Resilience in a Riskier World

MANAGING SYSTEMIC RISKS FROM BIOLOGICAL AND OTHER NATURAL HAZARDS

Asia-Pacific Disaster Report 2021

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Asia-Pacific Disaster Report 2021

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Foreword

Millions of people around the Asia-Pacific region remain exposed to a higher frequency and intensity of natural hazards, from locust swarms and earthquakes to cyclones and other exceptional events. The onset of the COVID-19 pandemic has demonstrated how, in an increasingly globalized world, such hazards can threaten a systemic global collapse, creating risks that often interconnect, with one triggering another in a cascade of devastating events. The unrelenting pressure of climate change, coupled with the pandemic-induced socioeconomic crisis, has further transformed the whole "riskscape," from the steppes of Central Asia to the small island developing States of the Pacific.

This edition of the *Asia-Pacific Disaster Report 2021* comes at an opportune time within a broader and more perilous disaster riskscape in the region. The *Report* argues that all these hazards need to be considered in relation to the larger systems that they are likely to disrupt. The increasing likelihood of extreme weather events is degrading ecosystems and habitats and increasing further the possibility of another pandemic by altering relationships in our ecosystem. Policymakers must consider more complex and varied future scenarios by leveraging technological advances and innovative approaches.

As the region prepares to recover better together, the *Report* suggests policy pathways on how to manage disasters, prepare and issue timely warnings for them, and offer support and shelter, especially to safeguard our most vulnerable people and groups. The principles of political commitment and collaboration are key drivers for managing disaster risks in a more coherent and systematic way at the regional and subregional levels.

I hope that the *Report* will contribute to a deeper understanding of what has been achieved so far, and illuminate the possibilities for building disaster, climate and health resilience to better protect people and planet, now and in the future.

Armida Salsiah Alisjahbana
Under-Secretary-General of the United Nations and Executive Secretary of ESCAP

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Executive Summary

Over the past two decades, many countries in Asia and the Pacific have strengthened their resilience against numerous natural calamities. Fewer people are dying as a result of natural hazards as countries have been devising more robust systems of early warning and responsive protection. But there is still a lot to be done. Most countries are still ill-prepared for multiple overlapping crises. Since the incursion of COVID-19 pandemic, the region has been hit by multiple natural and biological disasters, while climate change has continued to warm the world, exacerbating the impacts. The pandemic, combined with the persistent reality of climate change, has reshaped and expanded the Asia-Pacific riskscape. If the region is to achieve the goals of the 2030 Agenda for Sustainable Development, particularly Goal 1, Goal 9, Goal 11 and Goal 13, a hazard-by-hazard approach to disaster risk management is no longer viable.

The *Asia-Pacific Disaster Report 2021* addresses the complexity of these converging and cascading risks by analysing hazards (natural and biological) simultaneously, presenting the impacts of cascading risks on populations and infrastructure under current, moderate and worst-case climate change scenarios. It focuses on five risk hotspots of particular concern. The report further estimates that annual economic losses arising from such cascading risks could almost double to US$ 1.344 billion equivalent to 4.2 per cent of regional GDP under the worst case climate change scenario. Finally, the report makes the case for more purposeful and systemic national action with fiscal expenditure on resilience amounting to only a fifth of annualized losses or 0.85 per cent of the GDP of the Asia-Pacific region, along with stronger subregional and regional cooperation as important adjuvants.

A. The state of disaster risk reduction

A mixed picture...

Over the past 50 years, natural hazards in Asia and the Pacific have affected 6.9 billion people and killed more than 2 million, almost all of whom were victims of water-related disasters, such as floods, droughts, and storms. Nevertheless, fewer people have been dying; there has been a substantial fall in the average loss of life per year, which in 2019 and 2020, fell to around 6,200 people. This is heartening progress, and a testament to the dedicated efforts of governments and communities to protecting human life. Nevertheless, the average number of people affected per year has fallen only slightly, to 122 million people. Disasters have also caused huge economic damage.

Disaster impacts are likely to intensify because climate variability and the increase in extreme temperature fluctuations can affect the frequency and intensity of disasters and make certain places and population groups more vulnerable. Climate change is thus not only a hazard in itself, but also exacerbates interactions between biological and other natural hazards, which in turn affects the underlying risk drivers of poverty and inequality, in a vicious circle.

...of cascading risks triggered by the biological shock of the century: COVID-19

For the first time, this report has estimated the economic costs stemming from the combined impacts of the disaster-climate-health nexus. For this purpose, it considers two climate change scenarios using ‘representative concentration pathways’ (RCPs). The first is a moderate scenario where RCP is 4.5 and the second is the worst-case scenario where RCP is 8.5. The current annual losses from both hydro-meteorological and geophysical natural hazards are estimated to be around $780 billion. Under RCP 4.5, these losses will increase to $1.1 trillion, and under RCP 8.5, to around $1.4 trillion.

Concurrently, countries all over the world are still coping with the COVID-19 pandemic, a disaster of unimaginable proportions and the worst biological shock of the century. As of 6 June 2021, countries in the Asia-Pacific region had reported 49 million confirmed COVID-19 cases, and more than 748,000 deaths. The pandemic has had the greatest impact in South and South-West Asia, with 37.2 million confirmed cases, and in North and Central Asia with 6.6 million cases.

While responding to the pandemic, Asia-Pacific countries have also had to contend with their regular sequence of other natural hazards, including cyclones, typhoons, storm surges, floods, droughts, heatwaves, glacial lake outbursts, locust swarms, earthquakes and volcanic eruptions, most of which have been hydro-meteorological. Tropical cyclones, such as Amphan, Nisarga, and Tauktae, have hit countries in South and South-West Asia. Major flood events were reported in China, Japan, Papua New Guinea, Pakistan, the Islamic Republic of Iran, Kazakhstan and Uzbekistan. In all these disasters, many of the established measures for prevention, response, and recovery were interrupted by lockdowns, travel restrictions and other containment measures imposed as a response to COVID-19. At the same time, these natural hazards have hampered the response to the pandemic and facilitated the spread of the virus, as people often had to crowd together in emergency shelters. The convergence of biological and other natural hazards added to the underlying drivers of vulnerability, which include poverty, inequality, and unplanned and rapid urbanization, all of which has damaged the life prospects of millions of people.

Undoubtedly, all countries have been learning how best to react to these multiple hazards. However, some have been in a better position than others. Those countries who had experienced the outbreak of the SARS virus were able to anticipate the needs in terms of surveillance, testing, contact-tracing, treatment and quarantine implementation. To better understand the transmission mechanisms, countries used 'frontier technologies', such as artificial intelligence (AI) and the manipulation of big data. They also used advanced modelling techniques for early detection and rapid diagnosis. Those Asia-Pacific countries that are at the forefront of these technologies have been able to exploit them on a wider scale, while others, though being less technologically advanced, have still been able to use them to some advantage. Least developed countries, lacking the necessary skills and capacities, have continued to struggle.

Effective action has also depended on social mobilization, that is, promoting social distancing and hygiene and installing efficient test-isolate-treat regimes. These techniques worked well in the more developed countries, but they still need to be adapted for the densely populated, urban slums of developing countries. In some countries, official action was complemented well by local community surveillance.

For all these activities, health experts, governments and at-risk communities have also had to ensure effective communication and dispel misinformation. Governments in Asia and the Pacific have, to varying degrees of success, partnered with national academic institutions and companies to track the rapidly changing situation. Based on this information, many countries have been able to make critical, risk-informed interventions by imposing lockdowns, for example, and insulating other provinces and cities from the spread of the virus.

Nevertheless, in practice, the response and interventions have had their shortcomings. Often, they have not been sufficiently 'granular' or have not been updated quickly enough to keep pace with the spread of the virus, which typically has been transmitted in waves. As demonstrated by the ongoing fourth wave, opening up too quickly, without universal access to WHO-approved vaccinations, has necessitated a constant and alert stance which is ready to seal off fresh outbreaks of infection.

In sum, the pandemic has shown that the new normal in Asia and the Pacific will be a disaster riskscape with increasingly complex, overlapping and cascading hazards. It has also demonstrated that while some countries have achieved success in dealing with individual disasters many countries are still ill-prepared for complex overlapping crises, and the intersections of biological and natural hazards remain poorly understood.

B. The intersection of COVID-19 with natural hazards and climate change

Emerging and intensifying risks...

The COVID-19 pandemic has brought to the forefront, yet again, how risks interconnect and how these systemic risks, biological and hydro-meteorological, will be affected by the changing climate. The analysis in this *Report* shows that in the worst-case climate change scenario, the number of people at high risk, in the Asia-Pacific region, will increase by around one-third. These vulnerable people are mainly located in the Ganges-Brahmaputra-Meghna basin, the Indus basin, parts of South-East Asia, and in some Pacific island countries.

Climate change will slow the progress made in poverty reduction and may even reverse hard-won gains in development. This is already evident in the region's rapidly growing cities. People living in the region's cities face heightened vulnerability, because concrete buildings that retain heat, along with the loss of green spaces, contribute to the 'urban heat island' effect. Slums and informal settlements with improvised housing can also form micro-heat islands. Many regions are experiencing higher temperatures and different patterns of rainfall, and those along the coasts are threatened by rising sea levels and by extreme weather events. In other parts of the region, people are increasingly vulnerable to heatwaves, which is an intensifying hazard that has only recently begun to attract the policy attention it deserves. Overall, the people hit hardest are usually those who live in poor-quality housing on marginal land.

In both urban and rural areas, some groups are particularly vulnerable, notably women, children and the elderly, and those living with disabilities. The combination of natural disasters and climate change could widen gender disparities, particularly with respect to access to nutrition, and clean water and education, as well as to menstrual hygiene management and to sexual and reproductive health services. The impacts will be particularly severe for the large number of women in low-paid or unpaid work.

During disasters, children too are at higher risk of encountering violence, abuse, neglect and exploitation. The convergence of climate change and biological and other natural hazards will also increase child malnutrition. At the other end of the age spectrum, people aged 65 and over, many of whom are women and disabled, could be at greater risk during slow-onset or sudden disasters.

...give rise to five risk hotspots

The *Asia-Pacific Disaster Report 2019* presented a riskscape that included slow-onset disasters for the first time along with floods, tropical cyclones, earthquakes, and tsunamis. However, the risks have now expanded with the addition of biological hazards and the impacts of climate change, all of which are occurring simultaneously. Under these new risk parameters, a set of hotspots emerge where the impact of systemic and cascading risks are severe.

- *East and North-East Asia*: Heatwaves and related biological hazards are increasing along with the existing riskscape of earthquakes and tropical cyclones.
- *North and Central Asia*: High rates of COVID-19 cases are being superimposed on newly emerging areas of drought, land degradation and biological hazards due to climate change.
- *South and South-West Asia*, and *South-East Asia*: Some parts of these subregions are the global epicentres of COVID19. The pandemic is being superimposed on intensifying floods, droughts, and cyclones, leading to systemic failures that threaten to reverse poverty reduction gains and the achievement of the SDGs. The poor living along river basins in these subregions are the worst affected,
- *Pacific small island developing States*: Emerging high rates of COVID19 are being superimposed on cyclones and multiple other hazards that have been exacerbated by climate change and have led to an emerging and complex riskscape not seen before.

Focusing on these hotspots can enable countries to capture the impact of systemic and cascading risks and highlight priority areas for action, as discussed in the next section.

C. The scaled-up contours of a regional resilience response

The COVID-19 pandemic has served as a wake-up call, a stark reminder, that humanity will always remain vulnerable to powerful natural forces. Thus, it is important to assess how countries, in the Asia-Pacific region, should respond to multiple, converging hazards. This report suggests four national priority areas for action. It also highlights areas where subregional cooperation can be strengthened and serve as building blocks for a regional strategy for disaster, climate and health resilience.

Scaling up national policy actions

1. ENVISAGE RISK SCENARIOS

Traditionally, risk is envisaged as an interaction between hazards with vulnerability, exposure, and adaptive capacity. But this does not take into account how, on our increasingly complex and fragile planet, all these hazards and impacts interconnect and overlap. Thus, most aspects of human societies can now better be considered in terms of these intersecting systems. In these circumstances, the best approach is to envisage a series of scenarios, each with different interlinkages and relationships. Planners will need to invest more in the development of composite risk matrices to identify and stratify vulnerable populations, and their varying needs and capacities, in order to make comprehensive risk assessments and take targeted actions.

In 2020, the ESCAP secretariat developed a prototype of composite matrices that placed districts or areas into appropriate risk zones, incorporating risks from endemic, natural, and biological hazards. The methodology was piloted for Bangladesh and India, and highlighted the states most exposed to cascading disasters, including monsoon floods that occurred amid the COVID-19 pandemic, along with the endemic risk drivers of poverty, inequality, and population density.

2. CAPITALIZE ON FRONTIER TECHNOLOGIES

In their race to control the COVID-19 pandemic and protect their people, countries have increasingly invested in 'frontier technologies', and adapting innovation to local exigencies. Artificial intelligence and the manipulation of big data have enabled a better understanding of the transmission mechanisms. Advanced modelling techniques have been used for early detection, rapid diagnostics, prevention of the spread of the virus, as well as for managing critical supplies and delivering equipment.

New technologies will need to be combined with enhanced social organization and mobilization, adapted, in particular, to the region's densely populated urban slums where such techniques are difficult to apply. There is scope for experience sharing and learning from countries that effectively used frontier technologies to support official actions and local community surveillance by offering 'ears to the ground'. For example, by checking for unintended consequences of official action and taking corrective steps, while also using social media to dispel misinformation, and improve communication between health experts, governments, and at-risk communities.

3. INVEST IN HEALTH AND SOCIAL PROTECTION

Disasters impose multiple pressures on the health systems and disrupt health services, exposing people to greater risks in facilities with poor health conditions. The impacts from COVID-19 highlight the urgent need to merge disaster risk reduction strategies into health preparedness systems, especially to support the most vulnerable populations. The pandemic has clearly demonstrated the value of digital health systems, though their legal and privacy issues need to be carefully addressed.

The pandemic shock has also highlighted the importance of strong social protection that encompasses disaster preparedness. Over the years, governments have tried to ensure that social protection is more shock-responsive. But the scale of the pandemic has brought to the fore the need for social protection that is not just shock-responsive but also shock-prepared. Building on existing achievements, the aim should be universal social protection throughout people's life cycles. Equally important are risk-informed investments in health and education infrastructure and service delivery.

4. TARGET ADDITIONAL FISCAL SPENDING

Governments will need to boost resilience through targeted, more forward-looking fiscal spending. But the important question is how much fiscal investments will be required? Prior to the pandemic, estimates included the costs of building greater resilience to climate change. However, the costs of protection from biological hazards must also be added to these numbers.

The annual cost of adaptation to natural and other biological hazards under the worst-case climate change scenario is $270 billion, of which $68 billion is required for adapting to biological hazards. This is equivalent to 0.85 per cent of regional GDP for the total adaptation cost, and 0.22 per cent of regional GDP for the adaption cost for biological hazards. These costs need to be considered alongside the capacity to pay. The costs of adapting to climate change, as a percentage of GDP, vary from almost 1.4 per cent for the Pacific SIDS, to less than 1.0 per cent for South-East Asia, North and Central Asia, and the entire Pacific subregion.

Nevertheless, even when biological hazards are added, the cost of adaptation under the most severe climate change scenario is only one-fifth of the annualized losses from natural hazards for the region.

To increase adaptation spending, governments will need to diversify their sources of finance. In addition to those used for normal public spending, other financial instruments can include climate resilience bonds, debt-for-resilience swaps, and debt relief initiatives. Governments can also share the costs through public-private partnerships using such instruments as parametric insurance.

Scaling up subregional and regional cooperation

Initiatives at the subregional and regional levels can serve as adjuvants to these four national policy actions.

South-East Asia: As part of the effort to mobilize region-wide action on drought adaptation and disaster resilience, ASEAN and ESCAP have jointly produced the *Ready for the Dry Years* publication series. The findings from this report supported the adoption of the ASEAN Declaration on the Strengthening of Adaptation to Drought, that was held at the 37th ASEAN Summit on 13 November 2020. As a follow-up, the ESCAP and ASEAN secretariats are working on an ASEAN Regional Plan of Action on *Adaptation to Drought* 2021–2025, for ASEAN member countries to consider and adopt.

East and North-East Asia: The North-East Asian Subregional Programme for Environmental Cooperation has served as a comprehensive intergovernmental framework. There is thus scope to scale up the Program's work on desertification and land degradation and its interlinkages with climate change.

South and South-West Asia: Ministers dealing with environment and disaster risk management have called on ESCAP to shape a longer-term, holistic, coordinated and more strategic approach by developing a new regional framework for managing cascading risks from natural and biological hazards.

North and Central Asia: ESCAP is undertaking a study on the risk drivers of water-related disasters in inland water-basins, including the impacts of climate change, through advances in Earth observation, digital elevation modelling, geospatial techniques and high-resolution climate modelling. This will help promote understanding on ways to address crises, such as the Aral Sea basin catastrophe, from a multi-sectoral risk management perspective. To date, analysis on these long-standing environmental challenges, using disaster risk reduction perspectives, is a relatively under-studied approach, but one which lends itself to strengthened collaboration among countries of North and Central Asia.

Pacific island States: ESCAP, jointly with the Government of Samoa and the United Nations system, is implementing a project on strengthening resilience of Pacific islands States through universal social protection. ESCAP is also partnering with the Pacific Regional Environmental Programme and the Pacific Community and there is scope to scale up subregional activities related to disaster, climate and health resilience for the protection of people.

Asia-Pacific region: Disaster risks know no borders, so countries across Asia and the Pacific need to work together through overarching regional initiatives. Subregional initiatives can serve as the building blocks for regional approaches. The risks in the steppes of Central Asia may be very different from those of the Pacific small island developing States, but what countries across the region should have in common, however, are sound principles for managing disaster risks in a more coherent and systematic way, principles that are applied with political commitment and strengthened through regional and subregional collaboration.

In this regard, there is a need for a regional strategy on building back better with disaster, climate and health resilience. It is recommended that the strategy incorporate the analytical components and policy recommendations presented in this report. The four work streams proposed in this report are: (a) policy coherence, (b) multi-hazard and integrated early warning systems, (c) climate change adaptation, and (d) investing in resilient health infrastructure.

More complexity ahead

As climate change intensifies and more biological threats surely lie in wait, Asia and the Pacific will face an increasingly complex set of hazards. In the new disaster riskscape, these multiple threats will often overlap and intersect, triggering a cascading series of events. To combat these threats, countries will thus need to take comprehensive action to protect the poorest at national, subregional and regional levels.

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

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

East and North-East Asia: China; Democratic People's Republic of Korea; Hong Kong, China; Japan; Macao, China; Mongolia and Republic of Korea

North and Central Asia: Armenia; Azerbaijan; Georgia; Kazakhstan; Kyrgyzstan; Russian Federation; Tajikistan; Turkmenistan and Uzbekistan

Pacific: American Samoa; Australia; Cook Islands; Fiji; French Polynesia; Guam; Kiribati; Marshall Islands; Micronesia (Federated States of); Nauru; New Caledonia; New Zealand; Niue; Northern Marina Islands; Palau; Papua New Guinea; Samoa; Solomon Islands; Tonga; Tuvalu and Vanuatu

South and South-West Asia: Afghanistan; Bangladesh; Bhutan; India; Iran (Islamic Republic of); Maldives; Nepal; Pakistan; Sri Lanka and Turkey

South-East Asia: Brunei Darussalam; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Timor-Leste and Viet Nam

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

Developed ESCAP region: Australia; Japan and New Zealand

COUNTRIES WITH SPECIAL NEEDS

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

Landlocked developing countries: Afghanistan; Armenia; Azerbaijan; Bhutan; Kazakhstan; Kyrgyzstan; Lao People's Democratic Republic; Mongolia; Nepal; Tajikistan; Turkmenistan and Uzbekistan

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

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References to dollars ($) are to United States dollars, unless otherwise stated. The term "billion" signifies a thousand million. The term "trillion" signifies a million million.

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

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

COUNTRY PROFILE MAP

Map source: UNmap.

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

Acronyms and Abbreviations

AAL	Average Annual Losses
ADB	Asian Development Bank
AI	Artificial Intelligence
APDRN	Asia-Pacific Disaster Resilience Network
ArcGIS	Arc Geographic Information System
ASEAN	Association of Southeast Asian Nations
BNPB	Indonesian National Board for Disaster Management
C.auris	Candida Auris (fungal pathogen)
C. deuterogattii	Cryptococcus deuterogattii (fungal pathogen)
COVID-19	coronavirus disease 2019
DEM	digital elevation model
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EECC	essential emergency and critical care
ENEA	East and North-East Asia (ESCAP subregion)
ESCAP	Economic and Social Commission for Asia and the Pacific
EWS	Early Warning Systems
FHB	Fusarium head blight (fungal pathogen)
G2P	government-to-person
GBM	Ganga-Brahmaputra-Meghna
GDP	Gross Domestic Product
HDI	Human Development Index
HNAP	Health National Adaptation Plans
ICT	Information and Communications Technology
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPCC AR5	Intergovernmental Panel on Climate Change Assessment Report
LDC	Least Developed Country
ML	Machine Learning
MWICCC	Melbourne Water Industry Climate Change Committee
NAP	National Adaptation Plans
NAPA	National Adaptation Programmes of Action
NCA	North and Central Asia (ESCAP subregion)
NCCHAP	National Climate Change and Health Action Plans
NDC	Nationally Determined Contributions
NDHM	National Digital Health Mission
PNG	Papua New Guinea
PM	Particulate Matter
RCP	Representative Concentration Pathways
SARS	severe acute respiratory syndrome
SDG	Sustainable Development Goals
SDS	sand and dust storms
SEA	South-East Asia (ESCAP subregion)
SHDI	sub-national Human Development Index
SIDS	small island developing States
SST	sea surface temperatures
SSWA	South and South-West Asia (ESCAP Subregion)
TC	tropical cyclones
TERI	The Energy and Resources Institute
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
WMO	World Meteorological Organization

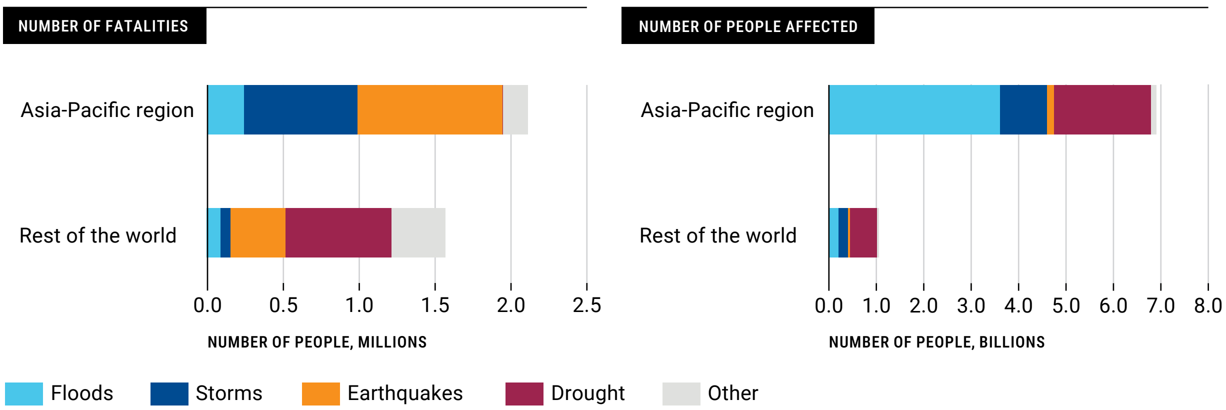
CHAPTER 1

The shifting contours of the Asia-Pacific disaster riskscape

Over the past two decades, countries in Asia and the Pacific have made significant progress in achieving the Sustainable Development Goals related to disaster risk reduction (Goal 1, Goal 9, Goal 11), and to promoting good health and well-being (Goal 3).[1] But most are still ill-prepared for complex overlapping crises. The simultaneous impacts of various hazards presents a riskscape that is expanding, and in particular, when biological risks are combined with those from other natural hazards, such as cyclones, earthquakes or drought. This was harshly demonstrated by the global spread of the COVID-19 pandemic, which presented an additional biological shock of a scale not experienced in a century. The world experienced deep consequences for health and survival, and national economies and societies suffered. Adding biological risks into loss calculations has increased current annual average losses from disasters to $780 billion. The pandemic, combined with the persistent reality of climate change, is thus reshaping and expanding the Asia-Pacific disaster riskscape. The region has regressed on the critical goal of climate action (Goal 13),[2] and the emerging disaster-climate-health nexus demands a much more systemic approach to disaster risk reduction.

