, regional, national and local. What was hitherto seen as a difficult and complex task by most of the developing countries is now emerging as a concrete agenda for action. There is also the potential for additional financial resources, as stipulated in July 2015 in the Third International Conference of Financing for Development, and also promised for the Green Climate Fund as part of the new climate agreement in December.

Integrating disaster risk reduction into development planning means looking critically at each programme, activity and project, ensuring that it reduces existing risks and also avoids creating new ones–what is referred to as 'prospective' or 'anticipatory' risk management.[33]

The principles for ensuring that disaster risk reduction is a national as well as a local priority were established in the Hyogo Framework of Action. Its first priorities for action prescribed six strategic principles (Table V-2). These principles provide a 'horizontally and vertically integrated systems approach with strong coordination across sectors and a delegation of responsibilities at the local level based on the principle of subsidiarity'.[34]

TABLE V-2

Principles for integrating disaster risk reduction into development

Strategic Principles	Targets
A. Legal and regulatory mechanisms	Adopt, or modify where necessary, legislation to support disaster risk reduction, including regulations and mechanisms that encourage compliance and promote incentives for undertaking risk reduction and mitigation activities.
B. Institutional mechanisms	Support the creation and strengthening of national integrated disaster risk reduction mechanisms, such as multisectoral national platforms, with designated responsibilities at the national through the local levels to facilitate coordination across sectors.
C. Policies and planning	Integrate risk reduction, as appropriate, into development policies and planning at all levels of government, including in poverty reduction strategies and sectors and multisector policies and plans.
D. Finance and budgeting	Allocate resources for the development and the implementation of disaster risk management policies, programmes, laws and regulations on disaster risk reduction in all relevant sectors and authorities at all levels of administrative and budgets on the basis of clearly prioritized actions.
E. Decentralization	Recognize the importance and specificity of local risk patterns and trends; decentralize responsibilities and resources for disaster risk reduction to relevant subnational or local authorities, as appropriate.
F. Capacity building	Assess existing human resource capacities for disaster risk reduction at all levels and develop capacity-building plans and programmes for meeting on-going and future requirements.

LEGAL AND REGULATORY MECHANISMS

Integrating disaster risk reduction in development requires a sound legal and regulatory structure (Box V-2). This refers not just to laws covering disaster management but also legislation for all other relevant sectors. Recently, countries in Asia and the Pacific have introduced specialized legislation on disaster management, generally aligned with global frameworks and addressing disaster risk reduction in a comprehensive manner. They include:

- *Bhutan* – The Disaster Management Act provides that the Government shall 'accord high priority to mainstreaming of disaster risk reduction into its development plan, policy, programme and project' and ensure that 'agencies receive adequate budget'.[35]
- *India* – The Disaster Management Act provides that disaster management plans shall be prepared at the national, provincial and local levels, which would include 'measures to be taken for the integration of disaster prevention and mitigation into development plans and projects'.[36]

BOX V-2

Laws and regulations for disaster risk reduction

Although many countries in Asia and the Pacific prioritize DRR in a range of programmes, policies, plans and strategies this is not necessarily reflected in legislation. In order to cultivate a whole-of-society approach to DRR and provide national leadership and policy direction, governments have often established a single agency, such as a national disaster management agency or a civil defence office, as the national focal point. These offices need to strengthen their coordination with other sectors and stakeholders, especially those related to development planning and climate change adaptation. They also need clear legal mandates and authority for DRR, matched with mandated resources and capacity.

There are, for example still significant gaps in the regulatory frameworks for safety in building and construction, as well as land use and spatial planning. And even countries that have the necessary legislation do not fully implement it. This may be due to a weak 'culture of compliance' and insufficient resources at the local government level. Addressing these failings will mean investing more resources and building the capacity of technical experts at the local level, while promoting public awareness – combined, in some cases with sanctions for non-compliance in major developments.

Governments typically administer DRM laws and environmental laws, including climate change laws, separately from much of the building and spatial planning system. As a result, there is often little coordination between these sectors. One option is to use environmental impact assessments as DRR tools in the construction of new developments.

Source: IFRC and UNDP, 2014.

- *Indonesia* – Article 6 of the Indonesian Law Concerning Disaster Management stipulates that the 'Government's responsibility shall include disaster risk reduction and integration thereof into the development program'.[37] Article 35 defines that disaster risk reduction is one of the continuous activities to be undertaken during the pre-disaster phase that would include disaster management planning, prevention, integration into development planning, disaster risk analysis, spatial structure plans for implementation and enforcement, and education and training.
- *Pakistan* – The 2010 Disaster Management Act declares the establishment of the country's multi-tiered system for disaster management, including a National Disaster Management Authority.[38]
- *The Philippines* – The Philippine Disaster Risk Reduction and Management Act provides that it shall be the policy of the State to 'adopt and implement a coherent, comprehensive, integrated, efficient and responsive disaster risk reduction program incorporated in the development plan at various levels' and further to 'mainstream disaster risk reduction and climate change adaptation in development processes such as policy formulation, socioeconomic development planning, budgeting, and governance, particularly in the areas of environment, agriculture, water, energy, health, education, poverty reduction, land use and urban planning, and public infrastructure and housing, among others'.[39]
- *Viet Nam* – The Law on Natural Disaster Prevention and Control 2013 makes 'integration

of natural disaster prevention and control into national and local socioeconomic development master plans and sectoral development plans' one of the country's basic principles of disaster prevention and control.[40]

Other countries, including Bangladesh,[41] Sri Lanka[42] and Samoa[43] have also developed overarching frameworks on disaster risk management based on the HFA, and are calibrating these frameworks with the emerging global development agendas.

Some of the region's developed countries, such as Australia, New Zealand and Singapore, do not have stand-alone national laws on disaster risk management, but have firmly embedded the systems and processes of risk reduction across sectors, both within and outside government. This integration has taken place over years of development practice, through a continuous process of iterative learning from successive disaster events.

- *Japan* – The Disaster Countermeasures Basic Act provides that the Central Disaster Prevention Council shall formulate a basic disaster prevention plan, which would include (a) a long-term comprehensive plan for disaster prevention and (b) 'operational' and 'local' disaster prevention plans. These plans are 'reviewed each year in the light of research findings, conditions of disasters that have occurred, and the effect of measures taken', and revised if considered so necessary.[44] The Basic Act provides guidance for integration of disaster risk reduction in sectoral laws.
- *The Republic of Korea* _ There are 23 laws for disaster prevention. In addition, there is a Framework Act on the Management of Disasters and Safety and also the Countermeasures against Natural Disasters Act, which integrates disaster risk reduction across various sectors of development.

Another challenge for developing countries is to produce regulations for the private sector– which may be working with the government through public-private-partnerships, or carrying out infrastructure and real estate projects, such as housing, highways, airports and seaports, telecommunications, power generation, transmission and distribution networks, oil and natural gas, and mining. Thus far, however, the legal regimes have focused mainly on tariff structures and technical standards, and specifications have not always factored in measures for risk reduction.

INSTITUTIONAL MECHANISMS

In Asia and the Pacific the institutional arrangements for disaster risk reduction broadly follow one of three models.

A specialized authority

In the first model, there is a separate specialized national agency or authority, usually chaired by the head of government, which steers overall disaster risk management and provides guidance for similar authorities at provincial and local levels. This is the dominant model in South Asia – as in Bangladesh, Bhutan, India, Pakistan, and Sri Lanka. In India, the National Disaster Management Authority, with the prime minister as chairman and nine nominated full-time members, lays down policies and guidelines and monitors implementation. In Pakistan the same responsibilities are entrusted to the National Commission on Disaster Management with the prime minister as chairman and eight other members: ministers of federal government, chief ministers of provinces, and the leader of the opposition. The Commission is assisted by the National Disaster Management Authority which has full-time members. Similar arrangements are in place in Sri Lanka and Bangladesh with a National Council on Disaster Management with the president/prime minister as chairman and supported by a Disaster Management Centre/ Bureau.

Interministerial coordination

In the second model, disaster management is guided by a high-level interministerial coordination mechanism, but basic responsibilities remain with the respective government departments or agencies. This model is followed by China and by five South-East Asian countries: Cambodia, Lao People's Democratic Republic, Malaysia, Myanmar, and the Philippines. In China the inter-agency coordination body is the National Committee for Disaster Reduction headed by a vice-premier of the State Council which has representation from 33 ministries and departments, including relevant military agencies and social groups.[45] In Malaysia, coordination is carried out by the National Security Council in the Prime Minister's Department. In Cambodia coordination is the responsibility of the National Committee for Disaster Management, headed by the prime minister. In the Philippines, the corresponding body is the National Disaster Risk Reduction and Management Council which is headed by the secretary of the Department of National Defence.

A single agency

In the third model, disaster management is the exclusive responsibility of a single agency or government department which discharges this in coordination with other agencies. For many years in most countries this was the dominant model but it is giving way to the first or second models. It is still being used, however, by countries that do not have separate disaster management laws, such as Nepal, Maldives, Timor-Leste and most countries in Central Asia. In Nepal the responsible agency is the Ministry of Home Affairs, in Maldives it is the Ministry of Defence and in Timor-Leste it is the Ministry of Social Solidarity. Some of these countries are drafting disaster management laws that may see a transition to a multisectoral coordinating mechanism.

It is clear however, that even the first and second models are not yet working effectively. Having the head of state or government as the head of the national disaster management authority, or locating the national commission or committee on disaster management in the office of the prime minister or president, is meant to ensure a 'whole of government' approach. In practice this has not happened. Either the agencies and committees have not met regularly or they have not established the necessary actions and monitoring mechanisms in specific sectors.[46] Moreover,the coordinating agencies may still be working in silos without effective outreach to various development sectors. Many high-level functionaries of these agencies have been drawn from the armed forces, police and civil defence, and too often they have primarily followed their previous interest–disaster response and preparedness–rather than integrating DRR with other sectors.

The HFA prescribed 'multisectoral national platforms, with designated responsibilities at the national through the local levels to facilitate coordination across sectors', but, as of 2013, only 14 out of 64 countries in Asia and the Pacific have set up such platforms, and none of them meet regularly.[47]

POLICIES AND PLANNING

While there are national policies and strategic action plans on disaster risk management in many countries in the region, there is often no clear guidance on how these are to be integrated across government sectors – resulting in considerable gaps between professed policies and plans, and actual practices (Box V-3). Policy implementation across the Asia-Pacific region broadly differs according to level of development. The developed countries have invested enormous resources on structural and non-structural measures for disaster risk reduction in various sectors. The emerging economies that face high disaster risks have also started making such investments with some success – and have introduced low-cost community-based initiatives for risk reduction.

- *Bangladesh* – The National Plan for Disaster Management (2010-2015) has a five-fold strategy for integrating disaster risk reduction: advocacy, policy and planning reform, capacity building, planning frameworks, and uniform community risk assessment. The country has also made significant progress in integrating disaster risk reduction in poverty reduction programmes. This success has been due in part to a participatory risk assessment, a focus on the multidimensional nature of poverty, convergence of all development programmes at community level, and coordinated involvement of all development partners, with strong presence of civil society and women.
- *China* – The National Disaster Reduction Plan (1998-2010) was followed by the Comprehensive Disaster reduction Plan (2011-2015). These plans aimed to establish a unified management structure, bringing all levels of government together. Many recent initiatives in the country are based on the realization that rapid economic development in the past has created new risks of disasters which should be addressed in a comprehensive manner.
- *India* – The Planning Commission developed a blueprint for disaster risk reduction in Tenth Five Year Plan (2002-2007). This underlined the need for a multi-pronged strategy for total risk management, comprising prevention, preparedness, response and recovery, along with development efforts aimed towards risk reduction and mitigation.[48] The Twelfth Five Year Plan (2012-2017) emphasized that every new development project should be appraised on the basis of detailed assessment of hazards, risks and vulnerabilities, while every existing project should be retrofitted for the risks of disasters. The actual implementation, however, has fallen far short of the vision.
- *Indonesia* – The Government has a National Action Plan for Disaster Risk Reduction which is updated for successive three-year planning cycles. Each cycle identified more than 600 activities for disaster risk reduction across sectors– which required significant financial and technical support from multiple stakeholders and donors. Many of these could not be implemented since the support was not forthcoming; nevertheless, the plan catalysed new ideas and initiatives, created public awareness and provided rallying points for multi-stakeholder participation.
- *Japan* – The Basic Disaster Management Plan is continuously updated and has helped reduce vulnerabilities and strengthen the resilience of urban and rural communities. But the country remains at risk from complex disasters, as demonstrated by the 2011 earthquake, and the country is integrating the lessons learned.
- *The Republic of Korea* – The country has been building the resilience of critical infrastructure

BOX V-3

Disaster risk management: the divorce between discourse and practice

The disaster risk management sector in general has developed only weak connections with, and influence on, development sectors, and it has often lacked the political authority, governance arrangements and technical competencies to do so. Many development policies, plans and investments continue to enjoy political support even if they generate and accumulate risks.

Prospective disaster risk management generally requires lower levels of financial investments but higher levels of political capital and support than corrective disaster risk management. Given that disaster risk management has been understood and put into practice as a set of instrumental and administrative mechanisms to protect development against exogenous threats, this political support has rarely been forthcoming. At the same time, development sectors also tend to understand disaster risk management as disaster management.

As a result, the disaster risk management sector has little success in ensuring that other ministries or departments adopt policies, norms, standards and regulations to manage and reduce risks. Similarly, there has been little systematic engagement with the private sector in most countries, except through the lens of corporate social responsibility.

In effect the strong political determination by the HFA to promote and integrate disaster risk reduction into development programming has rarely materialized. The practice of prospective disaster management continues to be more symbolic than real. As the HFA comes to a close, it is difficult to identify countries where the strengthening of disaster risk governance has seriously influenced the direction of development.

Source: UNISDR, 2015b.

such as roads, railways, energy, communication systems and housing. One focus area is making cities more resilient to floods.

- *The Philippines* – The Strategic National Action Plan 2009-2019 identified 18 programmes and projects on disaster risk reduction. These include: (a) mainstreaming DRR in various government plans and programmes and (b) supporting DRR mainstreaming through sectoral approach.[49] The National Economic Development Authority is developing guidelines for regions and provinces to build DRR into local development plans such as the Provincial Physical Framework Plan, Comprehensive Land Use Plan, and Comprehensive Development Plan.
- *Singapore* – High physical and environmental standards of safety have helped protect from major natural or technological disasters, though in the long run there may be threats from sea level rise.

However, most of the region's developing countries lack the necessary resources and capacity and in many of the least developed countries the limited initiatives are mostly driven by UN agencies and donors with little buy-in from local government agencies. Implementation is also generally constrained by weak local capacities.

- *Cambodia* – The Strategic National Action Plan for Disaster Risk Reduction has as one of its six key components, mainstreaming DRR into policies and programmes for relevant government ministries,[50] but implementation has not made much headway.

- *Lao PDR* – The Strategic Plan on Disaster Risk Management provided road maps for the short term (2005), medium term (2010) and long term (2020). Some of the short- and medium-term activities have been implemented, but the long-term activities for integrating disaster risk reduction in various sectors of development have not.

- *Myanmar* – The Action Plan on Disaster Risk Reduction identified 13 priority projects for DRR, but none has passed the inception stage.

- *Timor-Leste* – The National Disaster Risk Management Policy guides risk analysis, vulnerability monitoring, early warning, emergency management, post-disaster research and review, recovery and knowledge development, awareness raising and human resource development. There is no initiative for integrating disaster risk reduction in development.

- *Pacific island States* – Most governments have had some form of national disaster plan for many years. UNDP has also helped develop more comprehensive plans, covering preparedness, response and recovery activities. But implementation has often been hampered by the limited interest of governments and the shortage of suitable funds and human resources. Some countries are receiving support from the Pacific Disaster Risk Management Partnership Network for DRM National Action Plans. Tonga is the first country to develop a Joint National Action Plan for Disaster Risk Management and Climate Change Adaptation.

FINANCE AND BUDGETS

Reports on implementation of the HFA commonly refer to a shortage of funds, either from national resources or from official development assistance (ODA). In the Asia-Pacific region, over the past decade prevention and preparedness accounted for only 0.65 per cent of total ODA.