Since 1970, Asia and the Pacific has accounted for 57 per cent of global fatalities from disasters and 87 per cent of the global population that has been affected by natural hazards (Figure 1-1). Between 1970 and 2020, natural hazards in Asia and the Pacific affected 6.9 billion people and killed more than 2 million, that is 41,373 lives per year, one life every 13 minutes.[3] Nevertheless, there has been substantial progress: from 2011 to 2020, the average loss of life per year fell to 10,936 lives, and in 2019 and 2020, the average annual loss fell to around 6,200 lives (Figure 1-2).

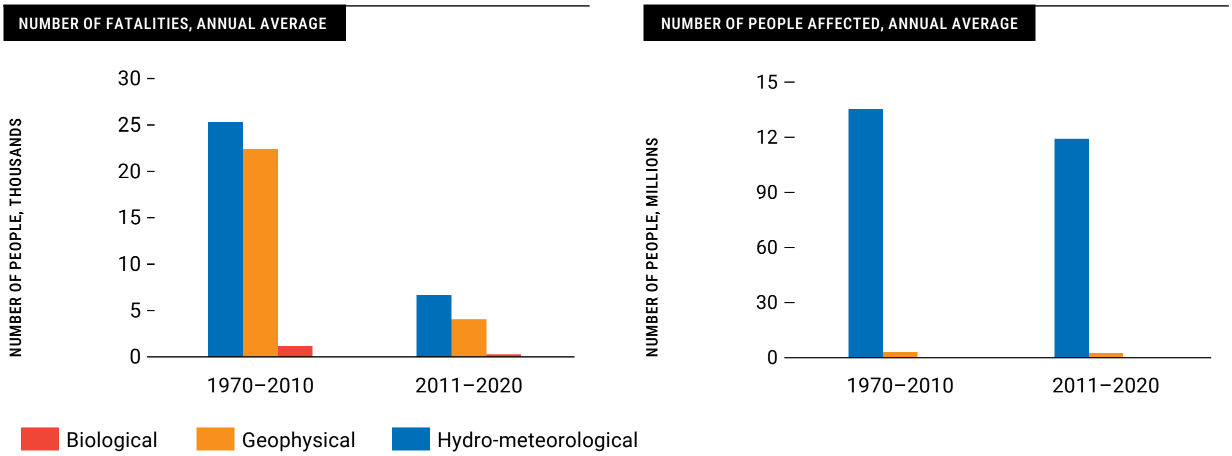
FIGURE 1-1 **Number of fatalities and people affected in the Asia-Pacific region and the rest of the world, 1970–2020**



Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

1 Asia and the Pacific SDG Progress Report 2021 (United Nations publication, 2021a). Available at https://www.unescap.org/sites/default/d8files/knowledge-products/ESCAP_Asia_and_the_Pacific_SDG_Progress_Report_2021.pdf
2 Ibid.
3 EM-DAT – The International Disaster Database. Available at https://www.emdat.be

FIGURE 1-2 Number of fatalities and people affected in the Asia-Pacific region, 1970–2020



Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

This is heartening progress, and a testament to the efforts that governments and communities have been dedicated to protecting human life. Indeed, disasters inevitably continue to affect the region but the efforts to preserve life have clearly borne fruit. Despite the continued onslaught of natural calamities, countries have learned important lessons and strengthened their resilience, anticipating where a disaster might strike and creating early warning systems that protect lives, livelihoods, and economies.

Nevertheless, while the fatality rates are lower, the average yearly number of people affected has fallen only slightly; from 139 million people between 1970 and 2010 to 122 million people between 2011 and 2020, with Asia and the Pacific accounting for around three-quarters of the world's population that was affected by disasters. Almost all of those affected were victims of water-related disasters, such as floods, droughts and storms.[4]

Disasters frequently drive people away from their homes. In 2019 alone, over 19 million people were displaced by natural hazards in Asia and the Pacific, which accounted for around three-quarters of the global total. Indeed, the Asia-Pacific region had the four largest numbers of people displaced that year: India, 5.1 million people; Philippines, 4.1 million people; Bangladesh, 4.1 million people; and China, 4 million people.[5]

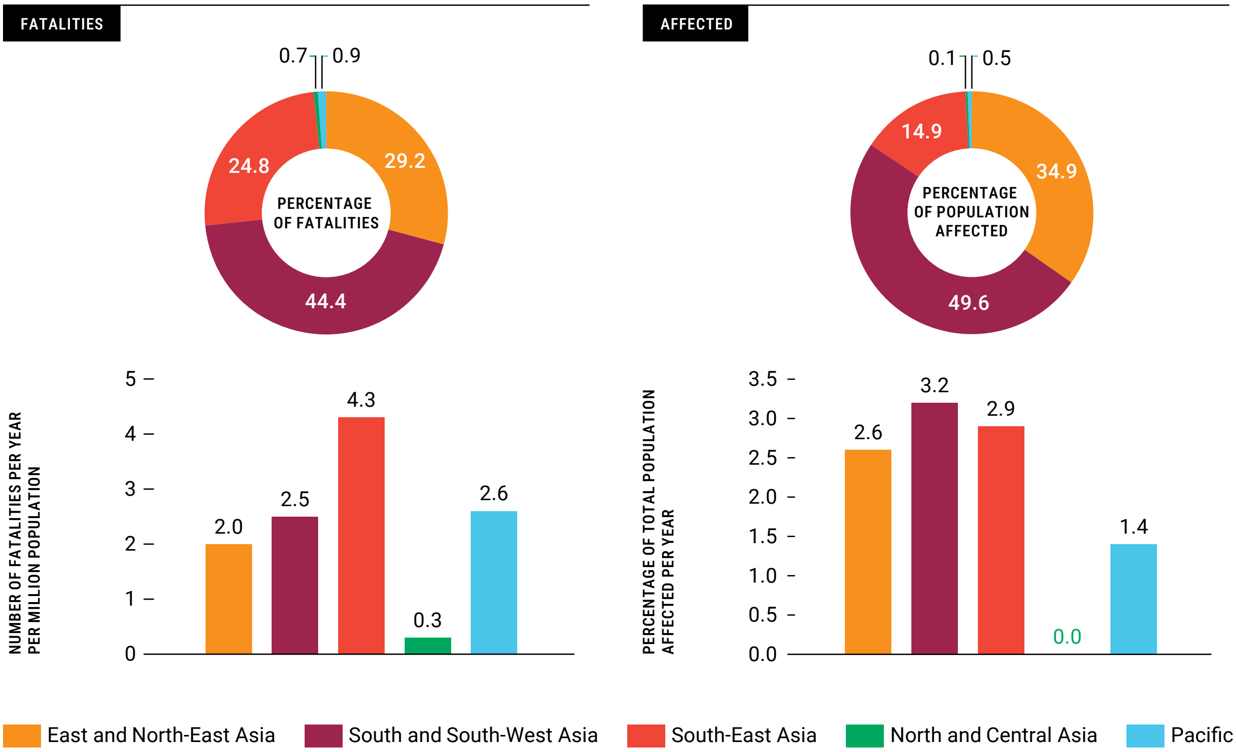
Among the ESCAP subregions, fatalities from 2011 to 2020 were greatest in South and South-West Asia (44 per cent), followed by East and North-East Asia (29 per cent), and South-East Asia (25 per cent) (Figure 1-3). The numbers are inevitably low in the Pacific because of small population sizes. Nevertheless, people in the Pacific are acutely vulnerable to disasters, which is clear from the number of deaths calculated as a proportion of the population. From this perspective, the Pacific experienced a fatality rate of 2.6 people per million, second only to the South-East Asia region which was at 4.3 people per million.

Disasters also caused huge economic damage (Figure 1-4). Between 1990 and 2018, the average annual damage across the region was 0.34 per cent of gross domestic product (GDP), which was significantly higher than the global average of 0.22 per cent. Among the subregions, the worst affected were South and South-West Asia, followed by East and North-East Asia. While the Asia-Pacific region is regularly exposed to geophysical hazards, such as earthquakes and tsunamis, the greatest damage, both human and economic, tends to be caused by hydro-meteorological hazards, especially floods, droughts, hurricanes and tornadoes.

4 Ibid.

5 Internal displacement monitoring centre, "Global Report on Internal Displacement, 2020". Available at https://www.internal-displacement.org/sites/default/files/publications/documents/2020-IDMC-GRID.pdf

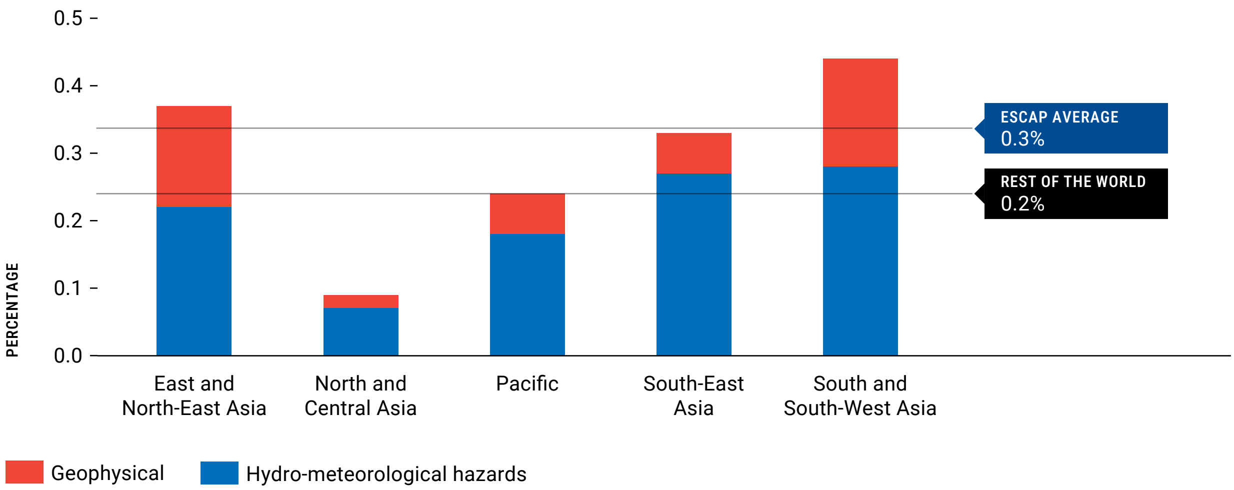
FIGURE 1-3 Number of fatalities and people affected in ESCAP subregions, 2011–2020



Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

The following sections track the contours of the Asia-Pacific riskscape as it has been reshaped by climate change. The years 2015 to 2019 were reported as the warmest five-year period on record being 0.2°C warmer than the previous five-year period. This affected both extreme weather events, such as cyclones, and slow-onset disasters, such as droughts, while also accelerating the rise in sea levels.[6]

FIGURE 1-4 Average annual damage as a percentage of GDP, 1980–2018



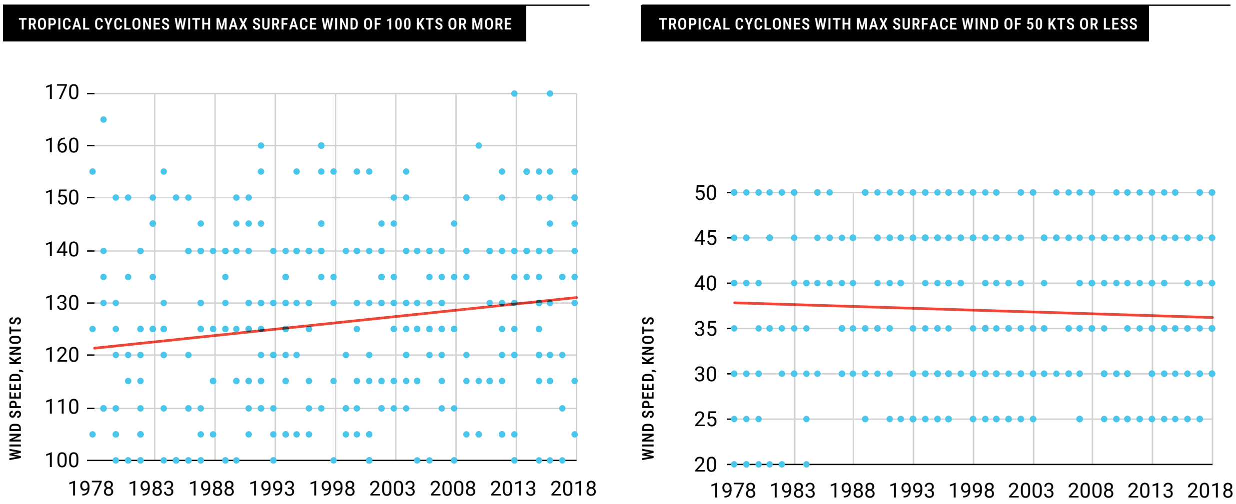
Source: Damage data (from 1990 to 2018) from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ and GDP data from United Nations, Economic and Social Commission of Asia and the Pacific (ESCAP), Statistical Database. Available at https://www.unescap.org/stat/data

6 World Meteorological Organization (WMO), "The Global Climate in 2015–2019", WMO Statements on Climate, (Geneva, 2019a). Available at https://library.wmo.int/doc_num.php?explnum_id=9936

Tropical cyclones

Climate change appears to be affecting the intensity of tropical cyclones and related rainfall, though it does not appear to be influencing the number of events.[7] In the Western North Pacific and between 1978 and 2018, the strongest cyclones, which have a maximum surface wind speed of 100 knots or more, seem to have been getting stronger, while the weaker cyclones of 50 knots or less have become somewhat weaker (Figure 1-5).

FIGURE 1-5 **Wind speeds of tropical cyclones in the Western North Pacific, 1978–2018**



Source: Data from Joint Typhoon Warning Center (JTWC), Annual Tropical Cyclone Reports.

A more positive trend is that there has been a decline in the number of fatalities (Figure 1-6). In the 1990s and 2000s, countries in South and South-West Asia and South-East Asia experienced huge losses of life, but over the past decade the number of fatalities has fallen dramatically. There has also been a decline, though smaller, in the number of people affected, which was 206 million for the period 2011 to 2020.

FIGURE 1-6 **Number of fatalities and people affected by tropical cyclones in Asia and the Pacific, 1991–2020**

Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

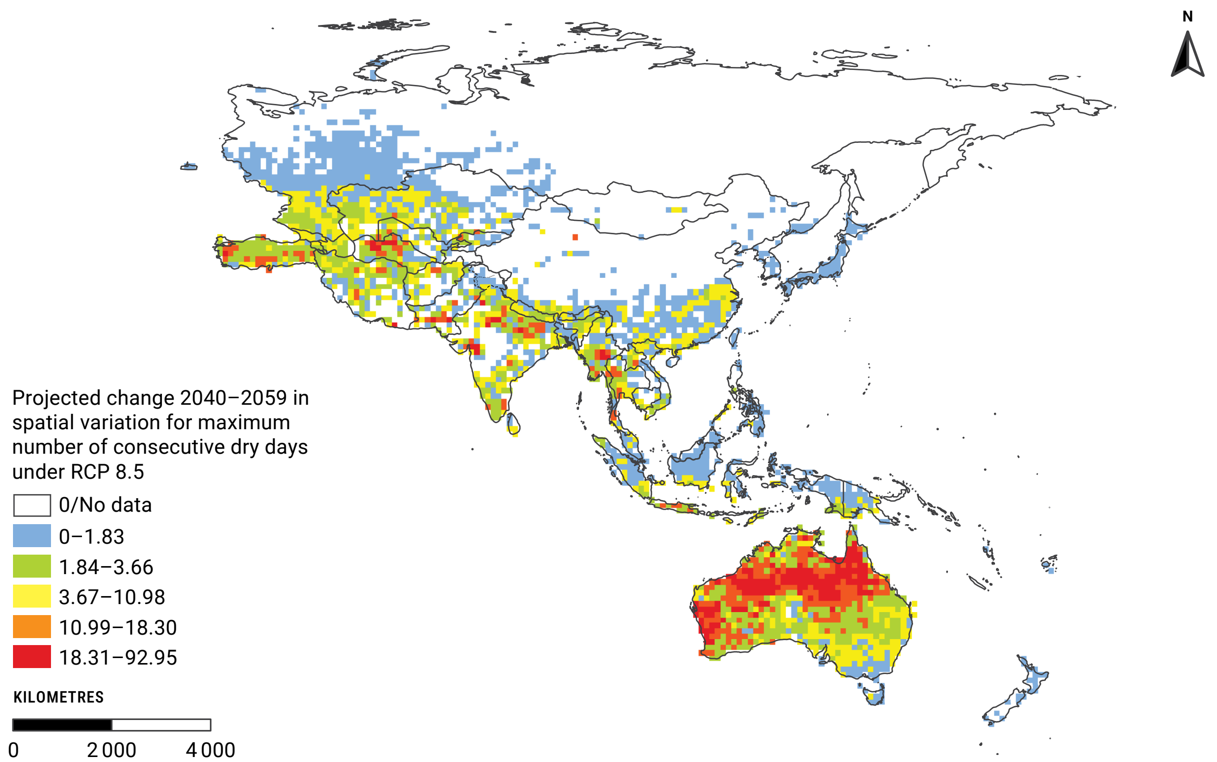
7 Intergovernmental Panel on Climate Change (IPCC), "Managing the risks of extreme events and disasters to advance climate change adaptation", (New York, Cambridge University Press, 2012). Available at https://archive.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

Droughts

Climate change is likely to alter the distribution of renewable water resources, reducing them most in dry subtropical regions, while increasing them at higher latitudes.[8] In Asia and the Pacific, this is likely to increase the occurrence and intensity of droughts, especially in drylands.[9] South-East Asia, in particular, will be affected as the combination of varying rainfall and higher temperatures could lead to severe droughts.[10]

Climate change projections from the Intergovernmental Panel on Climate Change (IPCC) are based on a series of scenarios using 'representative concentration pathways' (RCPs).[11] The business-as-usual, worst-case scenario is 'RCP 8.5' which would deliver global warming at an average of 8.5 watts per square metre across the planet and, compared with pre-industrial temperatures, an increase of about 4.3˚C, by 2100. Figure 1-7 illustrates the projected maximum number of consecutive dry days for 2040 to 2059 under RCP 8.5. It projects an increase in most of the low- and mid-latitude areas of the Asia-Pacific region. This is especially alarming for countries in South and South-West Asia, South-East Asia, and Australia.

FIGURE 1-7 **Number of consecutive dry days – projected change RCP 8.5, 2040–2059**



Source: Climate Change Knowledge Portal, 2018.
Note: Projected change 2040-2059 in Spatial Variation for Maximum Number of Consecutive Dry Days under RCP 8.5 ranges from 0 to maximum number of days.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

8 Rajendra K. Pachauri and Leo Meyer, eds., "Climate Change 2014, Synthesis Report", Intergovernmental Panel on Climate Change (Geneva, 2014). Available at https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

9 Food and Agriculture Organization, Proactive approaches to drought preparedness – Where are we now and where do we go from here? (Rome, 2019).

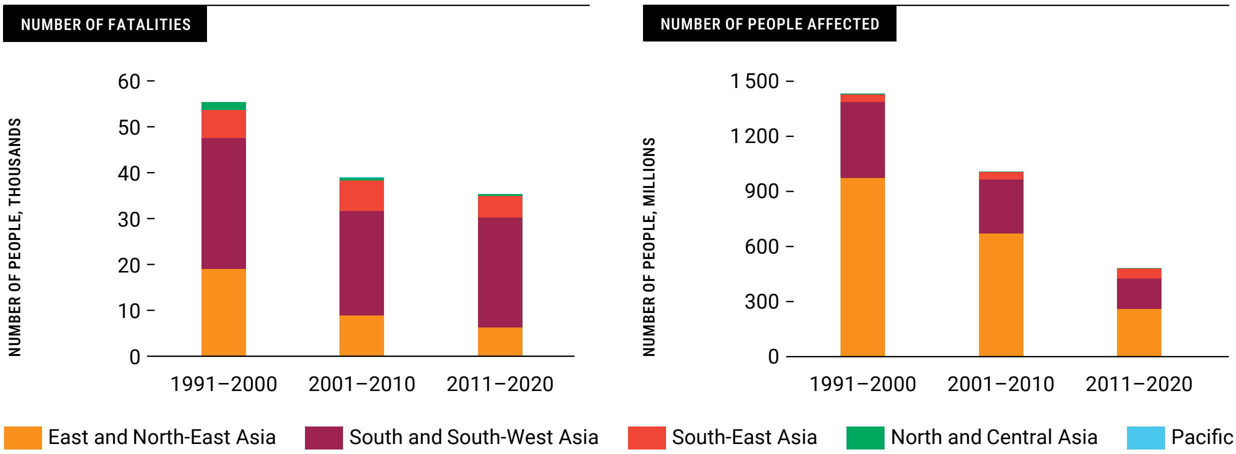
10 Ready for the dry years: Building resilience to drought in South-East Asia: With a focus on Cambodia, Lao People's Democratic Republic, Myanmar and Viet Nam, 2020 Update (United Nations publication, 2020d). Available at https://www.unescap.org/sites/default/files/publications/Ready%20for%20the%20Dry%20Years.pdf

11 RCPs specify concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to pre-industrial levels. Total radiative forcing is the difference between the incoming and outgoing radiation at the top of the atmosphere.

Floods

In recent decades, floods seem to be having less impact in terms of fatalities and the number of people affected (Figure 1-8). In the 1990s, floods killed 55,000 people, but that number fell to 39,000 in the 2000s. Moreover, the number of people affected, in the same period, fell by more than half. However, this decrease was mostly seen in East and North-East Asia. In South and South-West Asia and South-East Asia the impacts remained similar.

FIGURE 1-8 **Number of fatalities and people affected by floods, 1991–2020**



Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

The risks are greater in lower-latitude regions. This can be assessed by the 'return period', which is the frequency with which the maximum cumulative precipitation over five consecutive days is likely to return during a ten-year period. Figure 1-9 shows the ten-year return period for the period 2040–2059 under RCP 8.5. More precipitation does not necessarily lead to more floods, but the risks can increase, especially in flood-prone countries, such as Bangladesh and India, in coastal areas in South-East Asia and in the Pacific small island developing States.

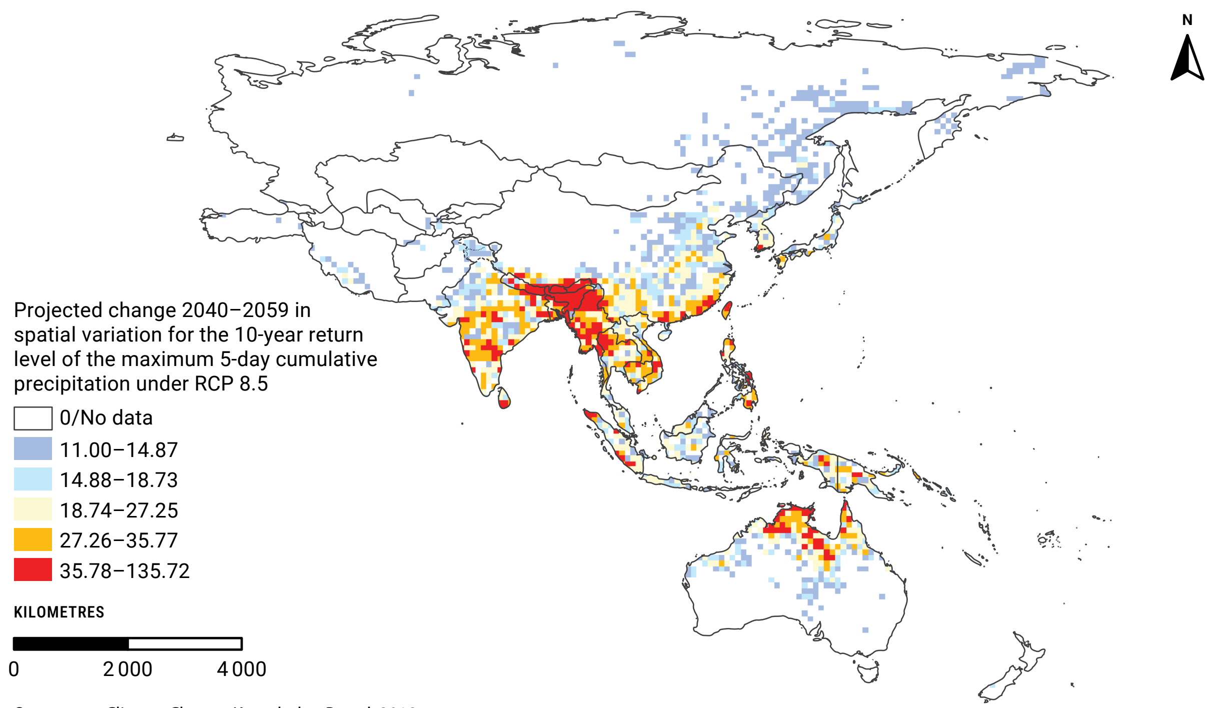
Extreme temperatures

Countries in the Asia-Pacific region also experience extreme temperatures, often in the form of heatwaves. Between 1998 and 2017, heatwaves caused almost 166,000 deaths.[12] Between 2000 and 2016, the number of people exposed increased by around 125 million, while the heatwaves lasted longer.[13]

- *2015* – There were more than 55,000 fatalities in the Russian Federation, 2,200 in India and 1,200 in Pakistan.[14]
- *2018* – There was a heatwave emergency in the Democratic People's Republic of Korea, with temperatures as high as 40˚C recorded across the country.[15]
- *2020* – Exceptionally high temperatures were recorded in eastern Australia, Hong Kong, China, Japan, New Zealand and the Russian Federation.[16]

12 World Health Organization, Heatwaves. https://www.who.int/health-topics/heatwaves#tab=tab_1 (accessed on 22 July 2021).
13 World Health Organization, "Heat and Health: Key Facts", 1 June 2018. Available at https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health (accessed on 22 July 2021).
14 EM-DAT – The International Disaster Database. Available at https://www.emdat.be
15 International Federation of Red Cross and Red Crescent Societies, "Emergency Plan of Action Final Report: DPR Korea: Heat Wave", 28 July 2019. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/MDRKP010dfr.pdf
16 World Meteorological Organization, "State of the Global Climate 2020: Unpacking the indicators", provisional report, 20 April 2021. Available at https://library.wmo.int/doc_num.php?explnum_id=10444

FIGURE 1-9 ## Maximum five-day cumulative precipitation amount projected to return in a ten-year period, RCP 8.5, 2040–2059



Source: Climate Change Knowledge Portal, 2018

Note: Projected Change 2040–2059 in Spatial Variation for 10 year return level of the maximum 5-day cumulative precipitation under RCP 8.5 ranges from 11mm to maximum precipitation.