Countries that have special funds for disaster risk management have mostly used these for disaster response and humanitarian relief. In India, for example, the Disaster Management Act 2005 mandated the creation of two dedicated funds at national, provincial and local levels – the Disaster Response Fund and the Disaster Mitigation Fund, though the latter has yet to be constituted (Box V-4). Pakistan and Bangladesh have also created national funds but only use these for disaster relief and rehabilitation. Most countries, however, do not have such funds, instead relying on the general budgets of the national, provincial and local governments.

Some countries have separate budgetary codes for natural calamities, but none has separate codes for disaster risk reduction. Nevertheless, in different development sectors they devote funds to structural and non-structural measures. Taken together such investments usually far outweigh the contribution of international aid for disaster risk reduction – and the gap could widen still further as a result of slow economic growth in donor countries.[51]

- *The Philippines* – Over the period 2009-2011, the budget allocation in the General Appropriation Act expanded by 61 per cent, but still comprised only 2.12 per cent of the national budget and 0.28 per cent of the GDP.[52] Even so, in the Philippines the Government invests 20 times more than the international community on disaster risk reduction.[53]

- *Indonesia* – Regulation 21 of 2008 classifies DRR investments in seven categories aligned with the Hyogo Framework of Action.[54] Based on these, during 2006-2012 there were 71 DRR-related activities. Over this period, the proportion of the national budget devoted to disaster risk management rose from 0.38 to 0.69 per cent. Of the total investment on DRR, disaster mitigation and prevention accounted for on average 76 per

BOX V-4

Tracking public investment on disaster risk reduction in India

National accounting systems generally do not generate disaggregated data for monitoring the resources allocated for disaster risk reduction. In India a study that tracked allocation of resources on programmes, activities and projects (PAP) in the budgets of 75 ministries/departments of government during 2005-2012 provide significant insights.

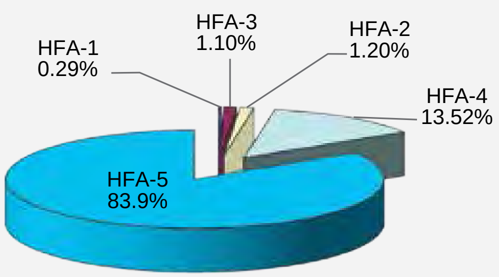
When 100 per cent of budgetary allocations were earmarked for disaster risk management they were categorized as 'dedicated schemes'. When the allocations were less than one hundred per cent they were classified as 'embedded schemes'. These were further classified according to the five priorities of the Hyogo Framework of Action. While the share of dedicated schemes never exceeded 1.2 per cent of total budgetary allocations, the share of embedded schemes was as high as 33.6 per cent.

Budget allocations for disaster risk management, INR billion

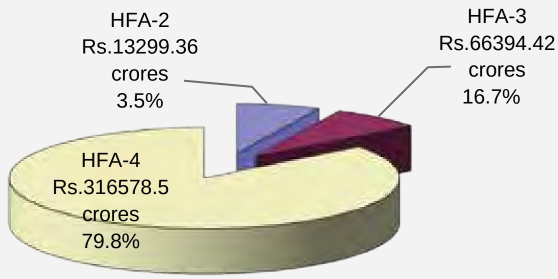
Financial Year	Total Budget Allocations	Dedicated Schemes	%	Embedded Schemes	%
2005-06	5,143.4	58.3	1.13	1,235.7	24.03
2006-07	5,639.9	68.6	1.22	1,505.3	26.69
2007-08	6,805.2	62.7	0.92	2,227.8	32.74
2008-09	7,508.8	70.6	0.94	2,304.9	30.70
2009-10	10,208.3	95.8	0.94	3,302.5	32.35
2010-11	11,087.5	114.2	1.03	3,728.4	33.63
2011-12	12,377.3	117.1	0.95	3,962.7	32.02

DRR elements in PAPs are so embedded that it is not possible to quantify them precisely, unless there are separate budgetary codes. Contrary to general perceptions, it was found that while nearly 84 per cent of allocations on dedicated PAPs were spent on disaster response and preparedness, nearly 80 per cent of allocations on embedded schemes were related to addressing the underlying risk factors.

Dedicated schemes



Embeded schemes



Source: Chakrabarti, 2012.

cent, followed by disaster preparedness (12.7 per cent), research, education and training (5.8 per cent), early warning systems (3.3 per cent), institutional capacity building (0.8 per cent), community participation for DRR (0.7 per cent) and disaster management planning (0.5 per cent). In 2011, about 14 per cent of the DRR budget was mobilized from foreign loans and grants, mostly for construction of flood control facilities and infrastructure.

- *India* – A study[55] that analysed expenditure based on the HFA classification found that 38 schemes of eight ministries or departments were for 'dedicated' schemes (all for disaster risk management).[56] In addition, 75 ministries or departments had 85 'embedded' schemes which had elements of risk reduction. In 2011-2012 these amounted to $2.1 billion-32 per cent of the total government budget, so around one-third of the budget was spent on schemes that had some elements of disaster risk reduction.

Governments can better integrate disaster management in finance and budgets by stepping up direct or dedicated public and private investments, while also recalibrating existing development schemes in different sectors to optimize their potential for reducing disaster risks.[57]

DECENTRALIZATION

DRR should not remain centralized in the national government. It should be a joint responsibility of all levels of government – national and local – with the participation and engagement of all stakeholders and communities. Decentralization in the Asia-Pacific region takes a number of forms. The weakest is 'deconcentration' – partial dispersal of tasks and resources from the central to local government with no devolution of authority – as, for example, in Cambodia, Myanmar, Pakistan and Sri Lanka. A stronger form is 'devolution' which also involves partial dispersal of resources and authority – as in Bangladesh, India, and Viet Nam. The strongest form is 'autonomy' where for certain functions the government disperses tasks, resources and authority – as in Indonesia and the Philippines – a model particularly appropriate for countries with vast territories and dispersed islands and archipelagos.

- *India* – The Disaster Management Act of India has created disaster management authorities at national, state and district levels, but stopped short of entrusting specific responsibilities to rural and urban local self-governing institutions.
- *Indonesia* – The Law Concerning Disaster Management provided for the creation of regional disaster management agencies and further outlined the rights and obligations of communities and business establishments.
- *The Philippines* – The Philippine Act has created provincial, city, and municipal disaster risk reduction and management councils and provided these councils with structured offices and funds. This was considered necessary to enable them to discharge their responsibilities in widely dispersed island settlements.

Decentralization should promote good governance as it can improve service delivery, involve citizens and make the system more open and transparent. Further it can promote community-based risk assessment, risk reduction and preparedness and enable effective utilization of local knowledge and resources. In addition it improves two-way risk communication between local and national levels. It enables participation of multiple stakeholders including civil society, community-based organizations, local leaders and other opinion makers. In short, decentralization it empowers local communities.

To be effective therefore, vertical and formal decentralization by horizontal and informal decentralization – among all stakeholders across all sectors. In most countries, however, this mix of vertical-horizontal decentralization has yet to take hold. Either vertical decentralization has been top down without effective devolution of power and resources, or it has remained formal without effective engagement with stakeholders. The mid-term review of the HFA found that although 86 countries had made local governments legally responsible for local disaster risk management, only 20 had dedicated budget allocations for local governments.[58]

Most countries have a large gap between policy and action. National Governments often make a commitment for community-based disaster management but fail to allocate the necessary resources, leaving the agenda in the hands of NGOs who have been managing small and scattered pilot projects.

Decentralization must also be supported by continuous and systematic efforts for strengthening the technical and institutional capacities of the local authorities. Most municipal authorities lack the capacity to assess local risks or to design and implement local-level programmes. In India, for example,only a handful of municipalities have revised their building codes to incorporate structural safety from natural hazards like earthquakes, floods and cyclones – as provided

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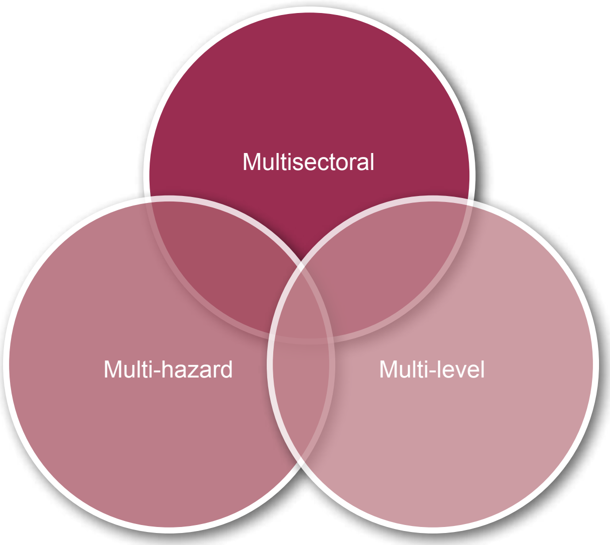
in the National Building Code.[59] The collapse of the multi-storey Rana Plaza garment factory in Bangladesh, for example, was in part a consequence of weak municipal administration. Many more such buildings in different hazard zones across Asia and the Pacific have been described as 'weapons of mass destruction'.[60] Building codes have to be enforced by local authorities – such responsibilities can neither be transferred to regional or national governments nor delegated to civil society or NGOs.

CAPACITY BUILDING AT ALL LEVELS

Capacity development for disaster risk reduction should not be limited to the national agency for disaster management. It must permeate all sectors, at all levels and for all types of hazards, natural and man-made (Figure V-1). In the case of construction, for example, designing or retrofitting buildings so as to be earthquake resistant will mean increasing the capacities of architects, engineers and masons.

FIGURE V-1

Capacity building framework for disaster risk management



But it also means enhancing the supervisory and enforcement capacity of officials in different sectors and at all levels of government.

Capacity building for disaster risk reduction is a massive task that has to be undertaken in an organized and systematic manner. It will mean assessing capacity gaps – for all sectors and all types of hazard, and working out the strategies to fill them. For high-level policymakers – legislative, ministerial and bureaucratic – some capacities can be upgraded through sensitization programmes. For middle-level officials, capacities can be refreshed through knowledge- and information-based programmes. For technical experts, capacities can be strengthened through skills development. For common citizens and communities, they can be developed through awareness programmes. This would require large number of trainers – and programmes for training the trainers.

At the same time countries will want to improve their institutional expertise. Universities and other institutions of higher learning can develop academic programmes in various disciplines to develop a pool of professionals on disaster risk management, while research institutions can take up scientific, policy and applied research.

Several countries in Asia and the Pacific have created specialized institutes for training on disaster management. In India, for example, the National Institute of Disaster Management has been developing capacities across sectors at national and state levels, while China's National Disaster Risk Reduction is providing similar training. In Singapore the Civil Defence Academy provides specialized training for disaster response, specifically for urban fire management. In the Philippines the work is done by the Crisis Management Institute which is part of the National Defence College. Indonesia has a Disaster Relief Training Ground. In Myanmar the Disaster Management Training Centre is now being set up. ESCAP through its Regional Network of Knowledge and Innovation Centres initiative is partnering with the institutions in China, India and Indonesia to help them share their capacity-building programmes with other countries that have low coping capacity.

Cross-border learning

Regional platforms are uniquely positioned to foster genuine and durable partnerships and cooperation. This is particularly the case in disaster risk reduction, as disasters frequently have cross-border impacts. Learning from one another could be useful for doing things right or avoiding certain actions that may not work. Regional learning platforms can also serve as clearing houses where countries could place their demands and supply for DRR methods, tools, products and practices that are, otherwise, not easily accessible to inform national processes. Such cooperation would be useful for monitoring and reporting on progress, undertaking peer reviews and sharing lessons. There are several regional level capacity development initiatives for DRR that are at various stages of implementation (Box V-5).

There are good examples of regional initiatives for sharing knowledge and technology, such as ESCAP's Regional Space Applications Programme for Sustainable Development (RESAP) and its Regional Drought Mechanism (Chapter 4). Similarly, as highlighted in Chapter 3, countries can work together to make more efficient use of limited public resources, for example by pooling resources for disaster preparedness and early warning, as demonstrated through the ESCAP's Multi-donor Trust Fund for Tsunami, Disaster and Climate Preparedness. There are also good examples of countries, especially in the Pacific, addressing shared vulnerabilities and risks through regional insurance pooling facilities.

STRATEGIC FRAMEWORKS AND NATIONAL GUIDELINES

Following the adoption of the Hyogo Framework of Action in 2005 some efforts were made to develop general guidelines for integrating disaster risk reduction in development, but these were not systematically pursued. Guidelines have also been produced by other institutions – for example, suggesting key policy areas such as: policy, strategy, geographical planning, project cycle management, external relations and institutional capacity.[61] The Pro Vention Consortium has also developed a series of 14 guidance notes for mainstreaming disaster risk reduction.[62] There have also been initiatives from many other institutions, global and regional, for integrating DRR into development planning (Box V-5).

It is clear, however, that the actual practice of integrating DRR into development planning will depend upon national circumstances – on the hazards faced, the level of development, and the country's capacity. In general, however, it will involve three interconnected processes: a strategic framework within the national development plan; national guidelines; and sectoral guidelines (Figure V-2).

Strategic frameworks

The overarching strategic framework for disaster risk management in a national development plan may be laid down by the national planning commission or a similar institution.

BOX V-5

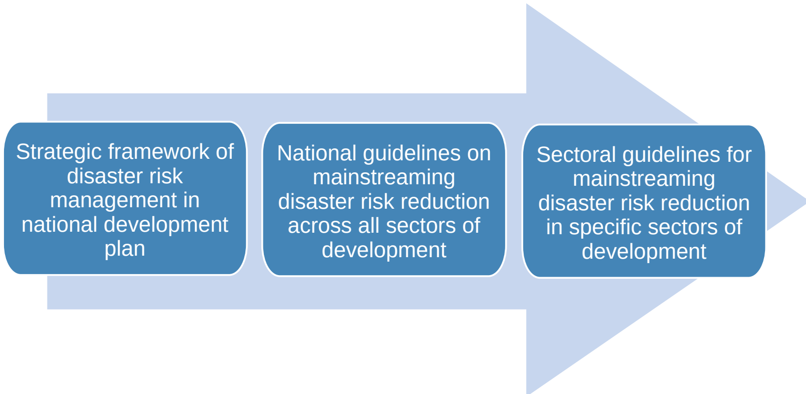
Initiatives for integrating disaster reduction in development planning

There have been a number of initiatives, global and regional, to help countries integrate disaster risk reduction into development planning. These include:

- ADPC – the Asian Disaster Preparedness Centre (ADPC) has been promoting the agenda of Priority Implementation Partnerships for mainstreaming disaster risk reduction in different sectors of development. The first phase (2005-2007) was taken up in the Philippines, Cambodia and Lao People's Democratic Republic; the second phase (2008-2011) in Bhutan, Lao People's Democratic Republic and Sri Lanka along with regional-level programmes. In the third phase (2012-2015) the programme was extended to issues of agriculture, infrastructure, urban development, health and financial services, followed by a programme for integrating disaster risk reduction with climate change adaptation in development.
- ASEAN – The Association of South East Asian Nations adopted the AADMER Work Programme which included assistance to the member States in mainstreaming disaster risk reduction into national development policies, plans and sectoral programmes.
- ESCAP – The Regional Commission has launched a regional programme on the integration of disaster risk reduction into development planning to support member States' efforts to create more disaster-resilient economies and societies. The programme has brought together key ministries with mandates in national development planning and financing and the nodal agency in charge of disaster risk reduction policy. These can then engage in dialogue with other sectoral ministries to integrate disaster risk reduction into multiple sectors. The programme develops guidelines for integrating disaster risk reduction into multisectoral and subnational development planning. It also develops tools for pre-disaster risk assessment for development planning, and for rapid post-disaster damage assessment for recovery planning.
- SAARC – In 2006, the South Asian Association for Regional Cooperation (SAARC) adopted its Comprehensive Disaster Management Framework, which aimed at 'mainstreaming disaster risk reduction into the development policies and practices of the government at all levels'. As a follow up measure, the *SAARC Disaster Management Centre developed the SAARC Road Map on Mainstreaming Disaster Risk Reduction in Development* through a consultative process. The implementation of the roadmap did not make much headway.
- SIDS – In September 2014 the third International Conference on small island developing States (SIDS) adopted the SIDS Accelerated Modalities of Action. This called for mainstreaming policies and programmes related to disaster risk reduction, climate change adaptation and development.[63]
- SOPAC – The Pacific Islands Applied Geoscience Commission (SOPAC) adopted the Pacific Disaster Risk Reduction and Disaster Management Framework for Action 2005-2015 which called for member governments to strengthen policies and plans for the mitigation and management of natural disasters through the development of National Action Plans.
- UNDP – The Global Report of the UNDP on 'Reducing Disaster Risks: A Challenge for Development' recommended that disaster risk analysis must be conducted for every development programme.[64]
- World Bank – Track-II of the Global Facility for Disaster Reduction and Recovery of the World Bank was designed to mainstream disaster risk reduction in development in priority countries. Activities focused on some of the basic issues of disaster management like hazard mapping and national DRR policy.[65]