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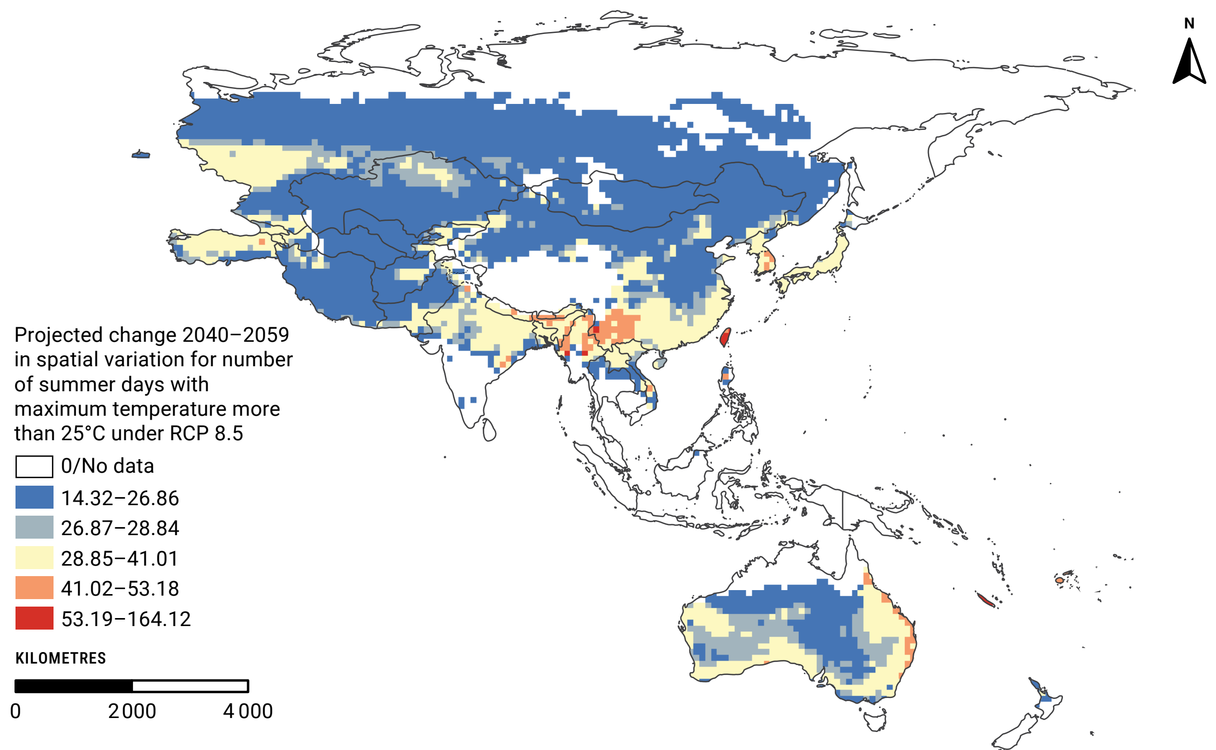
FIGURE 1-10 ## Projected change in number of days with temperature over 25˚C, RCP 8.5, 2040–2059



Source: Climate Change Knowledge Portal, 2018

Note: Projected Change 2040-2059 in Spatial Variation for Number of Summer Days with Maximum Temperature More than 25°C under RCP 8.5 ranges from 14 days to maximum number of days.

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

The risk of heatwaves is likely to increase, which will also have substantial impacts on various sectors including agriculture, health and water management. Under RCP 8.5, the number of summer days with a maximum temperature more than 25˚C is projected to increase in many areas, especially those in subtropical regions (Figure 1-10).

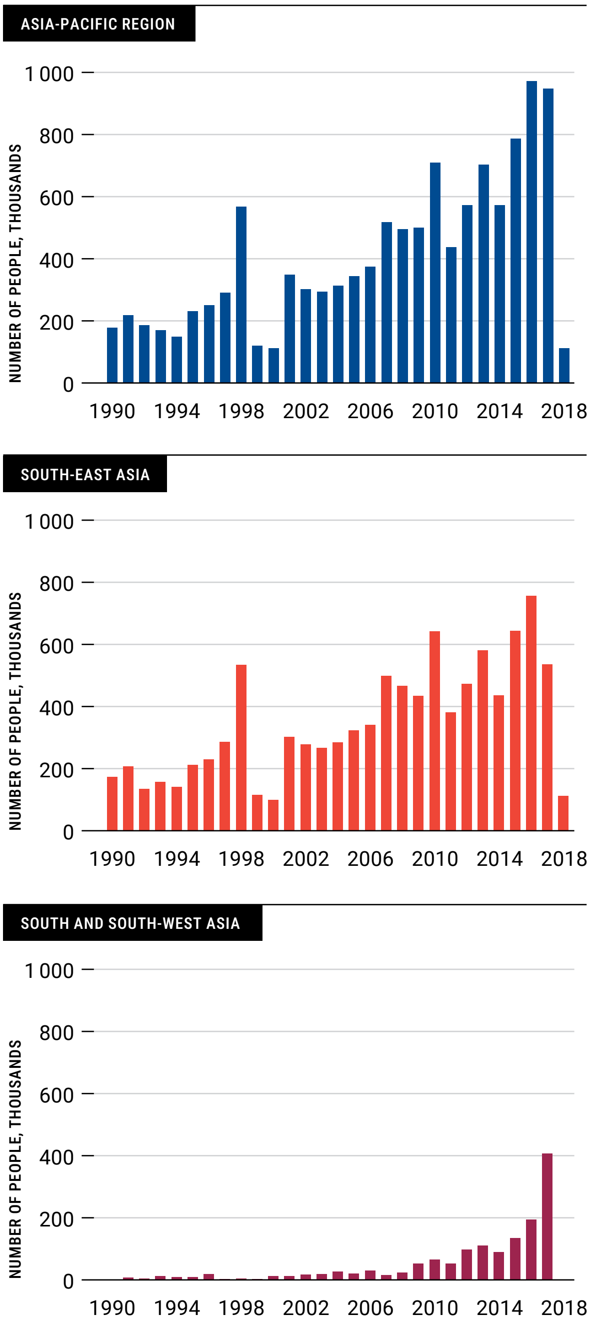
In other countries in the Asia-Pacific region, extremely low temperatures have also been recorded. In 2008, severe winter conditions cost over 1,300 lives in Afghanistan, and affected 77 million people in China. From 2016 to 2019, Mongolia suffered from '*dzud*', which are severe winters that killed large numbers of livestock.[17]

Climate change threatens health

Recent decades have seen an increase in the risk of climate-related diseases leading to illness and death.[18] For vector-borne diseases, such as malaria and dengue, rising temperatures can reduce the incubation period for mosquitos and facilitate the transmission of the disease.[19] Between the 1990s and 2010s, the average number of dengue cases per year increased from 200,000 to over 500,000. Between 1990 and 2018, there were particularly rapid increases in South and South-West Asia and in South-East Asia (Figure 1-11).

In 2019, several countries in these subregions again reported dengue outbreaks (Table 1-1). [20]

FIGURE 1-11 Confirmed dengue cases, 1990–2018



Source: World Health Organization, Dengue data application. Available at https://ntdhq.shinyapps.io/dengue5/ (accessed on 6 February 2021).

17 EM-DAT – The International Disaster Database. Available at https://www.emdat.be

18 World Meteorological Organization and others, "United in Science: High-level synthesis report of latest climate science information convened by the Science Advisory Group of the UN Climate Action Summit 2019", 2019b. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/climsci.pdf

19 World Health Organization, "Climate change and human health - risks and responses", technical report, 4 December 2003. Available at Link: https://www.who.int/publications/i/item/climate-change-and-human-health—-risks-and-responses

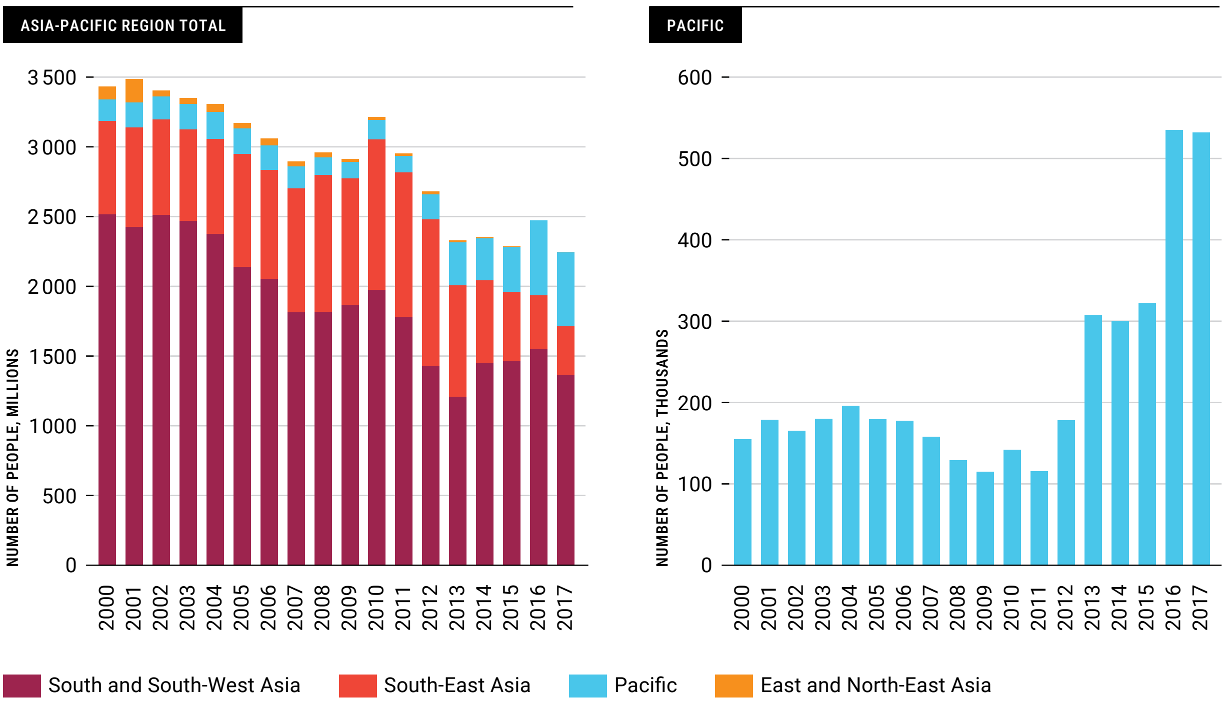
20 Government of Sri Lanka, "Dengue cases double in 2019", news.lk, 1 January 2020. Available at https://www.news.lk/news/political-current-affairs/item/28976-dengue-cases-double-in-2019; Gemma Holliani Cahya, "Dengue death toll climbs to 132, eight regions declare emergency", The Jakarta Post, 31 January 2019. Available at https://www.thejakartapost.com/news/2019/01/31/dengue-death-toll-climbs-to-132-eight-regions-declare-emergency.html; Government of the Marshall Islands, "Dengue-3 outbreak in Republic of the Marshall Islands June 25, 2019 – March 21, 2021", situation report, 23 March 2021. Available at https://reliefweb.int/report/marshall-islands/dengue-3-outbreak-republic-marshall-islands-june-25-2019-march-21-2021; World Health Organization, "WHO scales up response to worldwide surge in Dengue", 14 November 2019. Available at https://www.who.int/news-room/feature-stories/detail/who-scales-up-response-to-worldwide-surge-in-dengue; Anil Gejji, "With over 14k cases, Karnataka tops dengue list in the country", The Times of India, 6 December 2019. Available at https://timesofindia.indiatimes.com/india/with-over-14k-cases-karnataka-tops-dengue-list-in-the-country/articleshow/72405244.cms; Government of Philippines, "DOH declares national dengue epidemic", press release, 6 August 2019. Available at https://doh.gov.ph/press-release/DOH-DECLARES-NATIONAL-DENGUE-EPIDEMIC

TABLE 1-1 **Dengue outbreaks in 2019**

Subregion	Countries	Impact summary
South-East Asia	Philippines	The Department of Health declared a national dengue epidemic. There were 146,062 cases recorded from January to July 2019, which was almost double the number for the same period in 2018.
	Indonesia	Indonesia reported a total of 13,683 dengue fever cases in January 2019, and eight regions declared a dengue emergency. However, since 2016, the country has seen an overall decline in dengue cases and related deaths.
Pacific	Marshall Islands	There were 772 dengue-like illness cases of which 220 had been confirmed as of 25 June 2019.
South and South-West Asia	Bangladesh	In 2019, the worst dengue outbreak was recorded with more than 92,000 cases. The prolonged monsoon rains provided ideal breeding grounds for mosquitoes to thrive in warm, humid conditions.
	Pakistan	The worst dengue outbreak was recorded with over 45,000 people infected as of early November 2019.
	India	In 2019, 91,457 cases of dengue were reported until October.
	Nepal	More than 10,000 cases of dengue fever were reported as of late September 2019.
	Sri Lanka	The worst year was 2017, with more than 186,000 confirmed cases recorded. In 2019, 99,120 cases were recorded, which was nearly double the number in 2018.

For malaria, on the other hand, the total number of confirmed cases has gradually decreased since 2000. Nevertheless, over 2 million cases are reported every year, mainly in South and South-West Asia, and South-East Asia. In the Pacific, the numbers have been rising; from less than 200,000 per year in the early 2000s to over 500,000 in 2016 and 2017 (Figure 1-12).

FIGURE 1-12 **Confirmed malaria cases, 2000–2017**

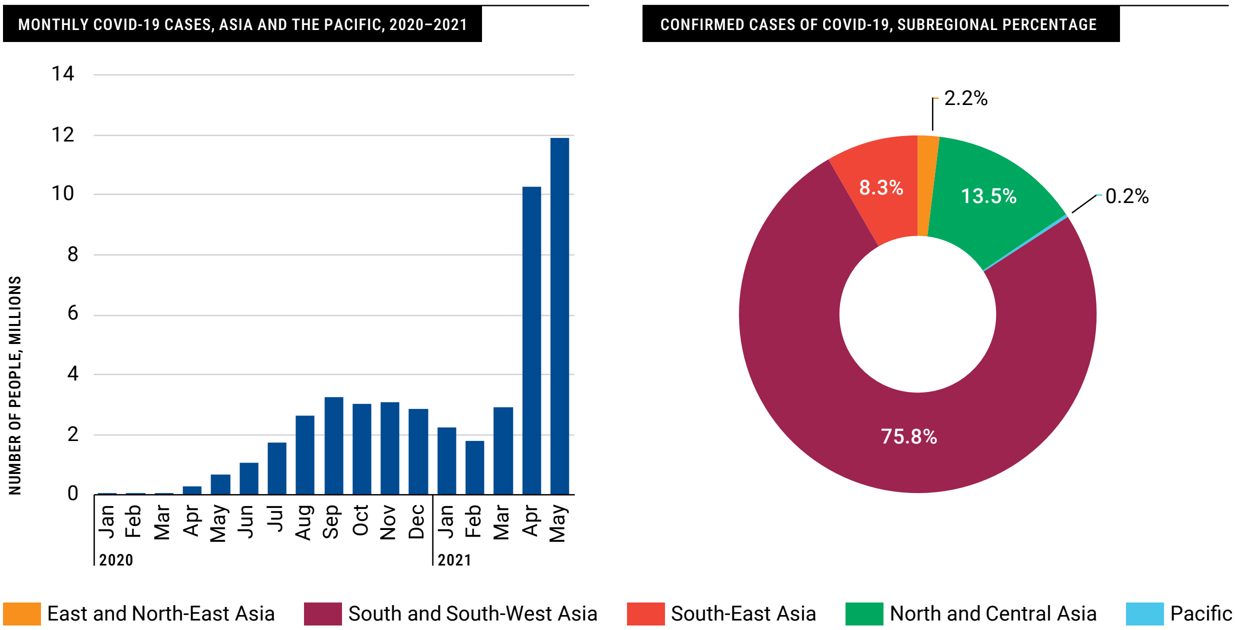


Source: Data from World Health Organization, Global Health Observatory. Available at https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/cases (accessed on 6 February 2021).

COVID-19-compounded disasters

As of 6 June 2021, countries in the Asia-Pacific region had reported 49 million confirmed COVID-19 cases, and more than 748,000 deaths. The pandemic has had the greatest impact in South and South-West Asia, with 37.2 million confirmed cases, and in North and Central Asia with 6.6 million cases (Figure 1-13).[21]

FIGURE 1-13 **Monthly COVID-19 cases in Asia and the Pacific, 1 January 2020—6 June 2021**



Source: Data from World Health Organization, WHO Coronavirus (COVID-19) Dashboard. Available at https://covid19.who.int (accessed on 7 June 2021).

While the COVID-19 pandemic raged on, the region continued to experience other natural hazards, many of which were hydro-meteorological (Figure 1-14). Tropical cyclones hit many countries across the region. Major flood events were reported in China, Japan, Papua New Guinea, Pakistan, the Islamic Republic of Iran, Kazakhstan and Uzbekistan.

The lockdowns, travel restrictions and other containment measures that were imposed as a response to COVID-19 interrupted many established measures for prevention, response, and recovery from natural hazards. At the same time, natural hazards also hampered the response to COVID-19 and facilitated its spread as people were forced to crowd together in emergency shelters.

In May 2020, the COVID-19 pandemic was rapidly spreading in India and Bangladesh when cyclone Amphan struck (Figure 1-15). It was one of the strongest recorded cyclones that hit densely populated coastal areas and led to extensive flooding. In West Bengal, it damaged 563 primary health centres, 169 block primary health centres and 5,142 community sub-centres.[22]

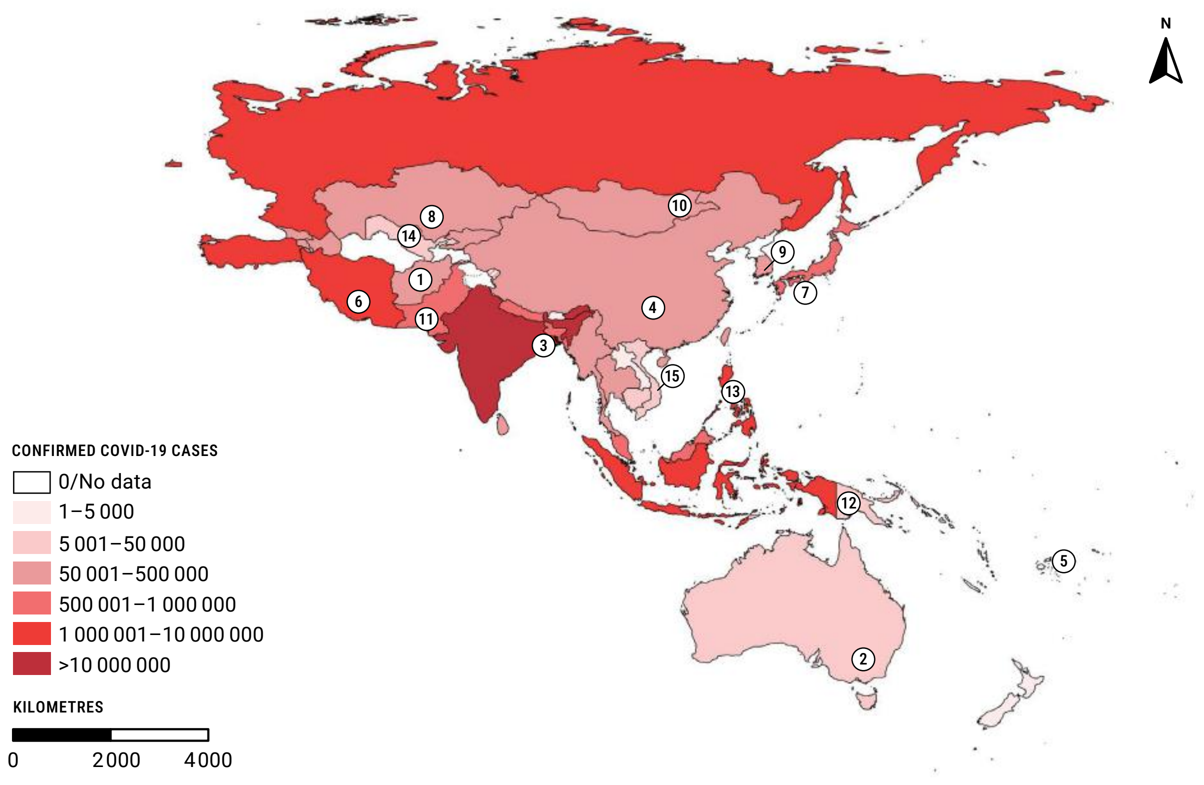
In August 2020, the city of Karachi, in Pakistan, was hit by record flooding and torrential rainfall which cost 440 lives and affected close to 1.6 million people. In the Philippines, typhoon Goni made landfall in the Bicol region, in November, which resulted in crowding in vaccination centres and triggered a far greater risk of transmission. The typhoon isolated several towns and damaged the main COVID-19 laboratory, resulting in the suspension of COVID-19 testing.[23]

21 World Health Organization, WHO Coronavirus (COVID-19) Dashboard. Available at https://covid19.who.int

22 International Federation of Red Cross and Red Crescent Societies, (IFRC), "India: Cyclone Amphan Operation Update Report", Situation Report, (India, 23 July 2020b). Available at https://reliefweb.int/report/india/india-cyclone-amphan-operation-update-report-dref-n-mdrin025 (accessed on 12 February 2021).

23 "'Super typhoon' Goni: Towns cut off as COVID-19 impacts response", UN News, 3 November 2020. Available at https://news.un.org/en/story/2020/11/1076742 (accessed on 13 February 2021).

FIGURE 1-14 COVID-19 and major disasters in 2020 and 2021



1 AFGHANISTAN
Hazard: Drought
Period: Jan–Apr 2021
Province: Badghis
Affected population: 9 million

2 AUSTRALIA
Hazard: Convective storm
Period: 19–21 Jan 2020
State: New South Wales & Victoria
Damage in USD: 1.5 billion

3 BANGLADESH AND INDIA
Hazard: Cyclone *Amphan*
Period: 16–21 May 2020
Affected population: 20.6 million
Damage in USD: 14.5 billion

4 CHINA
Hazard: Flood
Period: 21 May–30 Jul 2020
Province: Yangtze River Basin
Affected population: 4.2 million
Damage in USD: 17 billion

5 FIJI
Hazard: Cyclones *Harold, Ana*
Period: 8–9 Apr 2020, 30–31 Jan 2021
Province: Kadavu, Viti Levu
Affected population: 180,000 & 82,751

6 IRAN (ISLAMIC REPUBLIC OF)
Hazard: Flood
Period: 1–2 Apr 2020
Province: Fars, Hormozgan, Qom
Affected population: 2,845
Damage in USD: 1.2 billion

7 JAPAN
Hazard: Flood
Period: 29 Jun–10 Jul 2020
Province: Kyushu
Damage in USD: 5.8 billion

8 KAZAKHSTAN
Hazard: Flood
Period: 1–4 May 2020
Province: Turkestan
Affected population: 33,000

9 REPUBLIC OF KOREA
Hazard: Cyclone *Heishen*
Period: 6–8 Sep 2020
Province: Ulsan
Damage in USD: 1.2 billion

10 MONGOLIA
Hazard: *Dzud*
Period: Dec 2020
Province: Khovd, Gobi-Altai
Affected herders: 150,000

11 PAKISTAN
Hazard: Flood
Period: Aug–Sep 2020
Province: Sindh, Khyber Pakhtunkhwa
Affected population: 2.6 million
Damage in USD: 1.5 billion

12 PAPUA NEW GUINEA
Hazard: Flood
Period: 4–7 Apr 2020
Province: Moripi, Toaripi
Affected population: 60,000

13 PHILIPPINES
Hazard: Cyclones *Ulysses, Goni*
Period: 11-12 Nov 2020 & 31 Oct-1 Nov 2020
Affected population: 4.9 million and 2 million
Total deaths: 111 and 399
Damage in USD: 42 million and 369 million

14 UZBEKISTAN
Hazard: Flood
Period: 1-11 May 2020
Province: Syr Darya
Affected population: 70,050

15 VIET NAM
Hazard: Cyclone *Linfa*
Period: 6 Oct–3 Nov 2020
Province: Da Nang, Hà Tĩnh
Damage in USD: 6.7 billion

Sources: ESCAP, based on WHO Coronavirus Disease (COVID-19) Dashboard, as of 6 June2021; EM-DAT accessed on 4 May 2021; and Reliefweb, Accessed in February 2021.

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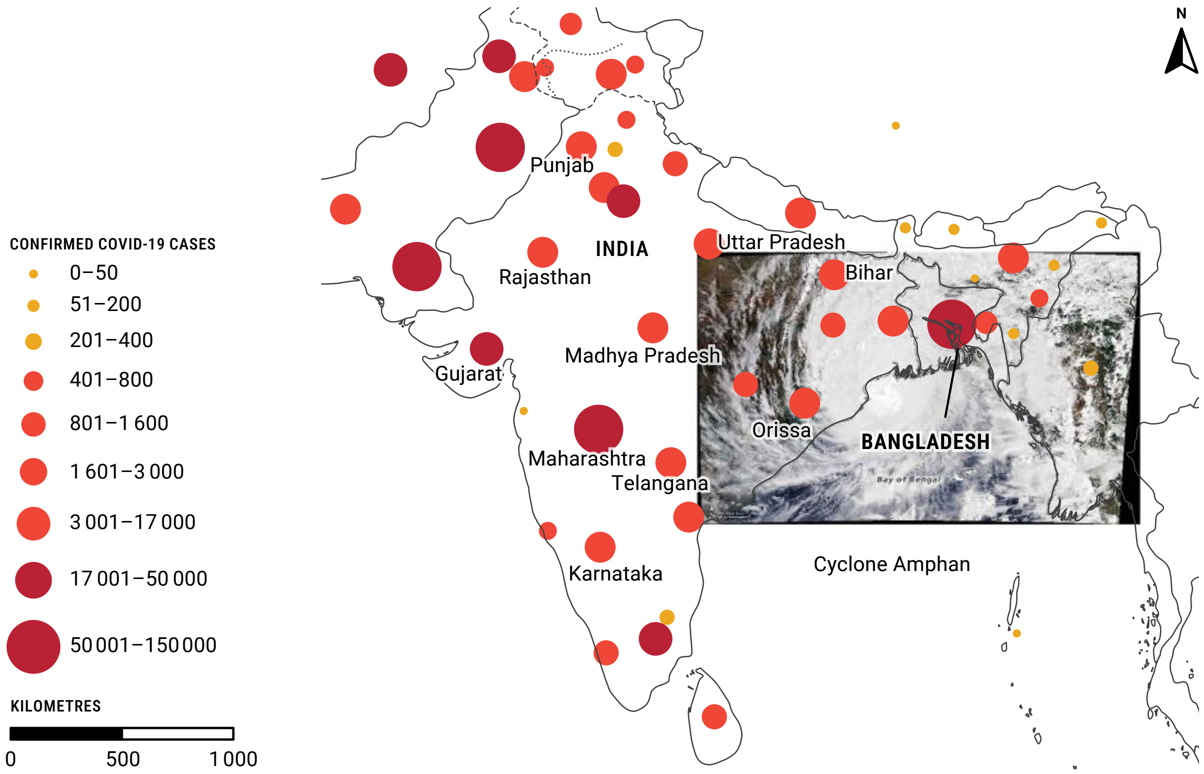
Note: Confirmed cases are as of 6 June 2021.

FIGURE 1-15 **Convergence of cyclone Amphan with the COVID-19 pandemic**



Sources: ESCAP, based on ESRI and John Hopkins University Coronavirus COVID-19 Cases V2, 16 June 2020 and Cyclone Amphan on NASA's Aqua satellite the Moderate Resolution Imaging Spectroradiometer (MODIS), 20 May 2020.

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

Source: United Nations, Economic and Social Commission of Asia and the Pacific (ESCAP), "Protecting the most vulnerable to cascading risks from climate extremes and the COVID-19 in South Asia", policy brief, 14 August 2020b. Available at https://www.unescap.org/resources/protecting-most-vulnerable-cascading-risks-climate-extremes-and-covid-19-south-asia

TABLE 1-2 **Number of people affected by the COVID-19 pandemic and natural hazards in the Asia-Pacific subregions**

Subregion	Number of people affected by COVID-19			Number of people affected by natural hazards (2020)
	2020	2021 (as of 6 June)	Sub-total	
East and North-East Asia	388 894	693 665	1 082 559	15 328 666
South and South-West Asia	12 801 945	24 392 271	37 194 216	30 910 631
South-East Asia	1 442 436	2 636 426	4 078 862	15 738 911
North and Central Asia	4 043 839	2 568 085	6 611 924	113 709
Pacific	55 160	21 421	76 581	359 636
Total	18 732 274	30 311 868	49 044 142	62 451 553

A riskscape of cascading hazards

The convergence of biological and natural hazards has added to the stresses of poverty and inequality, further damaging the life prospects of millions of people across the Asia-Pacific region. The pandemic has demonstrated that while some countries have achieved success in dealing with individual disasters, many others are still ill-prepared for complex overlapping crises. This will have implications for achieving the goals of the 2030 Agenda for Sustainable Development.

These limitations were already identified in the Sendai Framework for Disaster Risk Reduction 2015–2030, which was adopted by UN Member States in 2015 at the World Conference on Disaster Risk Reduction. The framework recognized the central importance of health threats, including biological hazards, which encouraged the development of the field of 'health emergency and disaster risk management.'[24] Even so, the intersection of biological and other natural hazards remains poorly explored and understood.[25]

Any natural disaster or other emergency that displaces large numbers of people is likely to lead to a surge in epidemic diseases, such as hepatitis A and E, measles, diarrhoeal diseases, meningitis, acute respiratory infections, malaria, or dengue. In August 2020, during the COVID-19 pandemic, the monsoon floods in South Asia heightened the risk of dengue and malaria outbreaks and stretched health resources to breaking point.[26] The coincidence of natural and biological hazards is illustrated in Figure 1-16.[27, 28]

The overlaps between multiple hazards are likely to intensify as a result of climate change, particularly in Asia and the Pacific, which is already the world's most disaster-prone region.[29] Climate-related disasters of increasing frequency, intensity and unpredictability are already battering vulnerable sectors and communities (Figure 1-17). Overlapping hazards, along with the interconnectedness of economies at different scales, are creating systemic risks that demand more sustained and rigorous approaches.[30]

BOX 1-1

Cascading hazards

The concept of cascading hazards comprises everything from vulnerability, risks, threats, triggers, to processes, responses, and outcomes. Cascading hazards turn into cascading disasters when their effects increase in progression over time and generate unexpected secondary events. These events can stem from overlaps of disaster events, from failures of physical structures and the social functions that depend on them, including critical facilities. The inadequacy of mitigation strategies, such as evacuation procedures, land-use planning and emergency management strategies further exacerbate the situation. Cascading disasters tend to highlight the major gaps in addressing vulnerabilities in human societies.

Adapted from: Shlomo Mizrahi, "Cascading disasters, information cascades and continuous time models of domino effects", *International Journal of Disaster Risk Reduction*, vol 49 (October 2020). Available at https://doi.org/10.1016/j.ijdrr.2020.101672

Biological hazards – Between 2000 and 2020, biological hazards accounted for almost 8 per cent of the total number of disaster events recorded in the Asia-Pacific region and affected more than 3 million people (Figure 1-17). Along with the epidemics and pandemics, there are also endemic health hazards including dengue, typhoid, tuberculosis, and chikungunya. Assessing the region's vulnerability to biological hazards, the World Health Organization (WHO) notes that the largest threats to the region are the Middle East respiratory syndrome, diarrhoeal diseases, Crimean-Congo haemorrhagic fever, Japanese encephalitis, and the Zika virus disease.[31]

24 Natalie Wright and others, "Health emergency and disaster risk management: Five years into implementation of the Sendai Framework", International Journal of Disaster Risk Science, vol. 11 (2020), pp. 206–217. Available at https://link.springer.com/article/10.1007/s13753-020-00274-x

25 Rajib Shaw and others, "Integrating biological hazards (including pandemics) into DRR planning", technical advisory document. Available at http://www.ccouc.ox.ac.uk/_asset/file/technical-advisory-document-on-biological-hazard-rajib-final.pdf

26 International Federation of Red Cross and Red Crescent Societies (IFRC), "17.5 million affected by floods and threatened by disease in South Asia", press release, 6 August 2020a. Available at https://media.ifrc.org/ifrc/press-release/17-5-million-affected-floods-threatened-disease-south-asia/

27 Kaveh Zahedi, "Confronting the new climate reality in Asia and the Pacific", blog, 23 September 2019. Available at https://www.unescap.org/blog/confronting-new-climate-reality-asia-and-pacific

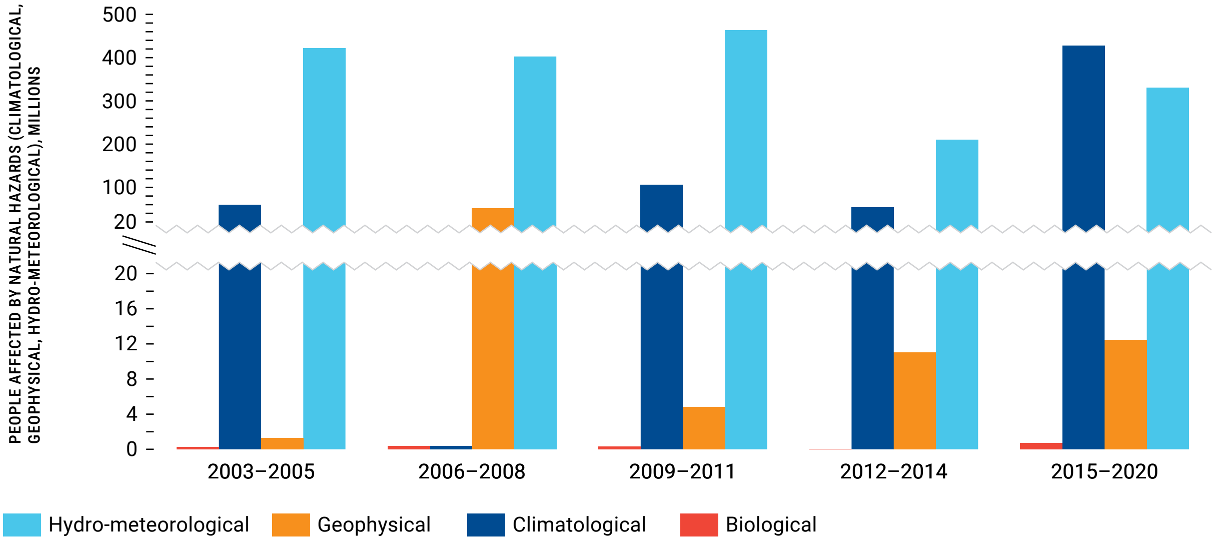
28 World Health Organization, Regional Office for South-East Asia, Roots for Resilience: A health Emergency Risk Profile of the South-East Asia Region (New Delhi, 2017). Available at https://apps.who.int/iris/handle/10665/258766

29 The Disaster Riskscape across Asia-Pacific: Pathways for Inclusion and Empowerment (United Nations publication, 2019).

30 United Nations Office for Disaster Risk Reduction, Integrating Disaster Risk Reduction and Climate Change Adaption in the UN Sustainable Development Cooperation Framework (Geneva, 2020).

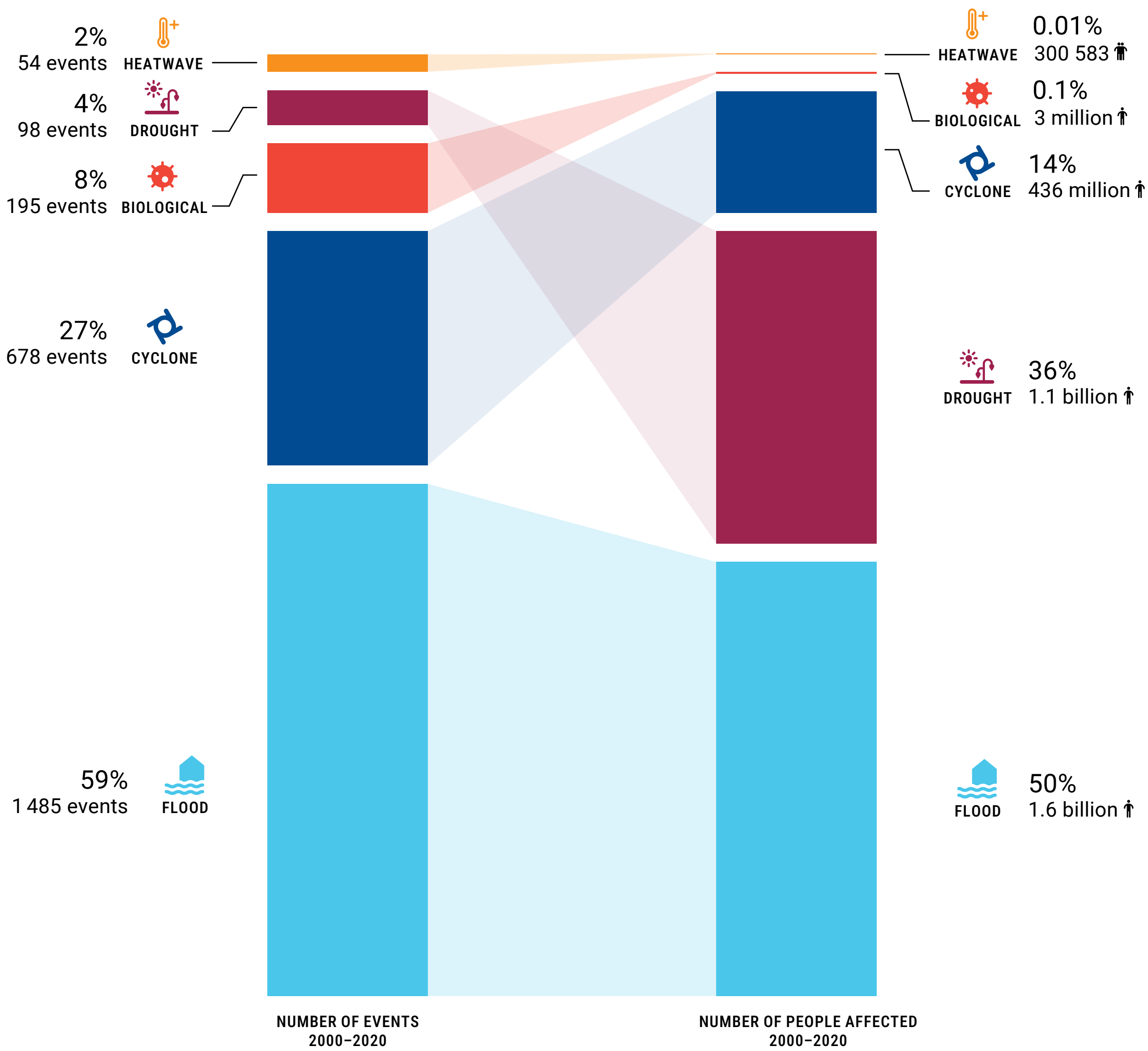
31 Asia and the Pacific SDG Progress Report 2020 (United Nations publication, 2020a). Available at https://www.unescap.org/publications/asia-and-pacific-sdg-progress-report-2020

FIGURE 1-16 Number of people in Asia and the Pacific affected by biological and other natural hazards, 2003–2020



Source: EM-DAT – The International Disaster Database. Available at https://www.emdat.be (accessed on 20 April 2021).

FIGURE 1-17 Types of disasters in Asia and the Pacific, 2000–2020



Source: EM-DAT – The International Disaster Database. Available at https://www.emdat.be (accessed on 20 April 2021).
Note: All figures have been rounded off.

Intersection of biological hazards with natural hazards

Floods – By worsening living conditions and displacing people from their homes, floods can lead to gastro-intestinal illnesses. They also interrupt the treatment of non-communicable diseases by disrupting supply chains. In addition, there is a heightened risk of vector-borne diseases, such as dengue and malaria.[32] The human-animal-insect interaction weaves a complex web of disease transmission that is further compounded during flooding, which provides a perfect breeding ground for mosquitos.[33]

Tropical cyclones – Through water contamination, cyclones can lead to communicable and infectious diseases. Following cyclone Ami, in Fiji in 2003, for example, drinking water was found to be filled with coliform bacteria, resulting in cases of diarrhoea and dysentery and other water-borne diseases, such as cholera and typhoid fever.[34] Subsequent waterlogging also creates breeding grounds for the vectors of malaria, dengue and chikungunya, with an increased risk of skin infections.[35]

Droughts – Droughts can lead to increased pollution, pests and diseases, and even famine.[36] Shrinking water sources increase the risks of contamination, and when droughts force people to migrate there is often an increase in child malnutrition,[37] stunting, and even adult malnutrition.[38] Droughts typically affect the most vulnerable populations, creating cycles of intergenerational deprivation.[39]

Heatwaves – These are more recent and poorly understood threats. They disrupt economies, result in losses in labour productivity, agriculture, transport and utilities, and present profound risks to health. Heatwaves increase deaths for those suffering from underlying cardiovascular and respiratory conditions, and are also associated with suicides. The very old, the poor, the socially isolated, and those who often work outdoors in informal economies, are the most susceptible. Poorer people, living in inferior housing conditions experience overheating, while the costs of water make bathing more expensive. The demand for healthcare soars, increasing requests for consultations and increasing admissions to hospitals that themselves are often poorly designed to cope with the heat. Another issue is the use of electricity for fans and air-conditioning which leads to shortages of supply. Furthermore, the poor may not be able to afford any form of mechanical cooling.[40] Even countries accustomed to high temperatures have not been spared. For example, during the 2015 heatwave in Karachi, Pakistan, almost 65,000 people were taken to hospital with heat-related symptoms.[41] Additionally, air-conditioning mostly uses energy derived from fossil fuels and, thus, contributes to climate change, while waste heat from the pumps also intensifies the urban heat island effect.[42]

This range of disasters exacerbates the underlying drivers of vulnerability, which include poverty, inequality, unplanned and rapid urbanization. Poor natural resource management along with compounding factors, such as increasing populations, population density, and declining and fragile ecosystems all converge into a riskscape of expanding and cascading hazards. And, this is the riskscape within which the COVID-19 pandemic appeared.

32 World Health Organization, Regional Office for South-East Asia, Roots for Resilience: A health Emergency Risk Profile of the South-East Asia Region (New Delhi 2017). Available at https://apps.who.int/iris/handle/10665/258766

33 Cyril Caminade, K. Marie McIntyre and Anne E. Jones, "Impact of recent and future climate change on vector-borne diseases", Annals of the New York Academy of Sciences, vol 1436, No. 1 (January 2019), pp. 157–173. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6378404/

34 Luke M. Mosley, Donald S. Sharp and Sarabjeet Singh, "Effects of a tropical cyclone on the drinking-water quality of a remote Pacific island", Disasters, vol. 28, No. 4 (December 2004), pp. 405–17. Available at https://pubmed.ncbi.nlm.nih.gov/15569381/

35 Zhengyi Deng and others, "Impacts of tropical cyclones and accompanying precipitation on infectious diarrhoea in cyclone landing areas of Zhejiang Province, China", International Journal of Environmental Research and Public Health, vol. 12, No. 2 (February 2015), pp. 1054–1068. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4344654/

36 M. Alimullah Miyan, "Droughts in Asian Least Developed Countries: Vulnerability and sustainability", *Weather and Climate Extremes*, vol. 7 (March 2015), pp. 8–23.

37 Matthew W. Cooper and others, "Mapping the effects of drought on child stunting", Proceedings of the National Academy of Sciences of the United States of America, vol. 116, No. 35 (August 2019). Available at https://www.pnas.org/content/pnas/116/35/17219.full.pdf

38 Carla Stanke and others, "Health effects of drought: a systematic review of the evidence", *PLoS Currents*, vol. 5, No. 5 (June 2013). Available at / https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3682759

39 Ready for the dry years: Building resilience to drought in South-East Asia, Second Edition (United Nations publication, 2020c).

40 "Heatwaves and health", *The Lancet*, vol. 392, No. 10145 (August 2018), p. 359. Available at https://doi.org/10.1016/S0140-6736(18)30434-3

41 Syed Ghazanfar Saleem and others, "Risk factors for heat related deaths during the June 2015 heat wave in Karachi, Pakistan", Journal of Ayub Medical College Abbottabad, vol. 29, No. 2 (April/June 2017), pp. 320–324.

42 "Heatwaves and health", *The Lancet*, vol. 392, No. 10145 (August 2018), p. 359. Available at https://doi.org/10.1016/S0140-6736(18)30434-3

BOX 1-2 Natural disasters, climate change and the emergence of fungal pathogens

In addition to viral and bacterial diseases, the emergence of fungal pathogens poses a significant threat to human health, environment, and food security. In India, amidst the COVID-19 pandemic, over 8,400 cases of black fungus, a rare infection, have been recorded. The cases are increasing due to the use of steroids in combating the COVID-19 virus. Fungal infections have no vaccines and there is a limited arsenal of anti-fungal agents. Furthermore, during natural disasters, these fungal infections can spread. For example, floods and cyclones disperse and aerosolize fungi causing wider dissemination.

Recent findings highlight that climate change is exacerbating this threat. Under increasing temperatures, fungi are not only evolving thermotolerance, but are also gradually adapting and multiplying faster in increased temperatures. The following table shows the emerging fungal pathogens whose growth may potentially be attributed to climate change and its impacts.

TABLE Influence of climate change on emerging fungal pathogens

Fungal pathogens	Major impact and features	Climate change causes/influence
Candida Auris (C.auris)	**Human health** • Colonises and spreads in healthcare settings • Remarkably resistant to antifungals and disinfectants • Low in virulence and has caused infection in people with severe comorbidities	First 'novel' pathogen to have evolved in response to climate change (conclusive evidence awaited)
Cryptococcus deuterogattii (C.deuterogattii)	**Human and animal health** • Traditionally found in tropical and sub-tropical climates, recently emerged in temperate regions, like western Canada and caused hundreds of infections in people and animals • High capacity for thermal adaptation	Spread attributed to human activities and their environmental impacts; for example, through vehicle wheel wells, footwear, construction, forest activity (aerial dispersal) and water; climate change suggested as a potential driver
Fusarium head blight (FHB)	**Food security** • Concern for wheat and cereal crops • Infection leads to reduced yield and quality, yield loss up to 75%	Outbreaks occur particularly in years with warm and humid weather; severity is likely to increase in future warmer climates

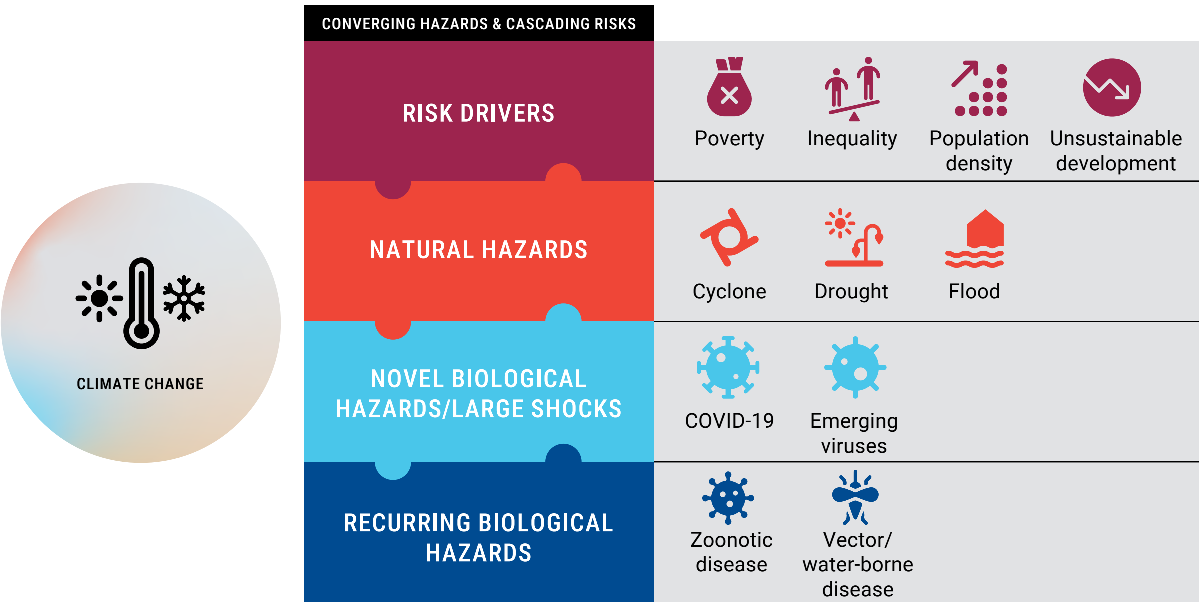
Overall, climate change and natural hazards are causing the emergence of new fungal pathogens, as well as the evolution of new traits, like virulence and anti-fungal resistance in existent fungi. Hence, these risks must also be incorporated when tackling the cascading risks of converging climate, health and natural hazards.