FIGURE V-2

Interconnected processes for integrating disaster risk reduction into sustainable development



This framework for a medium to long-term planning cycle (five to ten years) may be developed in consultation with all relevant stakeholders, including the central ministries and departments, state governments, scientific and technical institutions and experts. Thus far, few national planning commissions in the Asia-Pacific region have developed such a framework. The Planning Commission of India did so in its Tenth Five Year Plan but did not include it in subsequent plans.

National guidelines

The nodal agency on disaster risk management can develop general principles and guidelines in consultation with all sectoral ministries and departments. These should apply to every programme, activity and project across all development sectors. As yet no country has developed such generic guidelines. But some have issued guidelines for disaster impact assessments of major development projects.

- *Bangladesh* – The Government has introduced Disaster Impact and Risk Assessment for analysis of all development projects.
- *Sri Lanka* – For all development projects, the Disaster Management Centre has produced the Disaster Impact Assessment checklist. This is in four parts – assessing risks, incorporating risk reduction measures into designs, monitoring during construction and maintenance, and analysing post-disaster impact assessment. This has been field tested in the road sector and is to be introduced in other sectors.
- *India* – On the recommendation of the National Disaster Management Authority the Ministry of Finance has issued a Check List for Natural Disaster Impact Assessment. Any new project costing more than INR1,000 million must provide complete information on its hazards, risks and vulnerabilities. This would include not only the probable effects of natural disasters on the project but also its potential for creating new risks. This was an important step forward, even though this is self-assessment by the project implementing agencies rather than an independent evaluation by a body of experts.
- *Indonesia* – The National Disaster Management Agency has developed a disaster risk index as a tool for assessing the vulnerabilities of districts and municipalities and prioritizing the allocation of resources for planning various structural and non-structural measures for risk prevention and mitigation.[66]

The UN General Assembly has established an open-ended intergovernmental working group for developing a set of indicators for measuring global progress in the implementation of the Sendai Framework – in conjunction with the work of the Inter-Agency Expert Group on Sustainable Development Goal Indicators. This could also include indicators for measuring progress in integrating disaster risk reduction in development.

Sectoral guidelines

In consultation with the national authority on disaster management, each sectoral ministry and department can develop its own guidelines on disaster risk reduction. This would ensure that while the process is owned and driven by the unique demands of the sector, it also conforms to the overall national framework.

As a minimum, each sector needs to integrate disaster risk management principles in the following three areas:

– Policies, strategies and directives – Integrating disaster risk reduction into sectoral development plans and budget
– Key infrastructure – Risk reduction measures to protect facilities and assets
– Continuity plans – For maintaining critical services and supporting timely recovery and reconstruction

Although the relevant sectors will differ according to national circumstances, broadly they are likely to cover:

- Social sectors (health, education, housing and human settlements)
- Productive sectors (agriculture, manufacturing, business)
- Infrastructure sectors (roads and bridges, water supply, power transmission and distribution, communications)
- Cross-cutting sectors (poverty reduction, gender issues)
- Multisectoral planning processes (urban and rural development)

The following discussion illustrates how disaster risk management can be integrated into different sectors.

SOCIAL SECTOR

Across the region a wide range of development and social protection schemes have helped to reduce the vulnerabilities of large segments of population, enhance their capacities and reduce the risks of disasters. But some have also created new risks. For example, many new schools built in earthquake zones in China and Pakistan subsequently collapsed. This could have been avoided had they been constructed following building codes for earthquake resistance. Similarly, many people have been lifted out of poverty as a result of government subsidies and credit schemes that they have used to acquire income-generating assets – only to sink back into poverty when the assets were destroyed during floods or cyclones. These losses would have been reduced had the assets been secured through insurance or other securities.

Health

All health sector programmes, activities, projects and critical infrastructure should be protected from the risks of disasters, and further strengthened so they respond during emergencies.

- *New buildings* – Health care facilities, such as hospitals, primary health centres, dispensaries, and trauma centres should be built following disaster resistance principles and building codes, even if this adds to costs.

- *Existing buildings* – Structural safety should be periodically reviewed and, where necessary, buildings should be retrofitted to ensure structural resilience.
- *Non-structural features* – Gas, water, sewerage and power lines, air-conditioning ducts and other fixtures should be installed such that they will not be disrupted during disasters.
- *Maintenance and supplies* – Health care facilities should be maintained and fully staffed and equipped. Back-up facilities like generators with adequate fuel supply should always be available to meet any emergency.
- *Medical education* – Disaster health care and mass casualty management should be included in the curriculum of medical education for doctors, nurses and other para-medical personnel.
- *Emergency procedures* – Each hospital should have a management plan and an operating procedure to deal with any emergency. Hospital administrators and health care professionals and workers ought to be trained in emergency health care and in mass casualty management skills and procedures and take part in regular drills.

Education

Education systems from primary schools to universities and management schools should have their infrastructure, programmes, and activities be protected. They should also have sufficient resources to help create a culture of disaster prevention and preparedness and raise a professional pool of expertise.

- *Disaster management education* – All children should be aware of the hazards they face and the measures they can take to protect themselves at school and at home. This would require revising school curricula, developing text books and teaching aides, and training teachers
- *Advanced courses* – Disaster risk reduction requires advanced scientific, technical and professional skills on subjects like earthquake engineering, meteorology, hydrology, communications technology, disaster medicine, psycho-social care, and emergency management. Colleges, universities, and technical and professional institutes should design the necessary courses in all key areas of specialization.
- *Safe buildings* – Each new school building should be designed to be resistant to earthquakes and other disasters. And existing schools that are unsafe should be retrofitted. Given the scale of the need, education departments may initially have to prioritize schools in high-risk zones before extending the programme nationally.

PRODUCTIVE SECTORS

Agriculture and businesses are exposed to disasters and can also create the conditions for disasters. Most are owned by private entrepreneurs but governments can offer support and create conditions that will enable them to minimize risks. It is essential that these risks are assessed and analysed in a comprehensive manner.

Agriculture

Agriculture is particularly vulnerable to natural hazards like flood, drought, and saline water intrusion – with impacts on rural livelihoods and national food and nutritional security. At the same time, agriculture itself can increase disaster risks – through oil erosion, land degradation and deforestation, for example, and overuse of groundwater.

Making agriculture more resistant to the risks of drought and flood will require a range of programmes. These can address such issues as: protecting agricultural infrastructure; soil and water conservation, water harvesting, improved varieties of seeds and bio-fertilizers, drip irrigation, and weather forecasts. Agricultural research and extension services can also be reoriented to find innovative ways of adapting to the impact of climate change. Many Asia-Pacific countries are taking measures to address climate change adaptation and disaster risk reduction. There are innovative traditional and modern practices that can be disseminated for the benefits of farming communities.