Source: Nnaemeka E. Nnadi and Dee A. Carter, "Climate change and the emergence of fungal pathogens", PLOS Pathogens, vol. 17, No. 4 (April 2021). Available at https://doi.org/10.1371/journal.ppat.1009503 and Dona Cherian, "India COVID-19: White fungus and black fungus – symptoms, causes, treatment, Gulf News, 22 May 2021.

Climate change exacerbates the impacts of converging natural and biological hazards

In the years ahead, the Asia-Pacific disaster riskscape will continue to be reshaped by climate change.[43] Alarmingly, the *Asia and the Pacific SDG Progress Report 2021* notes that the region has substantially regressed on Goal 13: Climate Action.[44] Additionally, natural disasters linked to climate change disproportionately affect poor people and poor countries.[45] This is concerning as global warming is not only a hazard in itself, but it also exacerbates interactions between biological and natural hazards and other risk drivers, such as poverty (Figure 1-18). Global heating and the increase in variability of extreme temperature fluctuations can affect the frequency and intensity of disasters, and make certain places and population groups more vulnerable. Overall, there is extensive scientific evidence that climate change is affecting weather extremes.[46, 47]

FIGURE 1-18 Climate change exacerbates disaster risk



Since the early 2000s, there have been more than 300 peer-reviewed studies on the impact of climate change on weather extremes around the world. Of these, a number have concluded that climate change would make around 70 per cent of the extreme weather events either more likely or more severe. Within these studies, 32 per cent analysed extreme heat and 22 per cent analysed floods. From those that studied extreme heat, 116 found that climate change had made such weather conditions either more likely or more severe. Other events that are likely to be exacerbated include heavy rain and flooding, drought, cold/snow, storms and wildfires (Figure 1-19).[48] However, the coverage of these studies is uneven as they concentrate on certain hazards and particular areas. For example, of the studies on countries within Asia and the Pacific, 25 per cent were on China and 28 per cent on Australia.

43 World Health Organization, Regional Office for South-East Asia, Roots for Resilience: A health Emergency Risk Profile of the South-East Asia Region (New Delhi, 2017). Available at https://apps.who.int/iris/handle/10665/258766

44 Asia and the Pacific SDG Progress Report 2021 (United Nations publication, 2021a). Available at https://www.unescap.org/sites/default/d8files/knowledge-products/ESCAP_Asia_and_the_Pacific_SDG_Progress_Report_2021.pdf

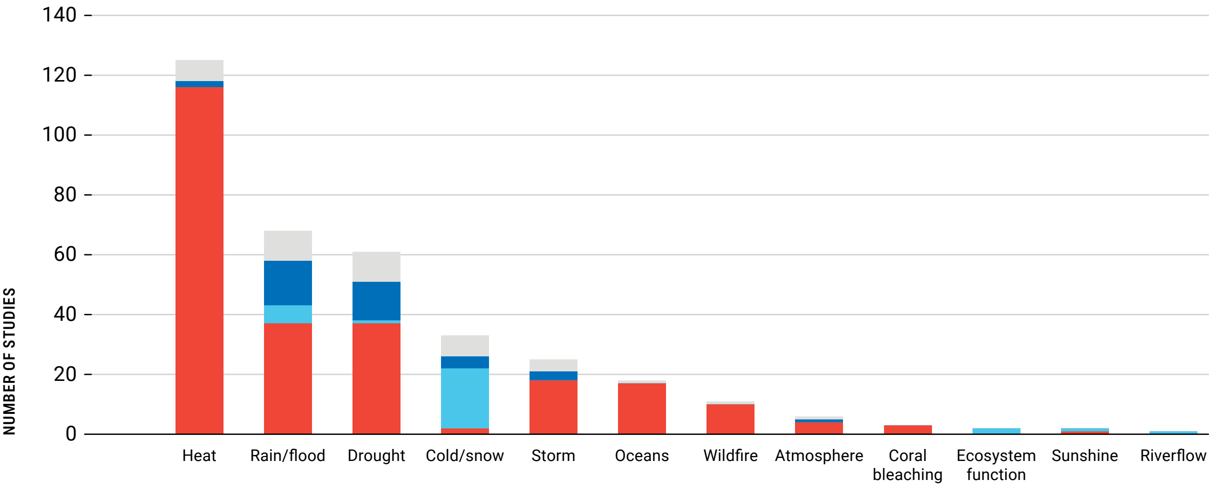
45 Economic and Social Survey of Asia and the Pacific 2021: Towards post COVID-19 resilient economies (United Nations publication, 2021b).

46 Susan Joy Hassol and others, "(Un)Natural disasters: Communicating linkages between extreme events and climate change", *World Meteorological Organization Bulletin*, vol. 65, No. 2 (2016). Available at https://public.wmo.int/en/resources/bulletin/unnatural-disasters-communicating-linkages-between-extreme-events-and-climate

47 Stephanie C. Herring and others, "Explaining extreme events of 2019 from climate perspective", *Bulletin of the American Meteorological Society*, vol. 102, No. 1 (January 2021). Available at https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/explaining-extreme-events-from-a-climate-perspective/

48 CarbonBrief, "Mapped: How climate change affects extreme weather around the world", 26 February 2021. Available at https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world

FIGURE 1-19 Impact of climate change on extreme weather conditions



	Heat	Rain/flood	Drought	Cold/snow	Storm	Oceans	Wildfire	Atmosphere	Coral bleaching	Ecosystem function	Sunshine	Riverflow
NUMBER OF EXTREME WEATHER EVENTS IN ASIA-PACIFIC REGION	43	23	11	4	5	8	3	1	3	1	1	0

More severe or more likely to occur
Less severe or less likely to occur
No discernible human influence
Insufficient data/inconclusive

Source: ESCAP based on data from CarbonBrief, "Mapped: How climate change affects extreme weather around the world", 26 February 2021. Available at https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world.

The clearest links between climate change and disaster events are those related to heatwaves, such as the Russian heatwave in 2010,[49] and the more recent heatwaves in Australia.[50] Attributing climate change to disaster events is more difficult for other disasters, particularly for droughts which have multiple drivers.

Floods, droughts, and biological hazards all damage human health, including mental health, and deepen inequalities. These impacts are being compounded by climate change which, combined with increasing anthropogenic pressure on the natural environment, is contributing to the emergence and transmission of infectious diseases.[51] Furthermore, if these impacts are sudden, they can overwhelm health-care systems.

- *Malaria and dengue fever* – The sixth assessment report of the IPCC notes that climatic variations will create new ecological niches for vector-borne and zoonotic diseases.[52] Global warming from 1.5°C to 2°C would not only increase the length of the transmission season, but also the geographic range of the vectors.[53]
- *Diarrhoeal disease* – Seasonal flooding, induced by climate change, can cause drainage systems to overflow and contaminate clean water sources, leading to outbreaks of disease among children under five years of age and, to some extent, adults.
- *Biological diseases* – People being shifted to temporary shelters due to flood evacuation, for example, run the risk of contracting measles, in addition to COVID-19.
- *Malnutrition* – Rural communities face food insecurity as a result of droughts, while frequent bouts of disease disrupt the growth of children under five years of age putting them at risk for moderate and severe malnutrition.

49 Quirin Schiermeier, "Droughts, heatwaves and floods: How to tell when climate change is to blame", Nature, 30 July 2018. Available at https://www.nature.com/articles/d41586-018-05849-9

50 Chelsea Harvey, "Scientists can now blame individual natural disasters on climate change", Scientific American, 2 January 2018. Available at https://www.scientificamerican.com/article/scientists-can-now-blame-individual-natural-disasters-on-climate-change/

51 Felicia Keesing and others, "Impacts of biodiversity on the emergence and transmission of infectious diseases", Nature, vol. 468 (2012), pp. 647–652. Available at https://www.nature.com/articles/nature09575

52 Intergovernmental Panel on Climate Change, "Sixth Assessment Report". Available at https://www.ipcc.ch/assessment-report/ar6/ (accessed on 26 February 2021).

53 Alistair Woodward and others, "Climate change and health: on the latest IPCC report", Lancet, vol. 383, No. 9924 (April 2014), pp. 1185–1189.

- *Chronic diseases* – Patients with chronic diseases like diabetes, hypertension, and kidney ailments suffer when disasters disrupt their treatment and access to medical supplies.
- *Injury and trauma* – The impact of cyclones over a season can be measured by the power dissipation index, which by 2100 is projected to increase by 40 per cent for RCP 2.6 and by 100 per cent for RCP 8.5.[54] More violent cyclones increase the risk of injuries, trauma and permanent life changes.[55]
- *Heat-related illness* – More people will be exposed to extreme heat, which, in turn, will increase illnesses such as heat exhaustion, heat cramps, heat strokes, and cardiovascular and respiratory disorders.

Figure 1-20 provides a snapshot of how climate change could alter the geography and intensity of natural and biological hazards and increase their combined impacts in various countries.

As climate change continues, governments are increasingly faced with new and more hazardous circumstances, such as those presented by the convergence of climate-related hazards with the COVID-19 pandemic. The next chapter will discuss how governments in Asia and the Pacific are addressing and managing the challenges brought about by the convergence of the pandemic with other disasters such as cyclones and floods. It will highlight the need to identify vulnerable groups, such as women or people with disabilities, so that governments can build social protection programmes that move away from being shock-responsive to being shock-prepared.

54 Peter Sousounis, "Climate change: RCPs and the emissions gap", AIR. Available at https://www.air-worldwide.com/blog/posts/2019/11/climate-change-rcps-and-the-emissions-gap (accessed on 26 February 2021).

55 James M. Shultz and others, "Risks, health consequences, and response challenges for small-island-based populations: Observations from the 2017 Atlantic hurricane season", Disaster Medicine and Public Health Preparedness, vol. 13, No. 1 (April 2018), pp. 5-17.

FIGURE 1-20 Impacts of climate change on natural and other biological hazards

Region	Country	CLIMATE CHANGE RISK	RELATED BIOLOGICAL AND HEALTH RISKS
East and East North Asia	China	Increase drought	Undernutrition due to food insecurity
		Increase precipitation and flooding	Increase vector-borne disease risks
		Increase sea level risk and flooding	Increase more than 50 million of population exposed to sea level rise
	Japan	Increase heatwaves	Increase excess death due to heatwaves by 0.2%
		Increase precipitation and flooding	Increase in infectious gastroenteritis cases by 8 %
	Mongolia	Increase precipitation and flooding	Increase in tick-borne encephalitis
	Republic of Korea	Increase heatwaves	Increase excess death due to heatwave by 0.3%
		Increase sea level risk and flooding	Increase DALY for cardio and cerebrovascular disease by 131%
South-East Asia	Indonesia	Increase sea level risk and flooding	Increase more than 50 million of population exposed to sea level rise
	Philippines	Increase heatwaves	Increase excess death due to heatwaves by 1%
		Increase sea level risk and flooding	Increase more than 50 million of population exposed to sea level rise
	Thailand	Increase heatwaves	Increase excess death due to heatwaves by 1.9%
	Viet Nam	Increase heatwaves	Increase excess death due to heat by 1.4%
		Increase precipitation and flooding	Increase more than 50 million of population exposed to sea level rise
South and South-West Asia	Afghanistan	Increase precipitation and drought	Increased cholera, typhoid, diarrhea and ascariasis
			Increase malaria and leishmaniasis
	Bangladesh	Increase precipitation and drought	Increase in diarrheal incidence rates by 5.6%
		Increase sea level risk and flooding	Increase in dengue
		Increase cyclones	Increase in leishmaniasis
	Bhutan	Increase glacial lake outburst floods, landslides and flash floods	Increase in malaria, dengue, Japanese encephalitis and chikungunya
	India	Increase drought	Undernutrition due to food insecurity
		Increase heatwaves	Increase in heatwaves related health risks (heatstroke etc.)
		Increase sea level risk and flooding	Increase of more than 50 million population exposed to sea level rise
			Increase of exposure to arsenic contamination of ground water in the eastern region
			Increase in malaria, dengue, Japanese encephalitis, leishmaniasis and diarrhea
			Increase in diarrhea expected by 13.1% by 2041
	Maldives	Decrease precipitation	Increase in dengue, chikungunya, scrub typhus ; Emerge of Zika virus
		Increase drought	Undernutrition due to food insecurity
	Nepal	Increase drought	Increased incidence of diarrheal
		Increase precipitation	Increase in malaria, chikungunya, and dengue, lymphatic filariasis and Japanese encephalitis; Emerge of Zika Virus
	Pakistan	Increase heatwaves	Increase in geographical range and incidence of vector-borne diseases
		Increase glacial lake outburst flood, severity of monsoons and cyclones and saline intrusion	Increase in water-borne diseases and malnutrition
	Sri Lanka	Increase drought and flooding	Increase in malaria, dengue, and heat related diseases
North and Central Asia	Russian Federation	Increase drought	Undernutrition due to food insecurity
		Increase precipitation and flooding	Increase in tick-borne encephalitis
Pacific	Australia	Increase precipitation and flooding	Increase dengue outbreaks by 16.6% and decrease by 42.3%
	Marshall Islands	Increase sea level risk and flooding	Freshwater resources affected by 0.4 meter rise in sea level
	Fiji	Increase precipitation and flooding	Increase in diarrhea by 3%

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CHAPTER 2

Managing disasters during a global pandemic

Across Asia and the Pacific, governments have raced to control the COVID-19 pandemic and protect their people. Many countries, in the region, have also had to simultaneously contend other natural disasters. The biological threat has compounded the impacts of floods, droughts, cyclones and locust swarms, making it more difficult to respond effectively.

National responses to the COVID-19 pandemic have differed according to the spread of the infection and the timing, as the virus has typically been transmitted in waves or centred in specific locations. During the early stages of the pandemic, countries with previous experience of the SARS virus appeared to be better prepared, basing their responses on surveillance, testing, contact tracing, and strict quarantine.[56]

In many cases, countries took advantage of scientific and technological advances.[57] Frontier technologies, such as artificial intelligence (AI) and the manipulation of big data, enabled a better understanding of the mechanisms of virus transmission. Advanced modelling techniques have been used for early detection, rapid diagnostics, prevention of the spread of the virus spread, as well as for managing critical supplies and delivering equipment.[58] Such technologies have been used effectively for example, in Australia, China, New Zealand, the Republic of Korea, Singapore, Thailand and Viet Nam.[59] Countries that are leaders in the use of such technologies have been able to successfully deploy them at scale, and even a few lesser technologically advanced countries have shown some degree of success. However, least developed countries have often lacked the capacity to harness the potential of such technologies, making their efforts to combat the pandemic even more challenging.[60]

Effective protection strategies, with or without the latest technologies, involve social distancing and better hygiene combined with efficient test-isolate-treat regimes. These techniques work well in the more developed countries. But, they need to be adapted to operate efficiently in the densely populated urban slums of developing countries. In these cases, official action can be complemented with local surveillance by communities which offer governments 'ears to the ground', for example, by checking for unintended consequences of official action and taking corrective steps. The value of community action taken in the early stages of the pandemic and empowered by new technologies, has been demonstrated in Dharavi, Asia's largest slum, located in Mumbai. The Dharavi model, which has been lauded by the World Health Organization, involves "chasing the virus" through micro-mapping, robust surveillance, public-private partnerships, community engagement, and proactive leadership (Figure 2-1).[61] Dharavi appeared to have kept its COVID-19 cases under check, during April/early May 2021, amid the second wave of the pandemic that swept through Mumbai and other parts of state of Maharashtra. Amid the rise of fresh infections, Dharavi reported fewer cases than expected.[62]

56 United Nations, Economic and Social Commission of Asia and the Pacific, "Weaving a stronger fabric: Managing cascading risks for climate resilience", Policy Brief, 26 January 2021c. Available at https://www.unescap.org/kp/2021/weaving-stronger-fabric-managing-cascading-risks-climate-resilience (accessed on 12 March 2021).

57 Jobie Budd and others, "Digital technologies in the public-health response to COVID-19", *Nature Medicine*, vol. 26 (2020), pp. 1183–1192. Available at https://www.nature.com/articles/s41591-020-1011-4

58 Sera Whitelaw and others, "Applications of digital technology in COVID-19 pandemic planning and response", *The Lancet Digital Health*, vol. 2, No. 8 (29 June 2020), pp. 435–440. Available at doi: 10.1016/S2589-7500(20)30142-4

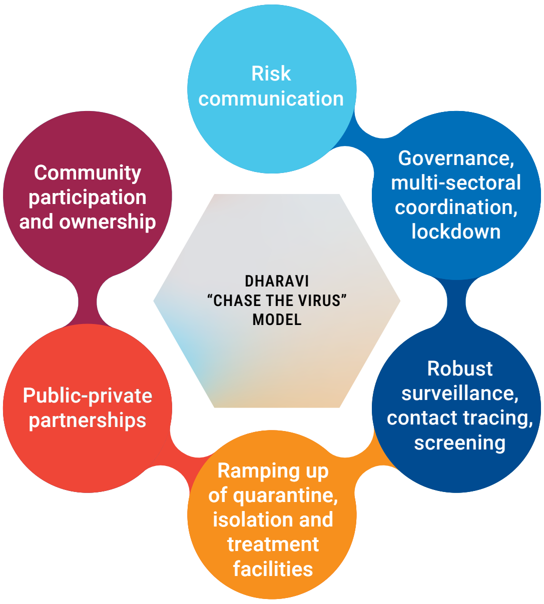
59 United Nations Economic and Social Commission for Asia and the Pacific, "Pathways for managing systemic risks in Asia and the Pacific: Regional and subregional approaches", Note by the secretariat, Seventy-seventh session, Committee on Disaster Risk Reduction, 26–29 April 2021b. ESCAP/77/19. Available at https://www.unescap.org/sites/default/d8files/event-documents/ESCAP_77_19_E.pdf

60 United Nations Economic and Social Commission for Asia and the Pacific, "Collaborative actions to harness technologies during Pandemics", Note by the secretariat, Third Session, Committee on Information and Communications Technology, Science, Technology and Innovation, 19–20 August 2020. ESCAP/CICTSTI/2020/1. Available at https://www.unescap.org/events/committee-information-and-communications-technology-science-technology-and-innovation-third

61 Mahaveer Golechha, "COVID-19 containment in Asia's largest urban slum Dharavi-Mumbai, India: Lessons for policymakers globally", *Journal of Urban Health*, vol. 97, No. 6 (December 2020), pp. 796–801.

62 News18, "How Dharavi is bucking the trend in Mumbai amid second wave of Coronavirus", video, 12 April 2020. Available at https://www.news18.com/videos/ivideos/how-dharavi-is-bucking-the-trend-in-mumbai-amid-second-wave-of-coronavirus-3633638.html

FIGURE 2-1 **The Dharavi "chase the virus" model**



Source: ESCAP based on Mahaveer Golechha, "COVID-19 containment in Asia's largest urban slum Dharavi-Mumbai, India: Lessons for policymakers globally", *Journal of Urban Health*, vol. 97, No. 6 (December 2020), pp. 796–801.

Effective risk communication

When faced with a series of cascading disasters, success depends on effective communication between health experts, governments and at-risk communities. In these circumstances, the authorities are expected to transmit real-time and actionable information. At the global level, this was achieved through the World Health Organization's Situation Dashboard. The ArcGIS platform within this dashboard has provided the latest location-specific updates on the outbreak, including numbers of infected people and deaths. The dashboard has also been locally adopted and modified at the country level, with relevant surveillance management systems in place. These systems have also incorporated the use of social media, which over recent years has been changing citizens' behaviours and expectations, and the ways in which power is sought, used, or contested. For example, in Indonesia, especially in the rural and sub-urban areas, religious leaders have used their social media accounts/channels to raise awareness about the risks of COVID-19 among their followers.[63]

Government action has also been supported by academic institutions and local companies, which have helped track the rapidly changing situation using data analytics, integrated geospatial data, machine learning and AI tools. Some small and medium enterprises have also helped with effective risk communication.[64] For example, in Thailand, a privately developed Covid-19 tracker is one of the most popular interactive web portals. However, governments need play an important role in consolidating the COVID-19 data to avoid the use of conflicting or overlapping information within the public domain.

The latest technologies have been boosting the efficiency and speed of existing disaster risk management tools. In particular, they can support risk hotpot mapping, a technique which has proved effective in previous complex and dynamic disasters. Such mapping has now been adapted for epidemiological risks, enabling countries to visualize the incidence of COVID-19. Using this tool, countries have been able to predict the spread of the virus, revealing the interconnections between cases and clusters of infections, and identify 'super-spreaders' or super-spreading events. Government agencies can play an enabling role in managing such integrated risk mapping exercises.

Based on this information, countries can make critical and risk-informed interventions, such as imposing lockdowns in risk hotspots, and insulating other provinces and cities from the spread of the virus. Within hotspots, governments can manage local outbreaks by establishing containment and buffer zones. For example, during the outbreak, Indonesia also experienced many floods and landslides and had to manage cascading risks. In response, the Government implemented targeted interventions in specific zones, based on dynamic risk assessments (Figure 2-2).[65] The resulting cluster-containment response strategies are yielding positive results and also helping other countries restrict the transmission of COVID-19, especially within vulnerable communities.[66] The Indonesian National Board for Disaster Management (BNPB) has been a central task force for coordinating and managing COVID-19, integrating disaster and COVID-19 information for relevant use, and also using information from OneData Indonesia.

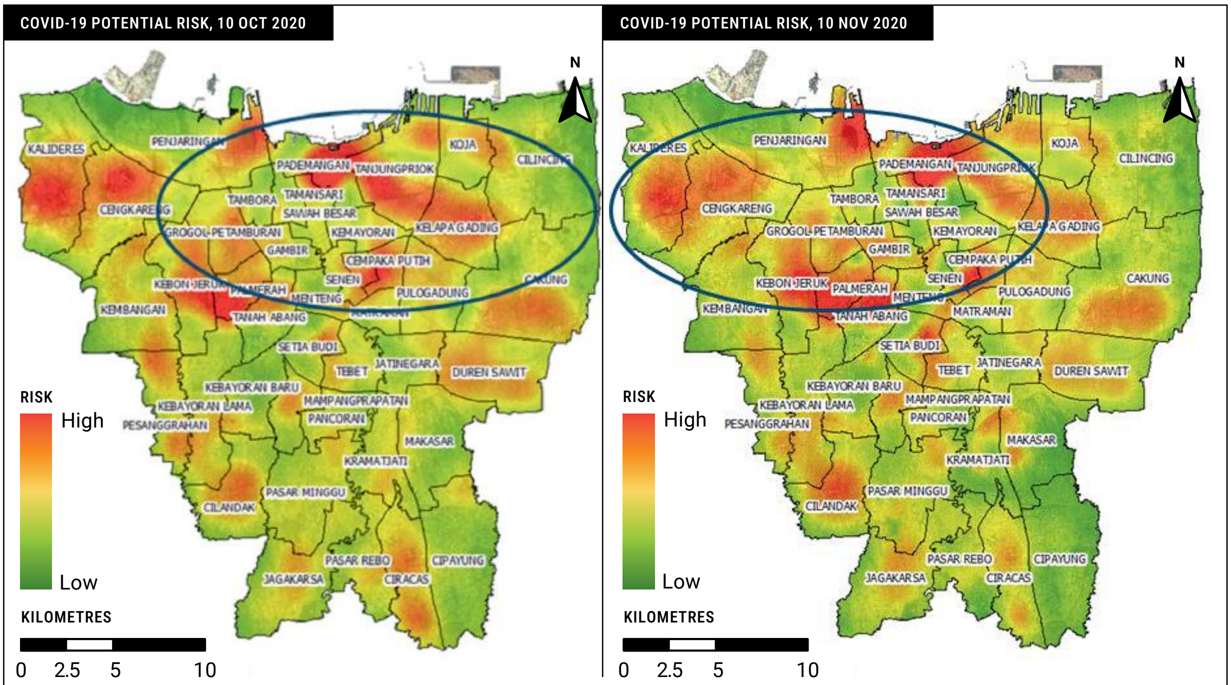
63 Hasanudin Abidin, Geospatial Information Agency, Indonesia, personal communication, 3 May 2021.

64 Sanjay Srivastava, "Flattening the curve of COVID-19", blog, 13 April 2020a. Available at https://www.unescap.org/blog/flattening-curve-covid-19

65 Fajar Yulianto, "How Space Technology Applications Contributed to Combating COVID-19: Development of LAPAN Hub COVID-19", presentation at the Regional Committee of United Nations Global Geospatial Information Management for Asia and the Pacific (UN-GGIM-AP) Meeting, 2020.

66 Sanjay Srivastava, "Outpacing COVID-19: Key innovations prompt early warning for early action", blog, 21 April 2020b. Available at https://www.unescap.org/blog/outpacing-covid-19-key-innovations-prompt-early-warning-early-actions

FIGURE 2-2 Mapping the potential risk of COVID-19 spread in Jakarta, Indonesia



Source: Fajar Yulianto, LAPAN, UNGGIM Asia-Pacific Meeting, ESCAP 2020.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Nevertheless, in practice, many interventions have had their shortcomings.[67] Often, they have not been sufficiently 'granular' or decentralized to identify and target risk-informed interventions to specific areas, or have not been updated quickly enough to keep pace with the spread of the virus. Furthermore, without the necessary measures to enforce social distancing or constrain large gatherings, there have been exponential increases in the number of COVID-19 cases. For this pandemic, another constraint has been the limited scientific understanding of the meteorological and air quality factors that influence its transmission and spread.[68]

Multi-hazard, early warning systems

For addressing pandemics, governments can build on previous experience of multi-hazard, impact-based early warning systems, which aim to provide reliable, targeted warnings and guidance for informed long-term planning. These systems also ensure that governments and other stakeholders are willing and able to prepare for reasonable worst-case scenarios.[69] New Zealand, for example, is well prepared for natural hazards, and has numerous Alert Level systems for volcanoes, tsunamis, and weather hazards. It was thus able to devise a similar set of protocols for its COVID-19 Alert Level System,[70] which has four colour-coded levels: prepare, reduce, restrict, and lockdown. For each level, permissible and non-permissible activities are well-defined, with specific outcomes, summaries, and measures for public health, personal movement, travel and transport, gatherings, public venues, health and disability care services, workplaces, and education. New Zealand is one of the few countries on track for rapid and complete control of the COVID-19 outbreak (Figure 2-3).[71]

67 Pramod K. Mishra, "COVID-19, Black Swan events and the future of disaster risk management in India", *Progress in Disaster Science* (2020). Available at https://pesquisa.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/pt/covidwho-939196

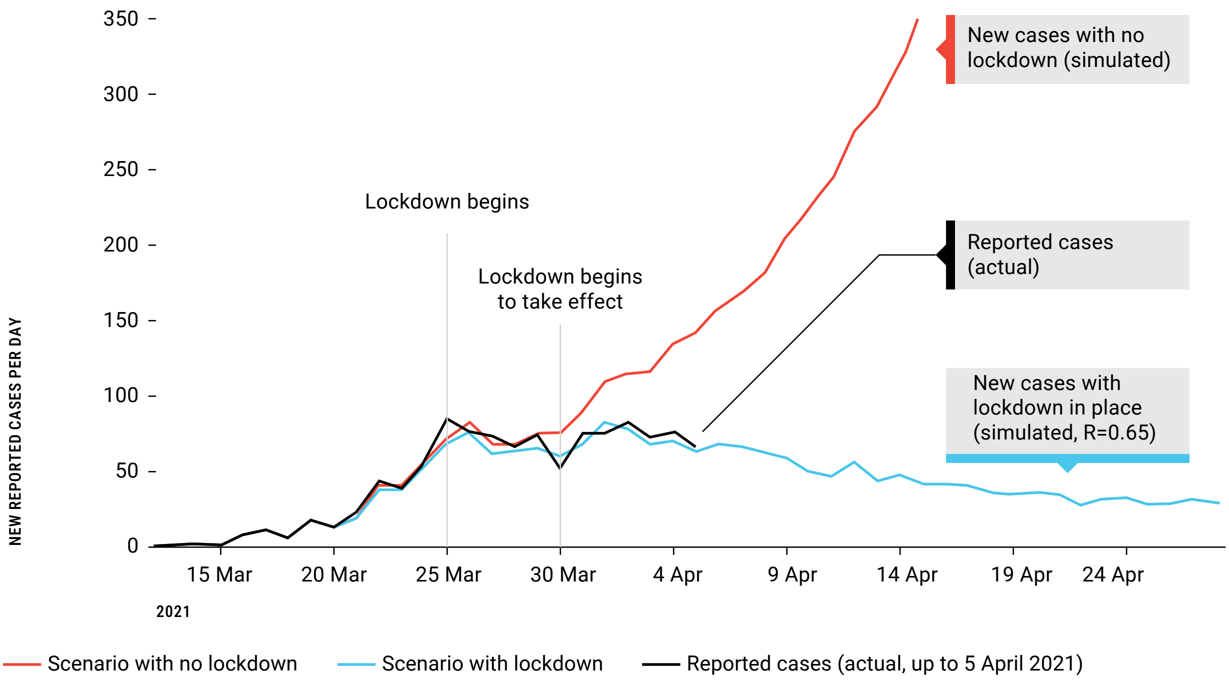
68 World Meteorological Organization, "First Report of the WMO COVID-19 Task Team: Review on meteorological and air quality factors affecting the COVID-19 pandemic" (Geneva, 2021a). Available at https://library.wmo.int/doc_num.php?explnum_id=10555

69 David P. Rogers and others, "Learning from multi-hazard early warning systems to respond to pandemics" (Washington, D.C., World Bank, 2021). Available at http://documents1.worldbank.org/curated/en/429511592591445701/pdf/Learning-from-Multi-Hazard-Early-Warning-Systems-to-Respond-to-Pandemics.pdf

70 Unite Against Covid-19, "COVID-19 Alert System". Available at https://covid19.govt.nz/alert-system/about-the-alert-system/

71 Michael J. Plank and others, "A stochastic model for COVID-19 spread and the effects of Alert Level 4 in Aotearoa New Zealand", Journal of the Royal Society of New Zealand (11 April 2020). Available at doi: https://doi.org/10.1101/2020.04.08.20058743

FIGURE 2-3 New Zealand – modelling the impact of lockdown



Source : A stochastic model for COVID-19 spread and the effects of Alert Level 4 in Aotearoa New Zealand, Michael J.Plank *et al*, 08/04/2020.

Responses to disasters during the COVID-19 pandemic

While responding to the pandemic, Asia-Pacific countries have also had to contend with their regular sequences of other natural hazards, including cyclones, floods, heatwaves, bushfires, sand and dust storms, locust swarms, typhoons, storm surges, droughts, earthquakes and volcanic eruptions. These, more familiar, events have different risk pathways from biological hazards, but the multiple emergencies can intersect and converge in complex and destructive ways. Nevertheless, in this shifting new riskscape, advances in risk assessment, early warning systems, disaster preparedness and response have helped many Asia-Pacific countries to keep infections at manageable levels.[72]

Cyclones and floods

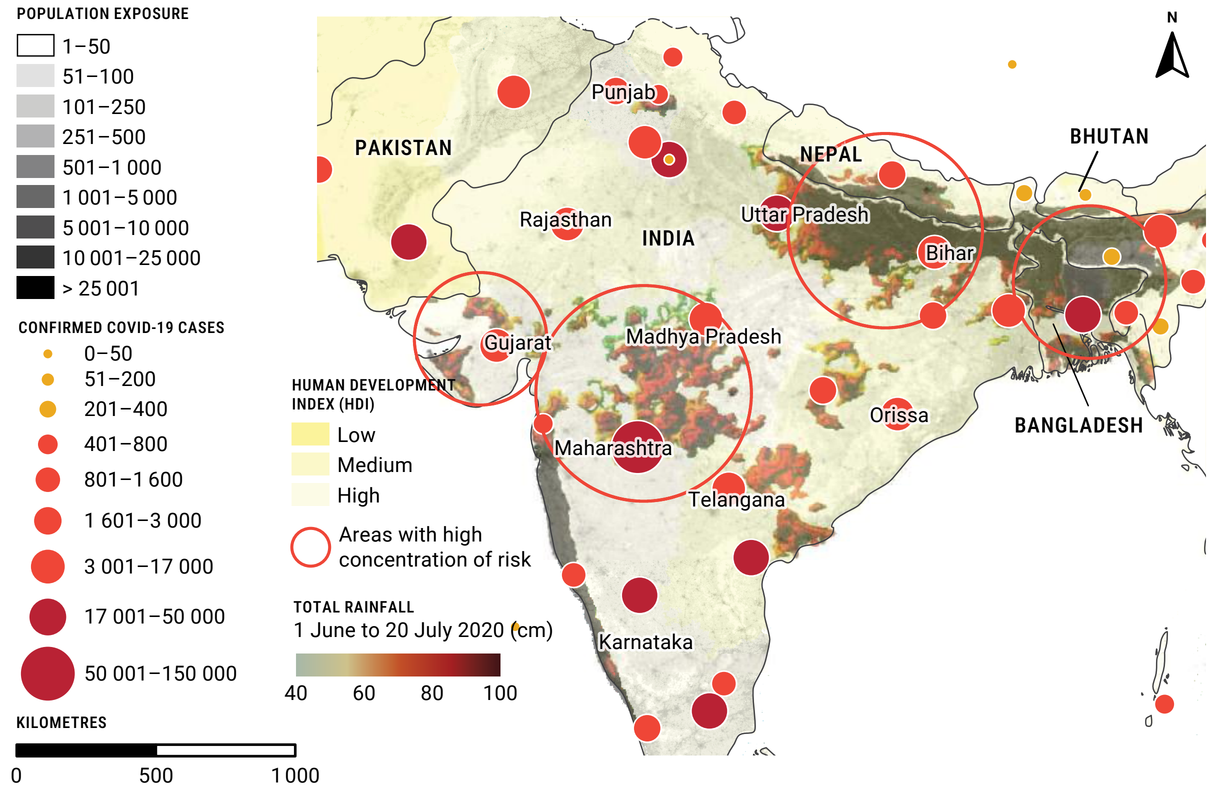
In May 2020, during the COVID-19 pandemic, cyclone Amphan hit the densely populated, low-lying coastal areas of Odisha, West Bengal, India, and the adjoining areas of Bangladesh. Cyclone Amphan affected 10 million people and killed more than a 100 people. But the casualties were far fewer than would have been expected without the early warning systems, which accurately forecasted the path of the cyclone and helped in the evacuation of more than 3 million people.[73] Local authorities, however, had to strike a balance between the impacts of these two crises. Where the risk of COVID-19 transmission was high, but the threat from the cyclone was lower, authorities only allowed shelters to be half full, in order to facilitate social distancing. In areas with the highest exposure to the cyclone, shelters operated at full capacity, with all possible preventative measures in place.

These large-scale evacuations relied on impact-based, risk-informed, early warning systems and thus saved thousands of lives. Having people in shelters, with limited space and services, nevertheless, increased the risk of infection. In India, it was reported that 59 members of the National Disaster Response Force, and 170 personnel who fought against cyclone Amphan, tested positive for COVID-19.

72 *The Disaster Riskscape across Asia-Pacific: Pathways for Inclusion and Empowerment* (United Nations publication, 2019c).

73 Asia-Pacific Disaster Resilience Network, "When crises converge: Responding to natural disasters in South Asia", policy brief, February 2020. Available at https://www.unescap.org/sites/default/files/Policy%20brief_when%20crises%20converge_v1%20(4).pdf

FIGURE 2-4 **Population affected simultaneously by floods and COVID-19, in South Asia (June to July 2020)**



Sources: ESCAP, based on ESRI and Johns Hopkins University Coronavirus COVID-19 Cases V2, 16 June 2020; NASA's Integrated Multi-Satellite Retrievals for GPM (IMERG) 1 June–20 July 2020; WorldPop 2020 Population Estimates and Sub-National Human Development Index (SHDI) Version 4.0, 2020.

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

Source: NASA Earth Observatory, "Excessive monsoon rains flood Asia - Integrated multi-satellite retrievals for GPM (IMERG) for 1 June to 20 July 2020". Available at: https://earthobservatory.nasa.gov/images/147006/excessive-monsoon-rains-flood-asia (accessed in August 2020).

Other areas in the Asia-Pacific region faced similar crises when hit by disasters, in 2020. In April, cyclone Harold hit the Solomon Islands, Vanuatu, Fiji, and Tonga and here too timely early warning systems minimized the impact. In May, cyclone Vongfong hit the province of Albay, in the Philippines, where precise early warnings and zero-casualty approach followed by timely evacuations undoubtedly saved lives.[74] There was a similar response, in June 2020, when cyclone Nisarga struck densely populated areas on the west coast of India where COVID-19 was already spreading fast.

The heavy monsoon flooding in South Asia, in 2020, was also a prime example of this convergence of disasters. In Assam, India, the highest single-day spike of over 1,200 COVID-19 cases occurred during the heaviest floods and multiplied the impacts on vulnerable populations. For example, farmers whose crops were damaged by the floods were unable to harvest the surviving crops due to the pandemic lockdowns.[75] The subregion of South and South-West Asia was most impacted by the simultaneous occurrence of floods and COVID-19 (Figure 2-4).

Drawing on the experience of 2020, five key lessons can be used to incorporate the COVID-19 pandemic into the new riskscape:[76] (i) revise the standard operating procedures for evacuation, (ii) re-purpose existing cyclone shelters, resources and tools for early warning, (iii) protect responders, (iv) reduce

74 Kareff Rafisura and Cedric Daep, "The world is in lockdown, but tropical cyclones are not", blog, 28 May 2020. Available at https://www.unescap.org/blog/world-lockdown-tropical-cyclones

75 Sanjay Srivastava and others, "2020: The year when crises converged", blog, 15 January 2021. Available at https://www.unescap.org/blog/2020-year-when-crises-converged

76 Kamal Kishore, "Managing tropical cyclones during COVID-19, Early lessons learned and reflection from India", World Bank Blogs, 27 July 2020. Available at https://blogs.worldbank.org/climatechange/managing-tropical-storms-during-covid-19-early-lessons-learned-and-reflections-india

additional burden on hospitals, and (v) apply classic principles of disaster risk management to protect the most vulnerable first. In addition, meteorological agencies in charge of providing early warning information need to be supported, with all possible measures, to ensure business continuity should they become inoperative due to the impacts of the pandemic.

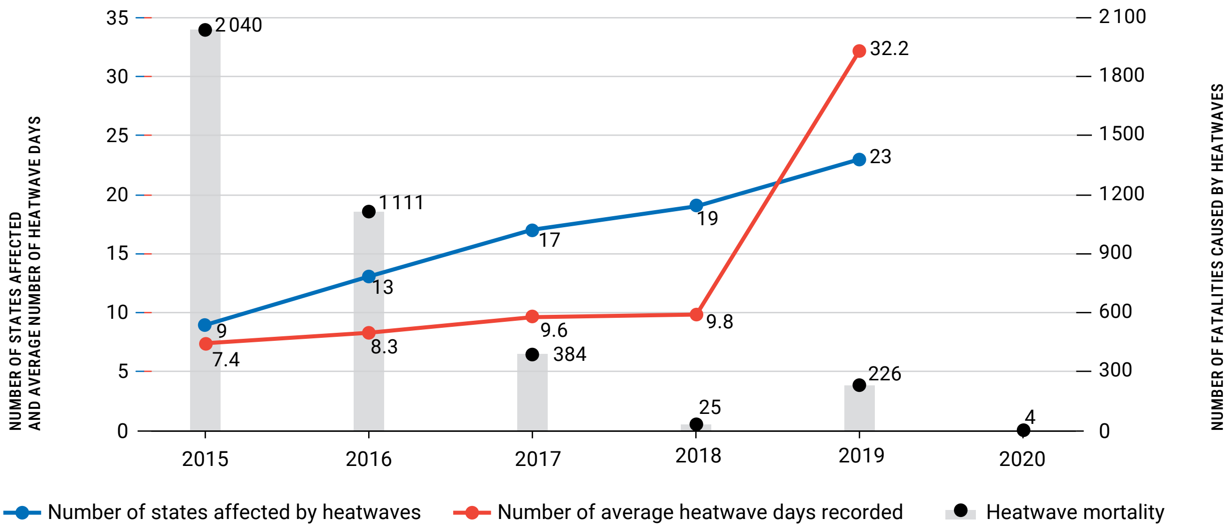
Glacial lake outburst floods

On 7th February 2021, in the Uttarakhand state in India, a block of the Nanda Devi glacier broke off, triggering landslides and a flash flood that killed at least 61 people, and around 143 people went missing. Simultaneously, as of 7th February, a total of 96,493 positive COVID-19 cases had been recorded in the state.[77] The combination of the glacial lake outburst with the pandemic placed additional burdens on all response authorities. A similar incident had occurred in 2013, in the adjoining town of Kedarnath, when a cascade of devastating floods and landslides killed more than 5,700 people, destroying bridges and roads and leaving 300,000 pilgrims and tourists trapped in the valleys for many days. These glacial lake outburst floods pose a serious threat to mountain communities across Bhutan, India, Nepal and Pakistan, and from the Himalayas as well as the Caucasus, Pamir, Hindu Kush-Karakoram and Tien Shan mountain ranges.

Heatwaves

Historically, India has been severely affected by heatwaves which, between 1992 and 2016, have caused 25,716 deaths. State authorities and India's National Disaster Management Agency have made preparations that successfully reduced deaths, as reflected in the 'Guidelines for Preparation of Action Plan — Prevention and Management of Heat-Wave,' (Figure 2-5).[78] Some of this success relies on precise warnings. The Indian Meteorological Department provides not only a seasonal outlook over the country, at a sub-divisional scale, but also guidance on temperatures over a two-week scale.[79] Australia too consistently ranks heatwaves as the greatest cause of death from natural hazards. Therefore, in response, Australia has developed and implemented heatwave prediction and modelling, as well as improved communication and outreach. In total, six Asia-Pacific countries have put heat action plans in place that cover heat vulnerability and impact science, impact forecasting, partnerships, risk communication and policy actions.[80]

FIGURE 2-5 More heatwaves but fewer deaths in Indian states, 2015–2020



77 Uttarakhand State Control Room, Integrated Disease Surveillance Programme, "Health Bulletin", 7 February 2021. Available at https://health.uk.gov.in/files/2021.02.07_Health_Bulletin_1.pdf

78 National Disaster Management Authority, "Beating the heat: How India successfully reduced mortality due to heat waves", Ministry of Home Affairs, Government of India, 2021. Available at https://ndma.gov.in/sites/default/files/IEC/Booklets/HeatWave%20A5%20BOOK%20Final.pdf

79 India Meteorological Department, "Forecast Demonstration Project (FDP) for Improving Heat Wave Warning in India: Implementation Report, 2019", (New Delhi, February 2020). Available at https://internal.imd.gov.in/section/nhac/dynamic/fdpheatreport2019.pdf

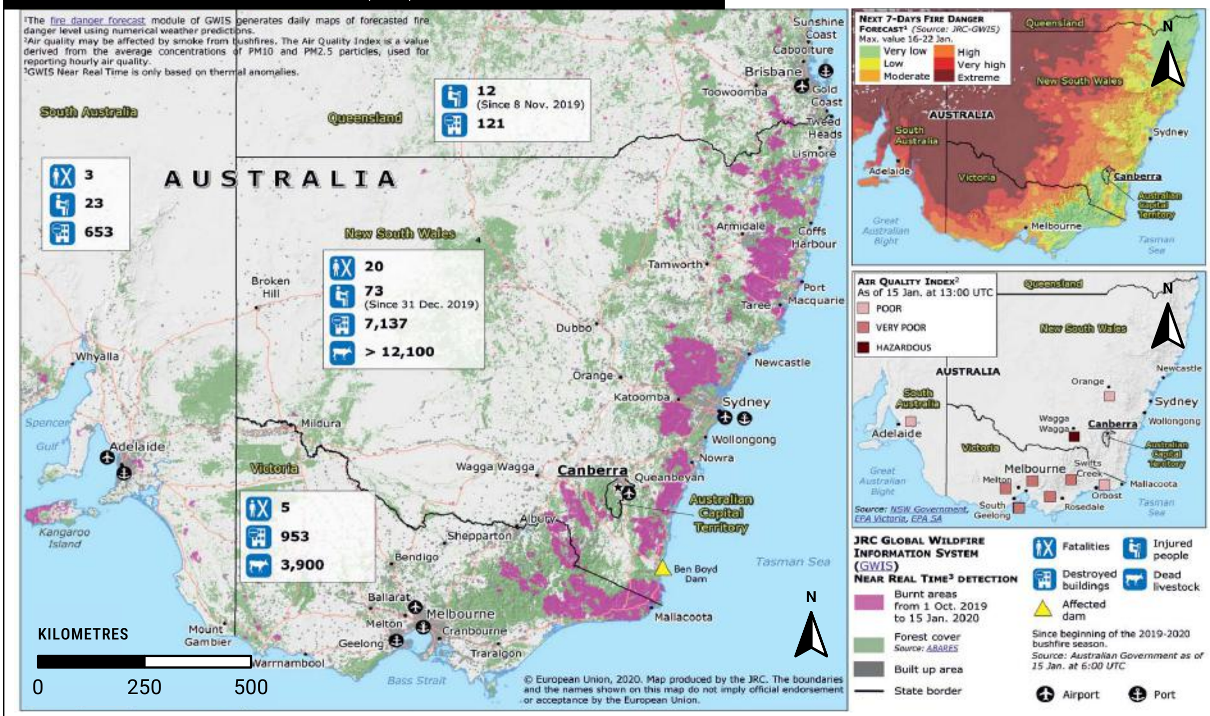
80 Joy Shumake-Guillemot and others, "Progress Report 2017–2020", Global Heat Health Information Network, 2020. Available at https://ghhin.org/wp-content/uploads/GHHIN-Progress-Report-2020.pdf

Bushfires

Between July 2019 and February 2020, bushfires of unprecedented scale and intensity raged across Australia, burning over 17 million hectares of land (Figure 2-6). As a result of prolonged drought, extreme heat and strong winds, the fires intensified rapidly in November, particularly in the Australian Capital Territory and the states of New South Wales, Queensland, South Australia, Victoria and Western Australia.[81] In all, 33 people lost their lives, 3 billion animals were killed or fled, and more than half of Australia's adult population was affected by smoke.[82] The Australian Bushfire Warning System was used by emergency service agencies to indicate the level of threat and the recommended action.[83] Amid the pandemic, recovery procedures and actions met with the additional challenge of safeguarding against the virus along with tackling the fires.

FIGURE 2-6 Australia seven-day bushfires forecast on 15 January 2020

EMERGENCY RESPONSE COORDINATION CENTRE (ERCC), DG ECHO DAILY MAP, 15 JANUARY 2020



Source: Government of New South Wales; Environment Protection Authority Victoria; South Australian Environment Protection Authority; European Union; Reliefweb, Experience of Care and Health Outcomes (ECHO) Australia, 15 January 2020;

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

Source: Emergency Response Coordination Centre (ERCC), "Australia | Bushfires: DG ECHO Daily Map", 15 January 2020. Available at https ://reliefweb.int/sites/reliefweb.int/files/resources/ECDM_20200107_Australia_Bushfires_update.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.