Business

Driven by trade and investment, and continued demands for cost reduction, businesses have been extending their activities across the region, often in coastal and other disaster-prone areas.[67] In general, businesses, including industry, trade and commerce, tend to take little account of the risks of disasters – though they stand to make heavy losses from disruptions to supply chains. Few small and medium-sized enterprises have continuity plans to deal with such situations; and only a few global corporations collaborate for this purpose with national and local governments. The ESCAP report, *Resilient Business for Resilient Nations and Communities*, called for a paradigm shift in the way private sector perceives and manages disaster risks (Box V-6).[68]

The private sector should be encouraged to adopt or improve business continuity and resiliency planning, and factor disaster risk into overall corporate planning and investment, business analysis and forecasting. These are issues that need to be addressed in business schools. In Japan, for example, following the 2011 earthquake the Government developed guidelines and incentives. International standards for business continuity were issued in 2012 in ISO 22301 which included taking into account the risk of disasters.

For this purpose businesses will need to work more closely with governments.[69] Traditionally, enterprises and business associations have done so by contributing funds or other resources for disaster relief and rehabilitation – as part of discharging their corporate social responsibilities. Now they need to go further and not only protect themselves but also help make society as a whole more resilient. The HFA prescribed 'public-private partnerships to better engage the private sector in disaster risk reduction activities'.[70]

Some businesses are already doing so, by investing sizeable resources in rural areas in agro-business, horticulture, poultry, fisheries and other sectors. For example, they have helped boost incomes in disaster-prone areas by introducing modern technologies of irrigation, plantation, hatcheries, breeding, processing, packaging, storage, and supply chains. This enables farmers, fishermen and other communities to cope with the risks of droughts, floods, and sea storms. One innovation in this area is the 5P model of 'pro-poor-public-private partnerships' – hybrid organizations involving government, the corporate sector, civil society and NGOs. Such models can be replicated in other sectors such as water and sanitation, rural and urban development, renewable energy.[71]

BOX V-6

A paradigm shift for business

The private sector and governments, national and local, can work together towards a sustainable future that has collective benefits for society at large. Although the private sector has become more aware of the threats that disasters pose to their interests, nevertheless, aiming to maximize profits, many businesses are myopic, focusing on short-term gains instead of long-term benefits for all.

Rather than remaining passive players, the private sector must actively reduce risk. This will require a paradigm shift from reactive and responsive interventions towards proactive, risk-sensitive business investments. Businesses also need to be held accountable for their own share of risk creation. This is important for the survival of both businesses and society at large. Instead of engaging in limited corporate social responsibility initiatives, they should choose interventions that provide wider societal benefits. Governments should therefore foster greater private sector involvement by providing sound legal and regulatory frameworks, timely risk information and other incentives and support, particularly to SMEs.

Source: ESCAP, ADPC and R3ADY, 2015.

INFRASTRUCTURE

Rapid economic development across Asia and the Pacific has required extensive infrastructure. This includes roads and bridges, railways and metros, seaports and airports, power plants and transmission lines, gas and oil storage depots, water supply systems and telecommunication networks, schools and hospitals, administrative headquarters and emergency operation centres.[72] Much of this was constructed many years back and has yet to be upgraded for resilience to current risks. This has left many countries vulnerable. Examples in 2014 included floods and landslides in Nepal and floods in Solomon Islands which disrupted vital infrastructure including roads, water and sanitation facilities.

All new critical infrastructure should be constructed with a high margin of safety and all existing critical infrastructure, in both public and private sectors, should be audited and upgraded to international standards to cope with worst-case scenarios. This will require a comprehensive strategy – mapping all critical infrastructure, reviewing standards and codes, reducing exposure and strengthening resilience.[73] All the major infrastructure ministries and departments–roads and highways, shipping, railways, communications, and energy –will need to incorporate disaster risk reduction in current and future activities.

CROSS-CUTTING ISSUES

Many development priorities cover a number of sectors. Poverty reduction, for example, concerns agriculture, employment, and industry, as well as multisectoral processes like rural and urban development. This is also true of other issues like gender equality, child protection and disability.

Poverty reduction

Working with poor communities, governments should analyse the major disaster risks faced by the poor, as well as their current survival and coping strategies. They can then select appropriate measures to prevent or reduce those risks. This has important implications for poverty alleviation programmes. These should incorporate elements to protect income-generating activities from the financial impact of disaster – such as micro-credit and micro-insurance. Bangladesh, for example, has developed tools for participatory risk assessment, focussing on the multidimensional nature of poverty with coordinated involvement of all development partners at the community level and a strong presence of civil society and women.

There should also be schemes to provide livelihoods for the poor should disaster strike. In India, for example, the National Rural Employment Guarantee Programme has been used to provide livelihood support to people affected by droughts, floods and cyclones.

Gender

Women should be involved at all stages of disaster risk management. At present most governments have limited understanding of how gender relations affect risk accumulation and coping capabilities. They can start with a careful analysis of gender-based in equalities and relations in society and the attitudes that affect women's vulnerability to hazard impacts and their capacities for recovery.

Deciding what risks to reduce and how to do so will mean considering the responsibilities of women during and after disasters, and ensuring gender-sensitive risk communication messages and programmes.

MULTISECTORAL LOCAL PLANNING

Much of the responsibility for disaster risk reduction lies with local governments. They have to execute disaster preparedness plans and are likely to be the first responders when disaster strikes. With the greatest experience and knowledge of local vulnerabilities and coping mechanisms they are best placed to ensure community-based disaster preparedness. However, the issues generally differ between rural and urban areas.

Urban development

Urban areas have complex systems of risks and vulnerabilities especially in the mushrooming slums in dangerous areas that are making poor people vulnerable to multiple risks. Most cities have master plans and many have detailed regulations that define the purpose for which a particular zone of the city can be used – such as commercial, residential, institutional, recreational, and city forests or parks. Such plans should be disaster risk sensitive, taking into account location, elevation, geological composition, soil characteristics, the availability of surface and sub-soil water, and natural hazards. For example, flood plains should not be used for construction, and areas prone to liquefaction during earthquakes should not have high-rise buildings.

The biggest source of risk in Asia-Pacific cities is unsafe buildings in thickly congested areas. Historically most construction has not conformed to safe standards nor been designed for resistance to natural hazards like earthquakes and storms. Another problem is maintenance, which is

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often hampered by archaic tenancy and land ceiling legislation. As a result many dilapidated buildings have collapsed even without a natural disaster event.

The first priority in most cities is the preparation and enforcement of building codes. Given the lack of capacity of most municipal authorities this is a daunting task. But it is important to make a start. Each city needs to develop its own strategy to identify and reduce the stock of unsafe buildings. This may require demolition or retrofitting – for which there could be both incentives and penalties for non-conformance.

The HFA prescribe 'incorporation of DRR in the planning and management of disaster-prone human settlements' and 'revision of existing or development of new building codes' with priority focus on 'informal housing in high-risk areas'. This did trigger some new initiatives but has not made a substantial difference. The region still has rapidly growing informal settlements and many unsafe construction practices.

Future policy should be based on a more comprehensive framework. This could include: relaxing land ceiling laws to release more land for housing; granting titles to slum dwellers to encourage investment in housing; lifting arbitrary rent control to improve the conditions of houses; developing satellite towns to decongest cities; providing subsidized housing for the poor; and developing capacity and accountability for enforcing building by laws. Giving urban dwellers title to their property encourages them to invest in their safety, and lifting rent controls creates incentives for landlords to comply with building codes, since they can then recoup the cost.[74]

When enforcement is weak due to poor governance, it may be possible to engage housing credit and insurance agencies to ensure independent inspections and compliance with building codes. Home purchasers too, if they are aware of the dangers can put pressure on builders to comply with the codes.

Rural development

Most Asian governments have ambitious programmes in rural areas for alleviating poverty and reducing vulnerabilities in the face of natural calamities like drought, floods, and cyclones. A few, like India and Viet Nam, have combined rural development schemes with relief activities like food for work programmes, but in most countries this has not been very systematic. All schemes for rural development and poverty alleviation need to be restructured so that they also reduce the risks of disasters.

CLIMATE CHANGE ADAPTATION

Disaster risk reduction (DRR) and climate change adaptation (CCA) are based on a common platform of sustainable development. After 1990 they branched in separate directions. DRR took the route of the International Decade for Disaster Reduction, the Yokohama Strategy and the Hyogo Framework of Action. CCA took the pathway of IPCC, UNFCCC, the Kyoto Protocol and the Conference of Parties. The two agendas converged again, however, when IPCC-4 concluded that a changing climate would have implications for disasters and the Bali Action Plan adopted at the COP-13 in 2007 included 'disaster reduction strategies and means to address loss and damage associated with climate change impacts'.

In 2004 IPCC-5 came out with its special report on *Managing the Risks of Extreme Events and*

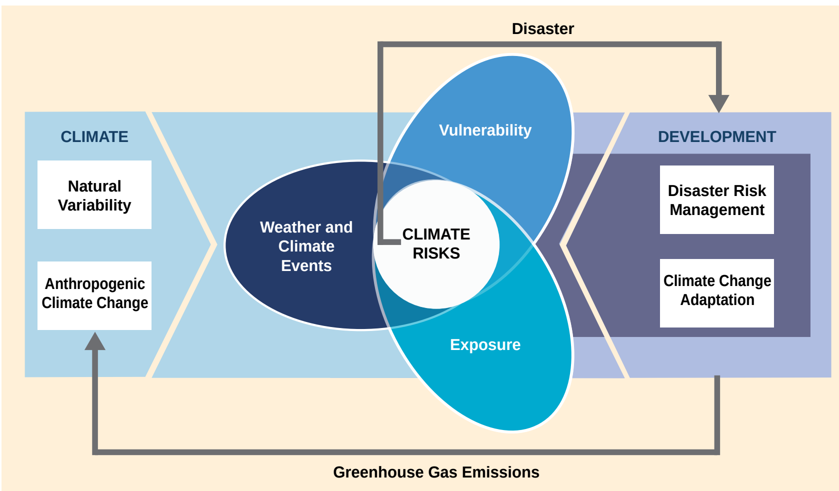
Disasters to Advance Climate Change Adaptation. Although climate change was only referred to in passing in the HFA, it received more attention in the Sendai Framework for Disaster Risk Reduction.

DRR and CCA have a number of synergies. Both aim to reduce vulnerability and have common tools to assess, analyse, monitor and address risks. Many of the disaster risk reduction measures have similarities with adaptation programmes – particularly those related to hydrometeorological disasters, such as drought proofing, flood protection, saline embankments and bio-shields, and alternative livelihood development. Thus, combining the two processes is likely to be more efficient and cost-effective (Figure V-3). At the local level in particular, the two must converge with clear plans of action, funding arrangements and guidelines for implementation and monitoring.

- *Maldives* – In 2011 the Government endorsed the world's first Strategic National Action Plan that integrated DRR and CCA through an inclusive and consultative process. A unique feature of this plan was its focus on governance and decentralization.
- *The Philippines* – In 2009 the Philippines passed the Climate Change Act which emphasized the importance of integrating disaster risk reduction into climate change programmes and initiatives. The following year the Government passed the Philippine Disaster Risk Reduction and Management Act which mandates the State to develop, promote, and implement a comprehensive National Disaster Risk Reduction and Management Plan that would inter alia institutionalize arrangements for reducing disaster risks, including projected climate risks, and enhancing disaster preparedness and response capabilities at all levels.
- *Pacific Island States* – In 2015 these countries will launch a joint regional strategy to integrate disaster risk management and climate change issues at the regional, national and local levels. They will consider issues such as capacity building, financing, institutions and policies, and implementation for integration.

FIGURE V-3

Synergies between disaster risk management and climate change adaptation



Source: IPCC, 2012.

As a follow up to this process each country should explore how the common elements in DRR and CCA can be integrated through better coordination in planning, design and implementation.

New funding opportunities for integrating CCA with DRR should result from the Green Climate Fund which to be finalized in the new climate agreement in December 2015.

THE FINANCIAL BENEFITS OF DISASTER RISK REDUCTION

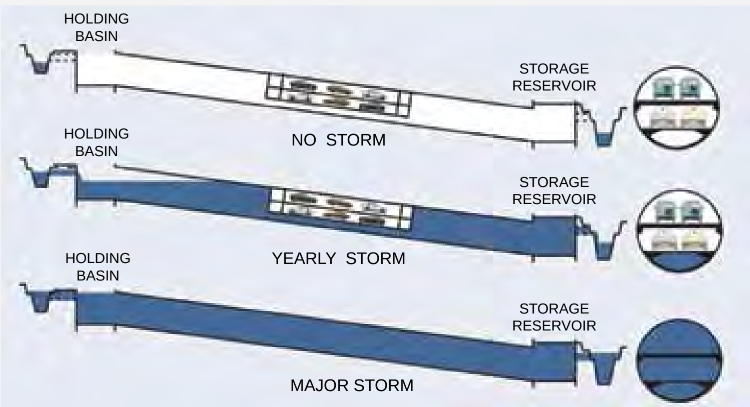
Integrating disaster reduction in each development sector will require additional expenditure, though not large sums. Countries are routinely constructing schools, hospitals, roads, and bridges, and often in hazard zones. Making these structures resistant to earthquakes, landslides, flood or cyclones is a marginal cost. In the case of earthquake resistant buildings, for example, this has been estimated at 2.5 per cent for the structural elements and 0.8 per cent for non-structural elements such as partitions and ceilings.[75] The best projects are likely to have multiple benefits (Box V-7). But the processes may be demanding in other ways – redesigning programmes and projects and developing new standards, codes, guidelines and capacities.

While it may be straightforward to estimate the costs, it is more difficult to calculate the financial benefits. The damages and losses avoided are inherently uncertain; they depend on local circumstances, and on the distribution of losses between different groups. In most countries there is very little data on vulnerabilities and impacts and values. There are also debates around the

BOX V-7

A dual-purpose project: storm water management in Malaysia

Dual-purpose projects provide direct economic benefits while also reducing the risks of disasters. One of the most innovative examples is the 9.7-kilometre storm water management and road tunnel in Kuala Lumpur, Malaysia. This has three levels: the lowest for drainage and the upper two for road traffic. This reduces traffic jams during rush hours and also solves the problem of flash floods. This has another advantage – it ensures maintenance of a drain that otherwise would be used only sporadically.[76]



Source: Mott Macdonald Group, 2009.

techniques for quantifying avoided losses and valuing non-market benefits and the choice of discount rates.

Generally, proposals for engineering projects such as embankments, sea walls or earthquake resistant buildings do not include analysis of the social, economic or environmental benefits, and even if these are mentioned they are rarely quantified. Most of the risk information and analysis is produced by the natural sciences and not connected to cost information examined by social sciences.

Overall, the economics of DRR have not yet matured into a sound subject of policy research. There is hardly any theoretical or econometric research on how a lack of investment in DRR has slowed down human, social or economic development.

In principle, risk assessment should be more straightforward for businesses. They are always dealing with opportunities and the associated risks. Not all risks are harmful, nor are they always a burden.[77] However the risks are not always assessed or priced properly. As a result, investments in otherwise attractive locations may come bundled with hidden contingent liabilities. The risk is often only revealed to investors when a major disaster occurs, as companies like Toyota, Honda, Nissan, Texas instruments and Hewlett-Packard learned to their cost following the 2011 floods in Thailand.

POLITICAL ECONOMY OF DISASTER RISK REDUCTION

Even if a private business factors the costs of hazards in its internal rate of return it will not generally take into account the external societal or environmental risks it is creating. Governments for their part should be able to do so – to take a longer term and broader view and act in the public interest. Yet they may fail to do so. Most Asia-Pacific developing countries do not have legal, regulatory and governance mechanisms to ensure that public and private investments are fully protected from the risks of disasters and that these do not exacerbate existing risks. In these circumstances, some policymakers have been reluctant to invest in risk reduction though they will readily provide funds for the more obvious requirements of disaster response.[78]

As the UN's 2015 *Global Assessment Report* concluded: 'In general, opportunities for short-term capital accumulation continue to outweigh concerns about future sustainability, resulting in massive discounting of all future risk, including disaster risk. The inadequate pricing of disaster risk and of broader externalities in economic activity means that disaster risk is discounted excessively in order to maximise short-term gains.'[79]

The most obvious cause is pressure on resources. Many developing countries have very limited funds, and international development assistance is still ad hoc and heavily oriented towards humanitarian assistance. This dilemma is well expressed in the submission of Solomon Islands on HFA progress: "If policies based on risk information would lead to increased project costs, budget constraints may limit utilization of the risk information".[80] Even developed countries whose economic base has enabled them to absorb recurring losses due to disasters may not yet convinced about the benefits of large-scale investments for disaster risk reduction.