81 Emergency Response Coordination Centre (ERCC), "Australia | Bushfires: DG ECHO Daily Map", 7 January 2020. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/ECDM_20200107_Australia_Bushfires_update.pdf

82 Elisabeth du Parc and Louisa Yasukawa, "The 2019–2020 Australian bushfires: From temporary evacuation to longer-term displacement", Internal Displacement Monitoring Centre (IDMC), (September 2020). Available at: https://reliefweb.int/sites/reliefweb.int/files/resources/Australian%20bushfires_Final.pdf

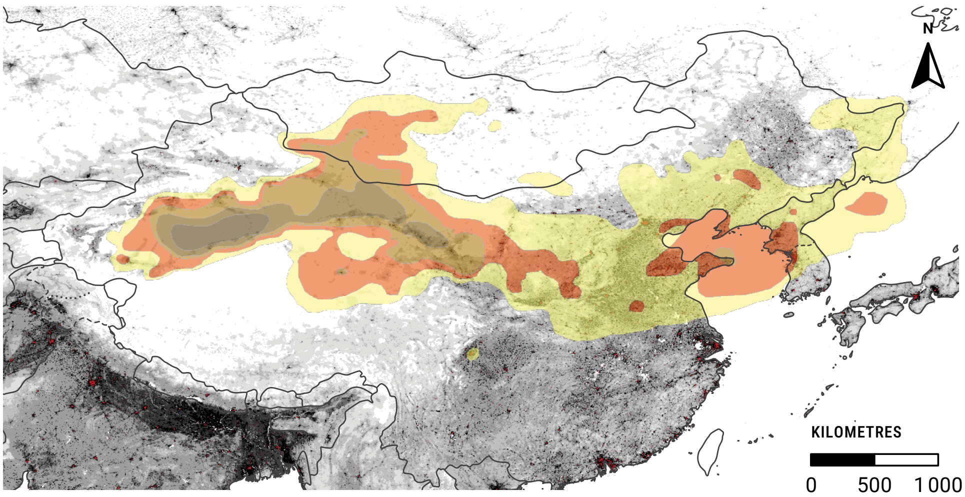
83 Department of Fire and Emergency Services, "Bushfire Warning Systems: How and when to use them", 2020. Available at: https://www.dfes.wa.gov.au/firechat/documents/downloads/bushfire-warning-systems-dfes-how-and-when-to-use-them.pdf

Sand and dust storms

In March 2021, amidst the COVID-19 pandemic, the populated areas of East and North-East Asia were hit by the worst sand and dust storms (SDS) in a decade.[84] These extended from the Gobi Desert and the central and western deserts over Mongolia, to some provinces in the North and North-West China including Beijing, and affecting 40 per cent of the population. The pollution level was more than 150 times the recommended limit (Figure 2-7).[85] SDS affected 66 per cent of the population in the Republic of Korea, and 8 per cent of the population in Mongolia. These countries issued yellow alerts for sandstorms and followed up with necessary response measures.

FIGURE 2-7 **Populations exposed to sand and dust storms in East and North-East Asia, 15–18 March 2021**

SAND AND DUST STORM FORECAST FOR 15 MARCH 2021, 21:00 UTC



Sources: ESCAP, based on Sand and Dust Storm Warning Advisory and Assessment System Asian Regional Center (SDS-WAS Asian-RC) Sand and Dust Storm Forecast for 15 March 2021, 21:00 and Worldpop Population Counts 2020.

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

Source: ESCAP based on World Meteorological Organization, "Severe sand and dust storm hits Asia", 16 March 2021b. Available at: https://public.wmo.int/en/media/news/severe-sand-and-dust-storm-hits-asia.

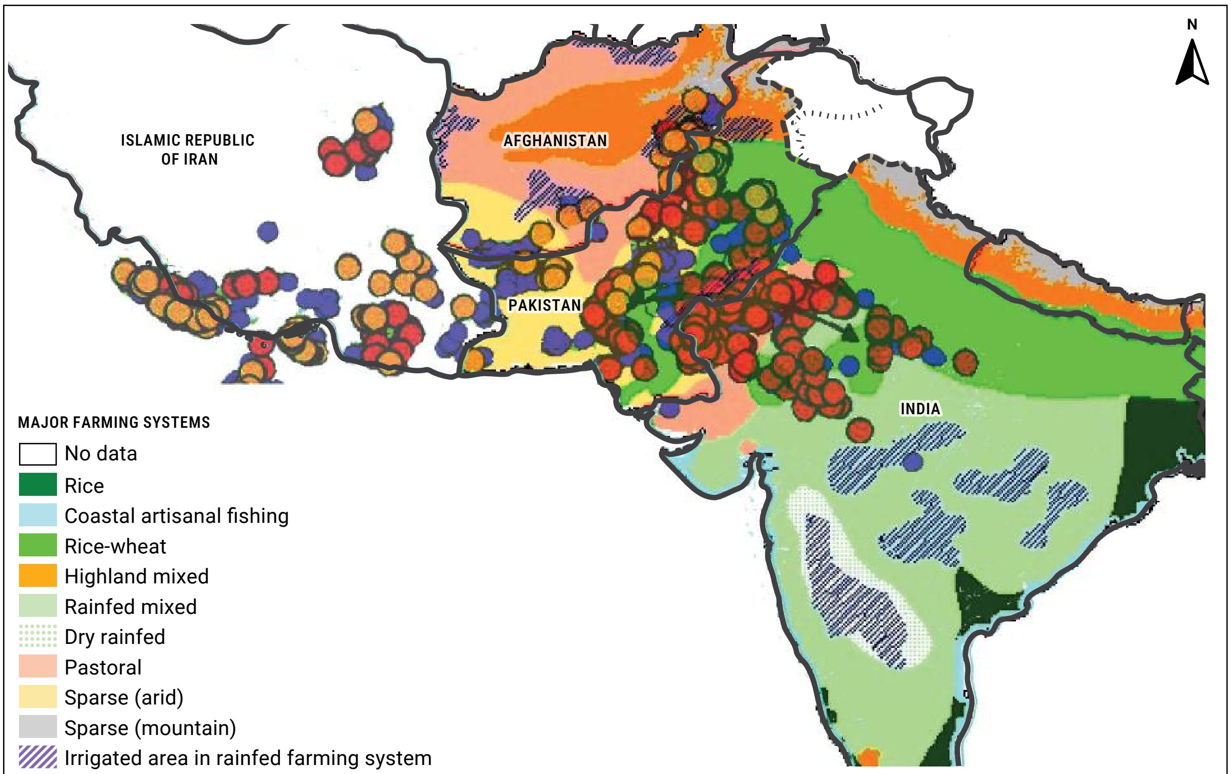
84 Scott Lindstrom, "Sandstorm hits Beijing China", Cooperative Institute for Meteorological Satellite Studies (CIMSS), Satellite Blog, 16 March 2021. Available at: https://cimss.ssec.wisc.edu/satellite-blog/archives/40262

85 World Meteorological Organization, "Severe sand and dust storm hits Asia", 16 March 2021b. Available at: https://public.wmo.int/en/media/news/severe-sand-and-dust-storm-hits-asia

Locust swarms

In both India and Pakistan, locusts threaten food security and livelihoods, particularly in the rice-wheat farm systems. In the spring of 2020, swarms of locusts formed in breeding areas and migrated east to the Indo-Pakistan border and beyond (Figure 2-8). The more extensive swarms in 2020 may have been caused by abnormal weather conditions. Timely early warning systems lessened the impact, though COVID-19 lockdowns constrained some of the usual measures of containment.

FIGURE 2-8 Locust swarms forming in spring 2020



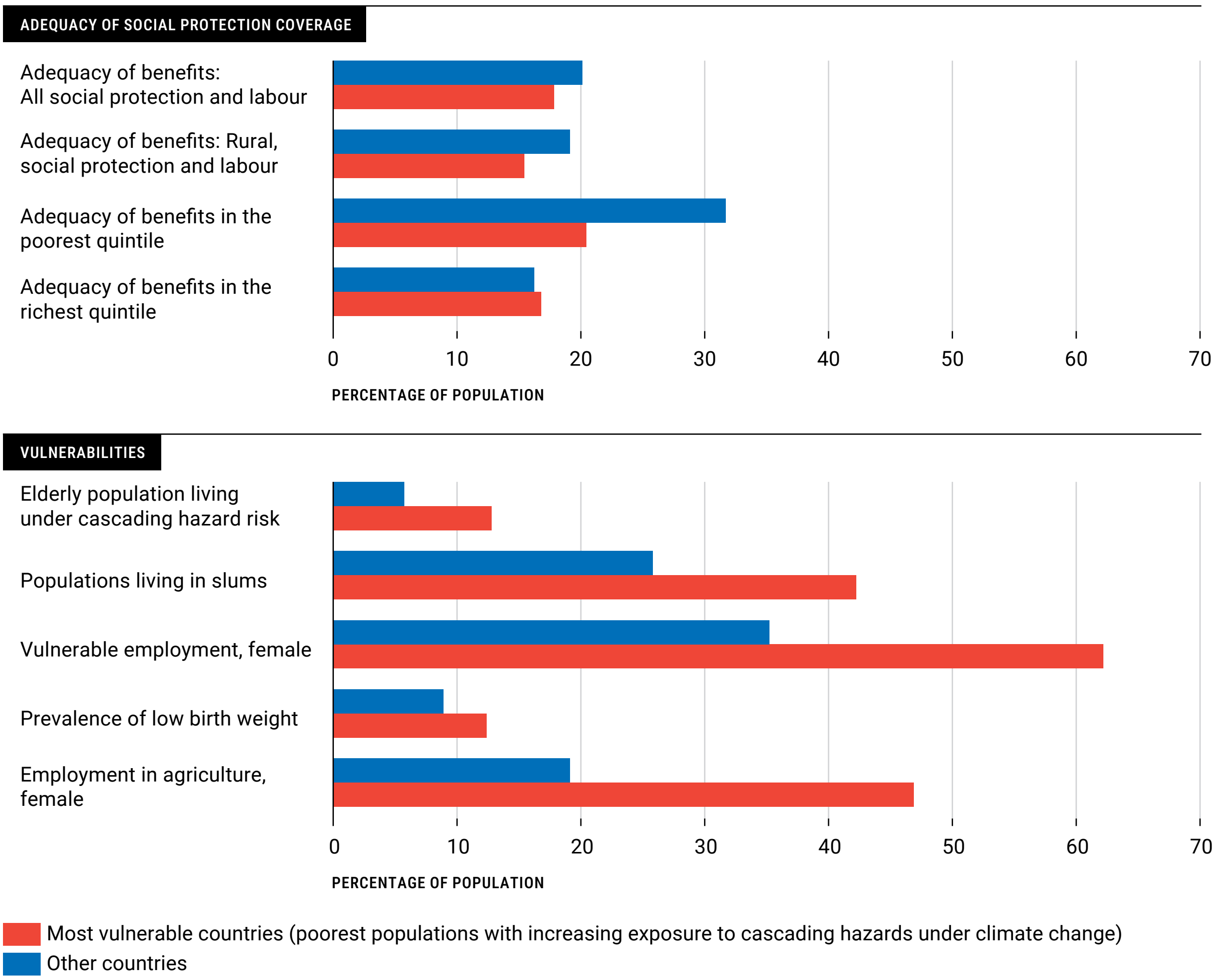
Sources: ESCAP, based on FAO Desert Locust data, 4 June 2020 and FAO Major Farmland Systems.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Social protection: moving from being shock-responsive to being shock-prepared

In countries that offer the least social protection, those most vulnerable to disasters are generally the poorest of people (Figure 2-9). ESCAP analysis has found that in countries with high pre-existing vulnerabilities, an epidemic sets back educational outcomes by a year and a half, and a natural disaster sets back environmental performance by six years.[86] These countries also typically have higher incidences of low birthweight, and have more people living in slums. They also have larger shares of their populations, as well as more women, working in agriculture and in vulnerable employment.

86 *Economic and Social Survey of Asia and the Pacific 2021: Towards post COVID-19 resilient economies* (United Nations publication, 2021a).

FIGURE 2-9 **Asia-Pacific countries vulnerable to climate hazards and social protection**



Source: ESCAP calculations based on GAR Risk Atlas (2015); Global Assessment Report on Disaster Risk Reduction 2015 (United Nations publication, 2015a). Available at https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2015 World Bank, Climate Change Knowledge Portal, 2018. Available at https://climateknowledgeportal.worldbank.org/#. For Disability Adjusted Life Years, see World Health Organization, Global health estimates: Life expectancy and leading cause of death and disability". Available at https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates; and World Bank, "The Atlas of Social Protection: Indicators of Resilience and Equity", 8 April 2021. Available at https://datacatalog.worldbank.org/dataset/atlas-social-protection-indicators-resilience-and-equity (accessed 10 March 2021).
Note: Adequacy of Benefits as define in the World Bank, 'The Atlas of Social Protection Indicators of Resilience and Equity' is the "*Total transfer amount received by all beneficiaries in a population group as a share of the total welfare of beneficiaries in that group*".

Overall, these communities would be less vulnerable to the impact of disasters if they could rely on social protection that includes disaster preparedness. Over the years, countries have been offering a social protection programme that is more shock-responsive. But the scale of the impacts of the pandemic has also shown that it would be better for social protection programmes to be shock-prepared, with a culture of prevention that builds on inclusiveness and resilience. This requires a comprehensive portfolio of investments in the poor throughout their life cycles. Many countries already have the building blocks in their health and education investments. Now they need to offer social protection that is universal and shock-prepared. Some of the measures needed are listed in Table 2-1.[87]

87 United Nations Children's Fund, *Programme Guidance: Strengthening Shock Responsive Social Protection Systems*, December 2019. Available at https://www.unicef.org/media/63846/file (accessed on 21 March 2021).

TABLE 2-1 **Key actions for shock-responsive social protection programme**

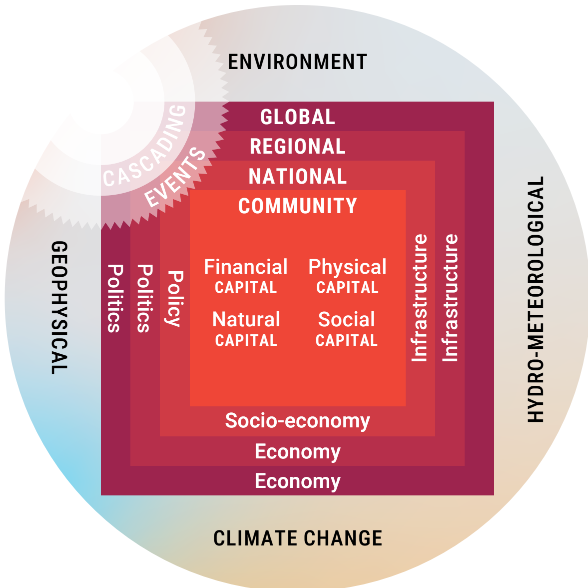
Use emerging technologies to support resilience, and ensure that routine social protection programmes are based on a solid understanding of the risks, shocks and stressors, including cascading hazards.		
Focus on vulnerability to shocks by expanding routine coverage in areas frequently affected by shocks; and incorporating vulnerability criteria into routine targeting.	Safeguard continuity of service delivery when recipients need support the most. This is often referred to as 'resilience building of systems' to future shocks by adopting the principles of contingency planning.	
Prepare to scale up existing programmes or activate new emergency programmes to accommodate new populations and needs.		
Vertical expansion of existing programmes. Benefits or lengths of programmes can be temporarily increased. New components may also be added.	Horizontal expansion of programmes to temporarily include new beneficiaries.	Where possible, build emergency programmes on existing systems. These could be led by the social protection sectors or by humanitarian actors, or those engaged in disaster risk management.
Align, where relevant, existing social protection programmes with scalable measures for disaster preparedness.		
Incorporate multi-hazard parameters to strengthen social protection systems and disaster preparedness, align the objectives, and improve targeting and delivery of social protection.	Extending services to fully cover complex and multi-dimensional risks, such as wrapping a child protection or nutrition-support programme around a standard cash transfer programme.	

Source: Adapted from United Nations Children's Fund, *Programme Guidance: Strengthening Shock Responsive Social Protection Systems*, December 2019. Available at https://www.unicef.org/media/63846/file.

Identifying vulnerable groups

Hazards can converge, across global and local levels, with their intensities and impacts multiplying in ways that have not been seen before.[88] Figure 2-10 demonstrates the links between local communities and larger structural forces that can produce social inequities at multiple levels and lead to cascading disaster events.[89] In these circumstances, the key principle of disaster risk management remains to identify the most vulnerable and protect them first. Usually these are people with low socioeconomic status, in both urban and rural settings, farmers and agricultural communities, children and young people, women, persons with disabilities, older people, and migrants or displaced populations (Figure 2-11). These vulnerabilities also overlap with one another creating populations with extreme susceptibility to converging hazards.

FIGURE 2-10 **A model of multi-hazard cascading risk and social vulnerabilities**



Source: Adapted from Deborah S. K. Thomas, Sojin Jang and Jean Scandlyn, "The CHASMS conceptual model of cascading disasters and social vulnerability: The COVID-19 case example", *International Journal of Disaster Risk Reduction*, vol. 51 (December 2020). Available at https://doi.org/10.1016/j.ijdrr.2020.101828

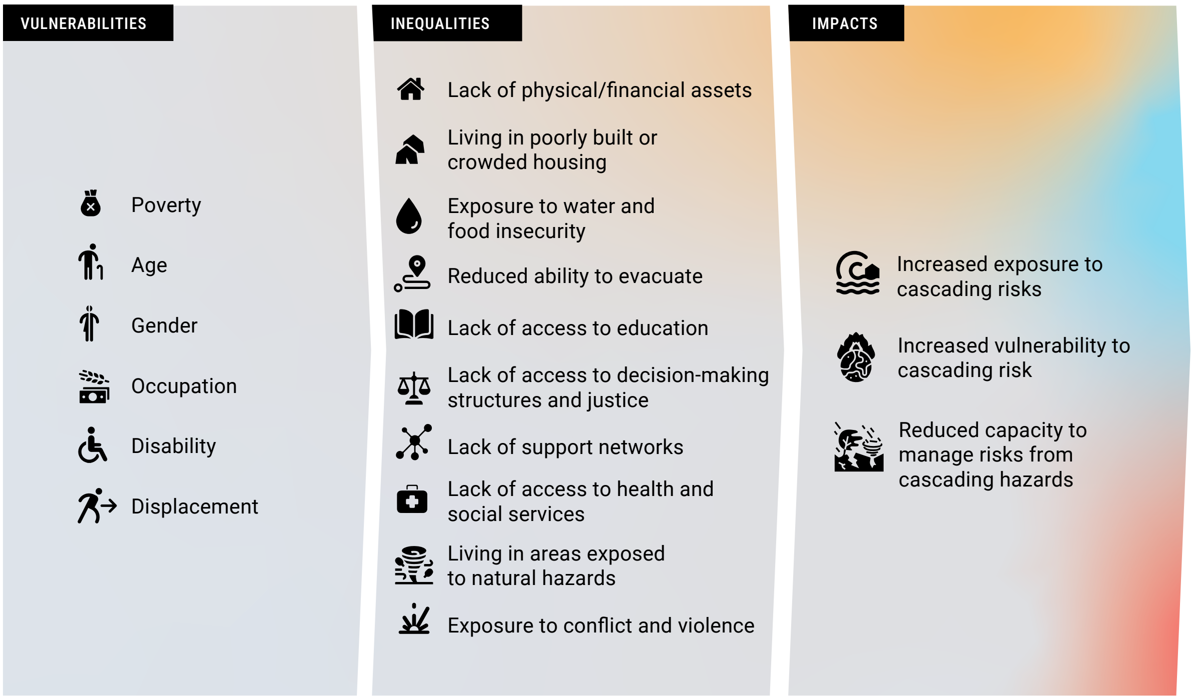
For such vulnerable people, the situation is likely to be worsened by climate change. The extent of vulnerability can be tracked using the Human Development Index (HDI). ESCAP analysis shows that in areas of low and medium HDI, in the worst-case climate change scenario, the number of people at risk will increase by around one-third (Figure 2-12). These people are mainly in the Ganga Brahmaputra and Meghna basin, the Indus basin, parts of South-East Asia and some Pacific countries. Poverty and disasters are always closely connected; the poorest people typically live in the most exposed places, who also lose a higher proportion of their assets during disasters, and are thus driven deeper into poverty.[90]

88 International Federation of Red Cross and Red Crescent Societies, "Come heat or high water: Tacking the humanitarian impacts of the climate crises together", World Disasters Report 2020 (Geneva, 2020). Available at https://media.ifrc.org/ifrc/wp-content/uploads/2020/11/20201116_WorldDisasters_Full.pdf

89 Ibid.

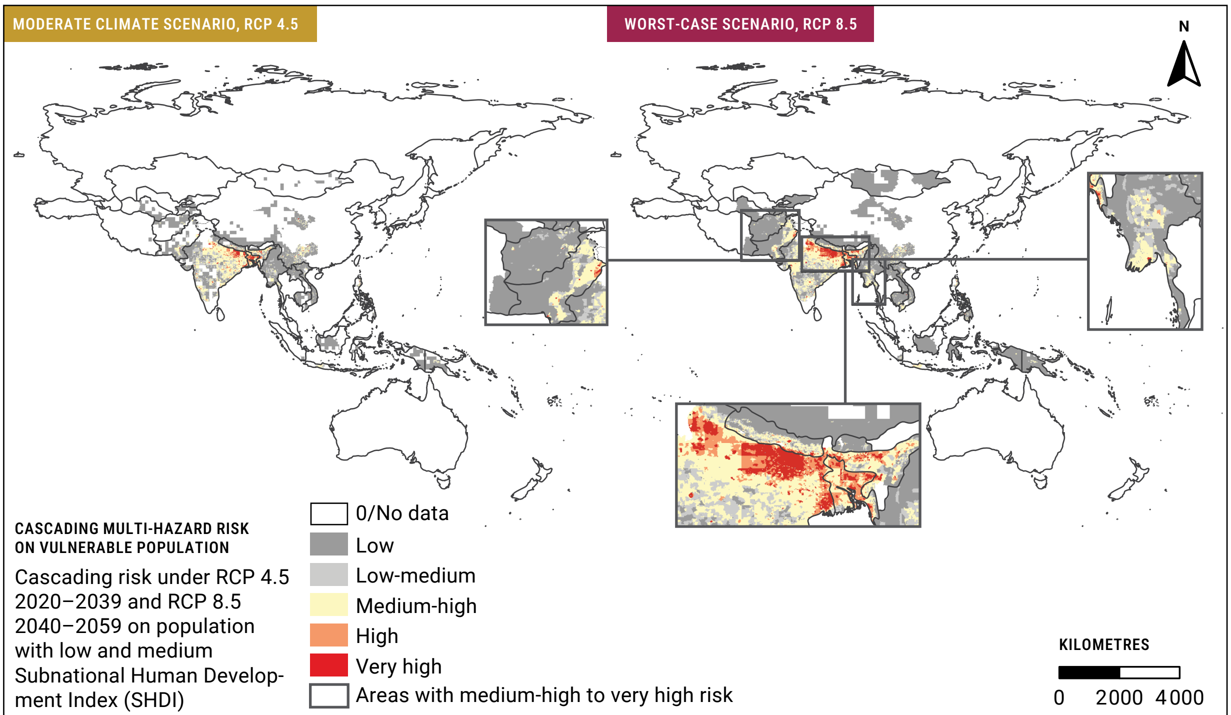
90 Stephane Hallegatte and others, *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters* (Washington, D.C., World Bank, 2017). Available at https://openknowledge.worldbank.org/handle/10986/25335

FIGURE 2-11 **Those most impacted by multi-hazard cascading risk**



Source: Adapted from International Federation of Red Cross and Red Crescent Societies, "Come heat or high water: Tacking the humanitarian impacts of the climate crises together", World Disasters Report 2020 (Geneva, 2020). Available at https://media.ifrc.org/ifrc/wp-content/uploads/2020/11/20201116_WorldDisasters_Full.pdf

FIGURE 2-12 **Populations with lower levels of human development at risk from cascading risks**



Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; Disability-Adjusted Life Years (DALYs) estimates 2000-2019; Sub-National Human Development Index (SHDI) Version 4.0, 2020 and UN WPP-Adjusted Population Density 2020, v4.11.

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Table 2-2 indicates the countries and subregions where poor people are at increasing risk of disasters under moderate (RCP 4.5) and severe (RCP 8.5) climate change scenarios. The poor populations at the greatest risk under RCP 8.5 live in: Bangladesh, India and Nepal in South and South-West Asia; Myanmar, Lao People's Democratic Republic and Philippines in South-East Asia; Tajikistan followed by Kyrgyzstan in North and Central Asia, China in East and North-East Asia; and Papua New Guinea in the Pacific. The top five countries which are at the greatest increase in risk, between 2020 and 2040, are Pakistan, Afghanistan, Bhutan, Myanmar and Cambodia.