Policymakers have to deal with competing demands for other seemingly more immediate priorities. And in competitive democratic politics they are likely to be influenced by the power of various institutions, as well as by pressures from business, civil society, the intelligentsia and other stakeholders.

One countervailing force should have been the various newly created disaster management institutions. But even these tend to give priority to response. This is generally because of the backgrounds of their members who, often from the military, have more experience in this area. But government institutions also have an eye to public perceptions. Disasters averted do not exist, but disasters responded to are very visible in the news.

Nevertheless opinion is shifting. Some of this is due to the success of preparedness projects – which in the past decade have dramatically reduced disaster mortalities, especially for hydrometeorological disasters for which early warning is possible. At the same time mounting economic losses combined with the spectre of climate change are bringing disaster risk reduction and climate change adaptation into the centre stage of public policy discourse. Other positive signs include the success of regional and global platforms on disaster risk reduction, and the unprecedented participation of countries and other stakeholders in the recently concluded World Conference on Disaster Risk Reduction.

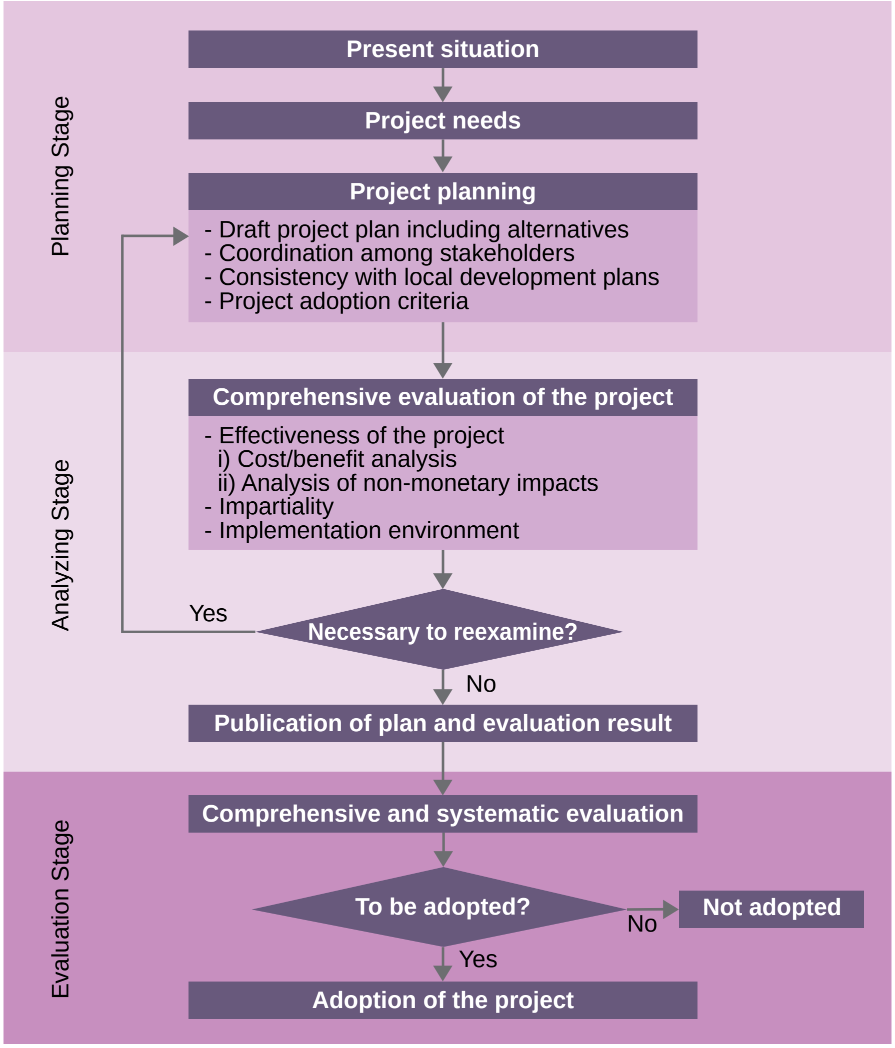
In Asia and the Pacific, one pioneering country has been Japan. During the 1960s, Japan invested heavily in various structural and non-structural measures for disaster risk reduction – around 8 per cent of the national budget. Without these measures the impact of earthquakes in 1995 and 2011 would have been much worse.[81] In 2004 the Government issued Technical Guidelines for Cost Benefit Analysis of Public Work Projects. The Ministry of Land Infrastructure Transport and Tourism has also established a comprehensive process which ensures that all construction projects are designed such that no new risks are created while existing risks are reduced through co-benefits (Figure V-4).

There is also considerable empirical evidence of the financial benefits of mitigation from other Asia-Pacific countries.[82]

- *Bangladesh* – A community-based disaster preparedness programme implemented over 15 years had a CBR of between 3.05 and 4.90 – an even this calculation excluded many benefits due to difficulties in collecting data.[83]
- *China* – In the 1960s and 1970s, the Government invested $3.15 billion for flood control measures that are estimated to have averted damages of over $12 billion.[84]
- *India* – A combined disaster mitigation and preparedness programme in Bihar and Andhra Pradesh had a CBR of 3.76.[85]
- *Indonesia* – An integrated water management and flood protection scheme for Semarang had an internal rate of return of 23 per cent and a CBR of 2.5.[86]
- *Nepal* – A livelihood-centred disaster risk reduction programme had a CBR estimated in 2011 of 2.04.[87] It should also be noted that in the Nepal earthquake of 2015 many buildings and infrastructure constructed with earthquake resistant technology survived – including 160 school buildings in the Kathmandu valley retrofitted under an ADB-supported school safety programme.[88]
- *Viet Nam* – A mangrove plantation project in 1994 which cost $1.1 million significantly reduced the costs of maintenance of dykes by $7.3 million per year as well as saving lives and property.[89]

FIGURE V-4

Japan: process for project evaluation of Ministry of Land, Infrastructure, Transport and Tourism



Source: World Bank, 2012b.

THE WAY AHEAD

Disaster risk reduction is set to occupy a larger space in the political economy of the countries of the Asia-Pacific region. The Sendai Framework has given clear goals and targets, the SDGs will open up windows of opportunity, and the new climate deal should facilitate integration of climate change adaptation and disaster risk reduction. The task now is to translate these opportunities into action throughout the region – to ensure that every investment in all development sectors has a component for disaster risk reduction.

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Achieving the Sustainable Development Goals will depend critically on greater resilience to natural disasters. But the process works both ways – as countries achieve higher levels of development they can invest more in disaster resilience. This report shows how the two objectives are inextricably connected – each supporting the other in a virtuous upward cycle.

The report also points out that in Asia and the Pacific disasters can strike many countries simultaneously. *Disasters without Borders* argues that countries can therefore best reduce the risks and the impacts if they work closely together – sharing information and expertise. Already the region's spacefaring countries are providing valuable satellite imagery and other information to their neighbours, and there are many further opportunities for regional cooperation.

Most disasters deliver a huge and sudden shock. But others are more insidious. Drought, for example, is a slow and silent killer – often a forgotten disaster. The report focuses on agricultural drought showing, for example, how the impact can be mitigated by recognizing drought as a long-term, recurring risk. Reducing this risk means addressing agriculture as part of an overall ecosystem that needs to be sustained – taking advantage of the skills of local people who are the ultimate custodians of the land.

For drought and other disasters a key component of risk reduction is timely warning. The report argues that the most efficient early warning systems are 'multi-hazard' – covering many different types of risk. It also identifies the key elements of end-to-end systems that deliver warnings to the 'last mile', reaching the most vulnerable people.

A critical part of disaster risk management is getting the right information to the right people at the right times. The report shows how vast quantities of data now being produced can be organized and analysed to make informed decisions.

Disaster risk reduction should not, however, be considered in isolation, but closely integrated with development planning and programming. Just as every sector can be affected by earthquakes or floods or cyclones, so every sector needs to consider how to make its activities disaster resilient. The report places disaster risk reduction at the heart of sustainable development.

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