TABLE 2-2 **Countries with the highest proportions of their poorest population exposed to multi-hazard cascading risk (current and two climate scenarios)**

		Timescale under climate change scenarios →			
Subregion	Country	Percentage of population with low/medium HDI under RCP 4.5 (2020–2039)	Percentage of population with low/medium HDI under RCP 4.5 (2040–2059)	Percentage of population with low/medium HDI under RCP 8.5 (2020–2039)	Percentage of population with low/medium HDI under RCP 8.5 (2040–2059)
South and South-West Asia	Afghanistan	12	35	19	34
	Bangladesh	98	97	91	98
	Bhutan	22	39	45	43
	India	58	65	60	71
	Nepal	79	88	88	90
	Pakistan	22	79	31	79
South-East Asia	Cambodia	7	4	26	25
	Indonesia	7	15	14	15
	Lao People's Democratic Republic	14	23	26	30
	Myanmar	29	26	47	50
	Philippines	15	24	26	30
	Thailand	0.28	0.09	0.39	0.45
	Timor-Leste			18	8
	Viet Nam	12	23	25	30
North and Central Asia	Kazakhstan		0.1	0.1	0.1
	Kyrgyzstan	0.1	7	8	8
	Tajikistan	12	18	15	16
	Turkmenistan		5		5
	Uzbekistan		0.02	0.05	0.09
East and North-East Asia	China	3	4	3	3
Pacific	Papua New Guinea	15	17	16	16

The urban poor

Climate change is already affecting people in the region's rapidly growing cities. People in cities are particularly vulnerable to heatwaves. Concrete buildings that retain heat, along with the loss of green spaces, contribute to the 'urban heat island' effect in which ambient temperatures are significantly higher than in surrounding rural areas. Slums and informal settlements with improvised housing can also form micro-heat islands.

Many people are experiencing different patterns of rainfall, and those living along the coast are particularly affected by rising sea levels, and more frequent extreme weather events. Those hit hardest usually live in poor-quality housing on marginal land, and with limited capacity to adapt to slow-onset changes, or to prepare for or cope with extreme weather events. As result, climate variability and change threatens to slow progress, or even reverse hard-won gains, in poverty reduction and development.[91]

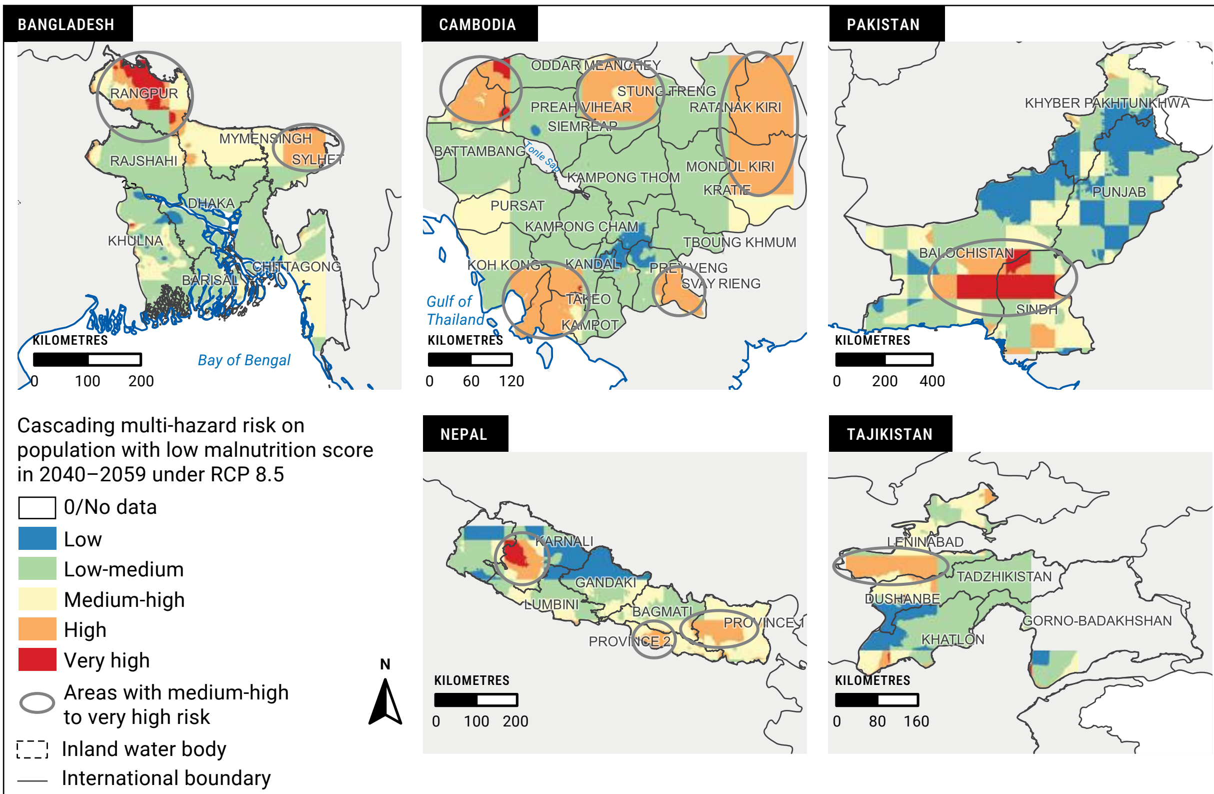
91 United Nations Economic and Social Commission for Asia and the Pacific, "Quick guide for policy makers on pro-poor urban climate resilience in Asia and the Pacific", 11 February 2015b. Available at https://www.unescap.org/resources/quick-guide-policy-makers-pro-poor-urban-climate-resilience-asia-and-pacific (accessed on March 12, 2021).

Children and young people

When disasters strike, children, more than adults, are at higher risk of encountering violence, abuse, neglect and exploitation.[92] Those exposed to meteorological hazards are prone to have lower birthweights and die before the age of five, or suffer from vector-borne diseases or have fewer years of schooling.[93] All these impacts are likely to increase as a result of climate change.

The convergence of climate change, and natural and biological hazards will also increase child malnutrition. This is illustrated in Figure 2-13 for Bangladesh, Nepal, Pakistan, Cambodia, and Tajikistan, countries for which data was available from the Demographic and Health Surveys. For example, in Pakistan, the children at greatest risk live in Balochistan, Sindh, and the Khyber Pakhtunkhwa provinces. In these areas, it will be important to ensure that critical infrastructure, like hospitals, schools, and electricity grids, are resilient to the impacts of cascading hazards.

FIGURE 2-13 **Projected child malnutrition under the worst-case climate change scenario, selected countries**



Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018;Disability-adjusted Life Years (DALYs) estimates 2000-2019; Demographic and Health Surveys (DHS) Programme for Bangladesh (2017), Cambodia (2014),Nepal (2016), Pakistan (2017-2018), and Tajikistan (2017) . Map source: UNmap for Cambodia, 2020.

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92 International Federation of Red Cross and Red Crescent Societies, "Come heat or high water: Tacking the humanitarian impacts of the climate crises together", World Disasters Report 2020 (Geneva, 2020). Available at https://media.ifrc.org/ifrc/wp-content/uploads/2020/11/20201116_WorldDisasters_Full.pdf

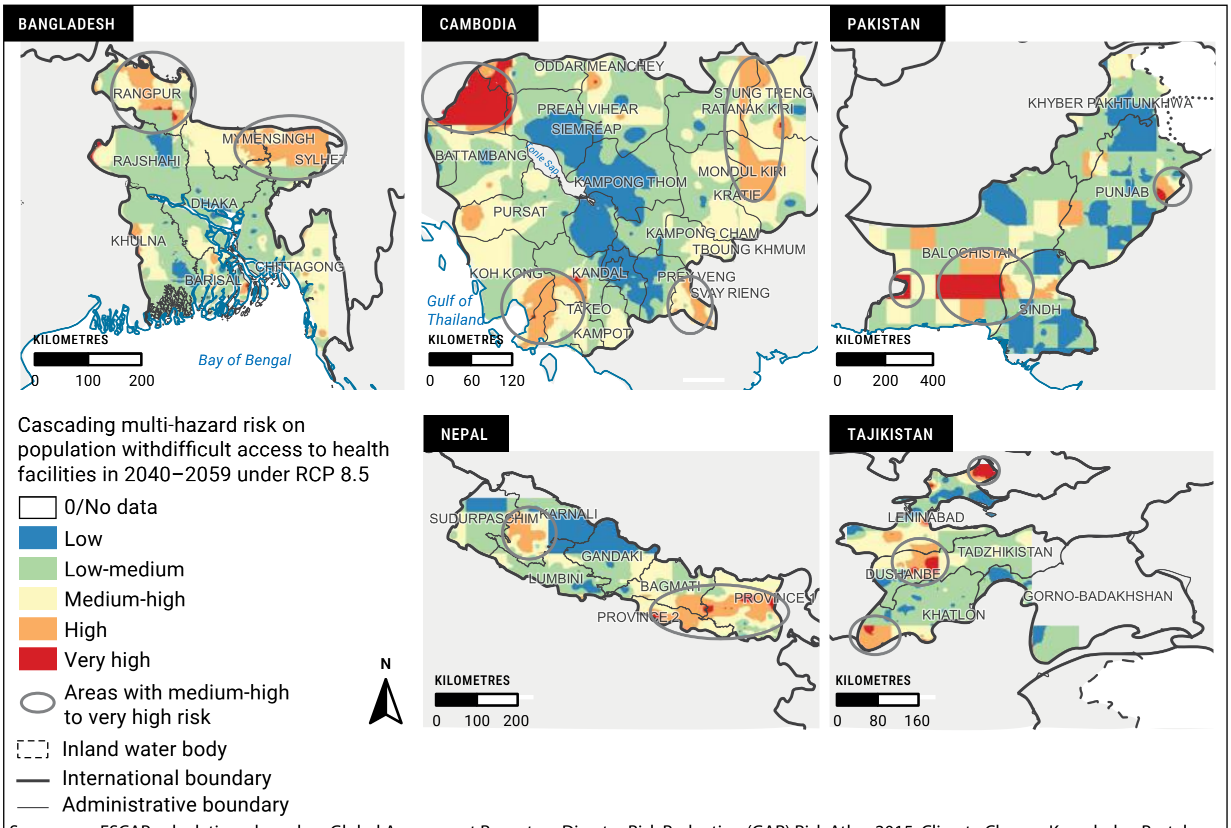
93 *The Disaster Riskscape across Asia-Pacific: Pathways for Inclusion and Empowerment* (United Nations publication, 2019c).

Women

The combination of natural hazards and climate change could also widen gender disparities, particularly with respect to access to nutrition, clean water and education, as well as in menstrual hygiene management and in sexual and reproductive health services.[94] The impacts will be particularly severe for the large numbers of women in low-paid or unpaid work.[95] Areas with high risks of hazards tend to have more women in employment, and therefore are more likely to have reduced employment following disasters.[96] Climate change is also likely to increase the proportion of women in vulnerable employment. Women are particularly vulnerable to the overlaps of natural and other biological hazards which are exacerbated by climate change.[97]

In many countries, women and girls already face multiple barriers in access to healthcare services.[98] Again, the combination of cascading hazards under climate change is likely to exacerbate the problem (Figure 2-14). These are often the same places with increases in child malnutrition, which also affects women as primary caregivers. For example, in Cambodia, the problems are likely to be greatest in the provinces of Bântéay Méanchey and Otdar Mean Chey.

FIGURE 2-14 **Proportion of women with limited access to health care under the worst-case climate change scenario, selected countries**



Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; Disability-adjusted Life Years (DALYs) estimates 2000–2019; Demographic and Health Surveys (DHS) Programme for Bangladesh (2017), Cambodia (2014), Nepal (2016),Pakistan (2017–2018), and Tajikistan (2017) . Map source: UNmap for Cambodia, 2020.

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94 Cecilia Sorensen and others, "Climate change and women's health: Impacts and policy directions", *PLOS Medicine*, vol. 15, No. 7 (10 July 2018). Available at https://doi.org/10.1371/journal.pmed.1002603

95 International Federation of Red Cross and Red Crescent Societies, "Come heat or high water: Tacking the humanitarian impacts of the climate crises together", World Disasters Report 2020 (Geneva, 2020). Available at https://media.ifrc.org/ifrc/wp-content/uploads/2020/11/20201116_WorldDisasters_Full.pdf

96 *The Disaster Riskscape across Asia-Pacific: Pathways for Inclusion and Empowerment* (United Nations publication, 2019c).

97 World Health Organization, "Gender, climate change and health" (Geneva, 2014). Available at https://www.who.int/globalchange/GenderClimateChangeHealthfinal.pdf (accessed on 21 March 2021).

98 *Inequality of Opportunity in Asia and the Pacific: Women's Sexual and Reproductive Health* (United Nations publication, 2019b). Available at https://www.unescap.org/resources/inequality-opportunity-asia-and-pacific-women-s-sexual-and-reproductive-health (accessed on 21 March 2021).

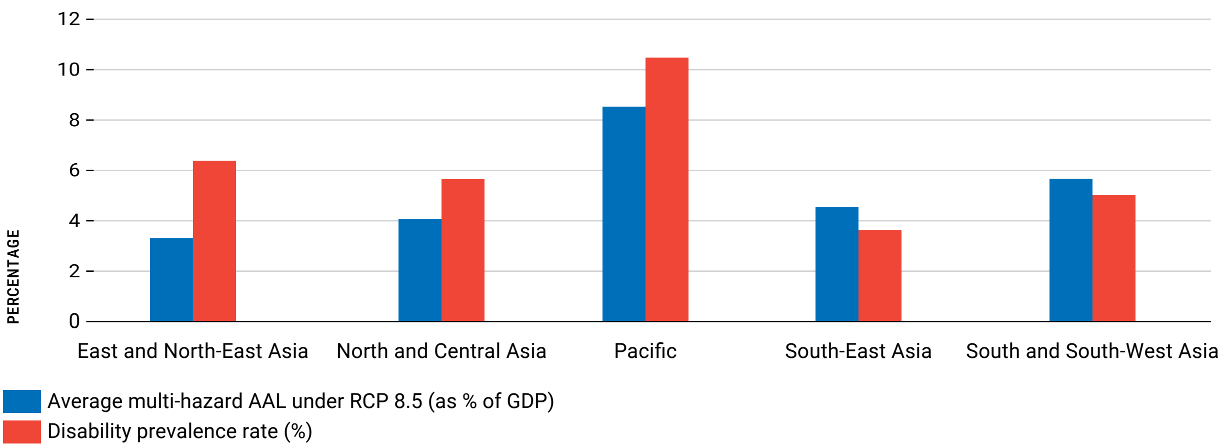
People with disabilities

In Asia and the Pacific, almost 690 million people live with disabilities and during disasters such people are at greater risk. People living with disabilities include those with physical disabilities, those with sight or hearing problems, those with learning disabilities, cognitive/developmental disabilities, or psycho-social disabilities.[99] Following the Great East Japan earthquake and tsunami, for example, the mortality rate for people with disabilities was double than that of the rest of the population.[100]

The Asia-Pacific subregions likely to suffer the greatest losses from climate change also have the highest proportions of people living with disabilities (Figure 2-15). In particular, the Pacific small island developing States, with Vanuatu, Tonga and Micronesia leading, will be at the greatest risk. Under RCP 8.5, 20 per cent of the subregion's GDP is at risk from disasters, and almost 10 per cent of the population lives with disabilities.

Persons with disabilities are often excluded from disaster risk reduction policies, plans and programmes so cannot contribute to decision-making on the measures that would support them.[101, 102] They may also miss emergency-related information and warnings. When considering multi-hazard, early warning systems, critical infrastructure, and the necessary social protection, it is important therefore to include data on disability.

FIGURE 2-15 **A subregional analysis of disability prevalence and losses from multi-hazard cascading risks**



Source: Disability statistics taken from *Disability at a Glance 2019: Investing in Accessibility in Asia and the Pacific* (United Nations publication, 2019a). Available at https://www.unescap.org/publications/disability-glance-2019.

Older people

In Asia and the Pacific, in 2019, more than 400 million people were aged 65 and older and could be at greater risk during slow-onset or sudden disasters.[103] Japan has the world's the highest proportion of older people, and torrential flooding, in July 2020 on the island of Kyushu, affected more than 50 nursing homes, leading to several deaths. Although a warning was issued, it was difficult to evacuate older people.[104] The countries with the highest proportion of their older population living with multi-hazard risks under RCP 8.5 are those in East and North-East Asia and South and South-West Asia (Figure 2-16).

99 *Disability at a Glance 2019: Investing in Accessibility in Asia and the Pacific* (United Nations publication, 2019a). Available at https://www.unescap.org/publications/disability-glance-2019 (accessed on 21 March 2021).

100 Ibid.

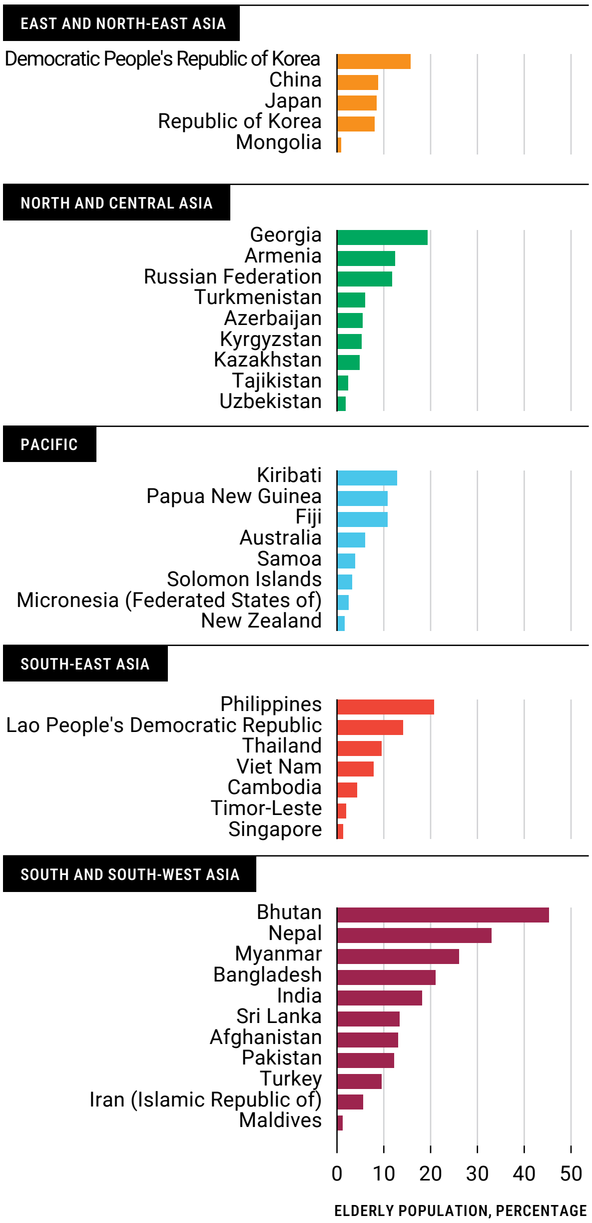
101 Takashi Izutsu, "Disability-inclusive disaster risk reduction and humanitarian action: An urgent global imperative", United Nations World Conference on Disaster Risk Reduction, 29 November 2019. Available at https://www.un.org/development/desa/disabilities/wp-content/uploads/sites/15/2020/03/Final-Disability-inclusive-disaster.pdf (accessed on 21 March 2021).

102 Fred Smith and others, "Disability and Climate Resilience: A literature review", Disability and Climate Resilience Research Project, November 2017. Available at https://www.researchgate.net/publication/320800956_Disability_and_Climate_Resilience_A_literature_review

103 *Disability at a Glance 2019: Investing in Accessibility in Asia and the Pacific* (United Nations publication, 2019a). Available at https://www.unescap.org/publications/disability-glance-2019 (accessed on 21 March 2021).

104 Nishinippon Shimbun, "Japan's nursing care facilities face challenge of safely evacuating during disasters", *The Japan Times*, 24 July 2020. Available at https://www.japantimes.co.jp/news/2020/07/24/national/japan-nursing-care-facilities-disasters/

FIGURE 2-16 **Percentage of elderly population at risk from natural hazards under worst-case scenario**

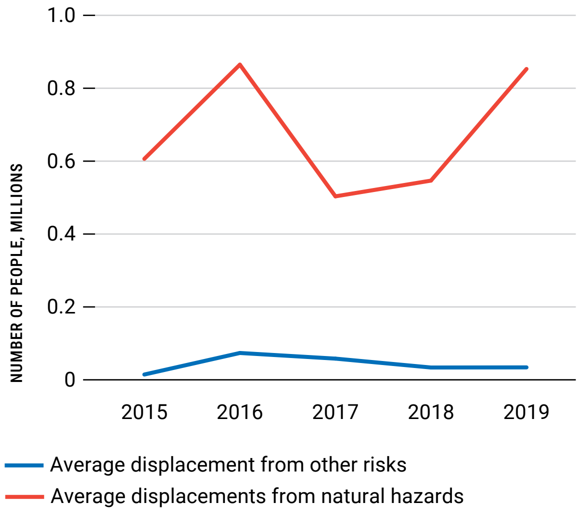


Source: ESCAP based on data from NASA, Socioeconomic Data and Application Centre, "Gridded Population of the World (GPW), v4". Available at https://sedac.ciesin.columbia.edu/data/collection/gpw-v4/maps/gallery/search

Displaced populations

In Asia and the Pacific, around 90 per cent of displacement is due to natural hazards. In the first half of 2020, four of the five countries which accounted for nearly 75 per cent of the new internal displacements due to disasters were in the Asia-Pacific region: India (2.7 million people), Bangladesh (2.5 million people), Philippines (811,000 people), and China (791,000 people).[105] Displaced populations have multiple vulnerabilities (Figure 2-17),[106] and amidst COVID-19, these populations are additionally susceptible. Displacement is also likely to increase as a result of climate change, particularly in the Pacific subregion.

FIGURE 2-17 **Displacement in Asia and the Pacific from natural hazards and other risks, 2015–2019**



Source: ESCAP based on data from Vicente Anzellini, Bina Desai and Clemence Leduc, "Global Report on Internal Displacement 2020", Internal Displacement Monitoring Centre and Norwegian Refugee Council, 30 October 2020. Available at https://resourcecentre.savethechildren.net/library/global-report-internal-displacement-2020

More complex hazards ahead

As climate change intensifies and further biological threats surely lie in wait, Asia and the Pacific will face an increasingly complex set of hazards. In the new disaster riskscape, these multiple threats will often overlap and intersect, triggering a cascading series of events. To combat these threats, countries will need to take comprehensive action to protect the poorest by integrating health and disaster risk management into stronger systems for health and social protection.

105 Vicente Anzellini, Bina Desai and Clemence Leduc, "Global Report on Internal Displacement 2020", Internal Displacement Monitoring Centre and Norwegian Refugee Council, 30 October 2020. Available at https://resourcecentre.savethechildren.net/library/global-report-internal-displacement-2020

106 Max-Planck Gesellschaft, "Climate change increases migration at the expense of the poor: A climate game shows that global cooperation can be possible — although not without effort", *ScienceDaily*, 26 May 2020. Available at https://www.sciencedaily.com/releases/2020/05/200526131531.htm (accessed on 24 March 2021).

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CHAPTER 3

Hotspots of exposure to cascading risks

The devastating impacts of the COVID-19 pandemic along with the frequent occurrence of other biological and natural hazards combined with the effects of climate change, has placed millions more people at risk. A set of hotspots have emerged under these new and converging risk parameters. Countries in these hotspots need to capture the impact of systemic and cascading risks and highlight priority areas for action.

The *Asia-Pacific Disaster Report 2019* presented, for the first time, a riskscape that included slow-onset disasters along with floods, tropical cyclones, earthquakes, and tsunamis. However, the risks have expanded with the addition of biological hazards and the impacts of climate change that are occurring simultaneously. Thus, the riskscape now needs to include a new set of complex parameters. The *Asia-Pacific Disaster Report 2021* combines, for the first time, data on biological hazards, natural hazards and climate change to identify hotspots where people are simultaneously exposed to multiple risks. These hotspots are listed below:

- East and North-East Asia — where heatwaves and related biological hazards are increasing along with the existing riskscape of earthquakes and tropical cyclones.
- North and Central Asia — where high per capita rates of COVID-19 are being superimposed on new areas of drought and biological hazards due to climate change.
- South and South-West Asia and South-East Asia — as one of the global epicentres of COVID19, the pandemic here is being superimposed on floods, droughts, and cyclones, that are being exacerbated by climate change and leading to systemic failures. The multiple hazards threaten to reverse poverty reduction gains and the achievement of the Sustainable Development Goals.
- Pacific small island developing States — where emerging high rates of COVID19 are being superimposed on cyclones and multiple other hazards that are being exacerbated by climate change, leading to an emerging and complex riskscape not seen before.

East and North-East Asia

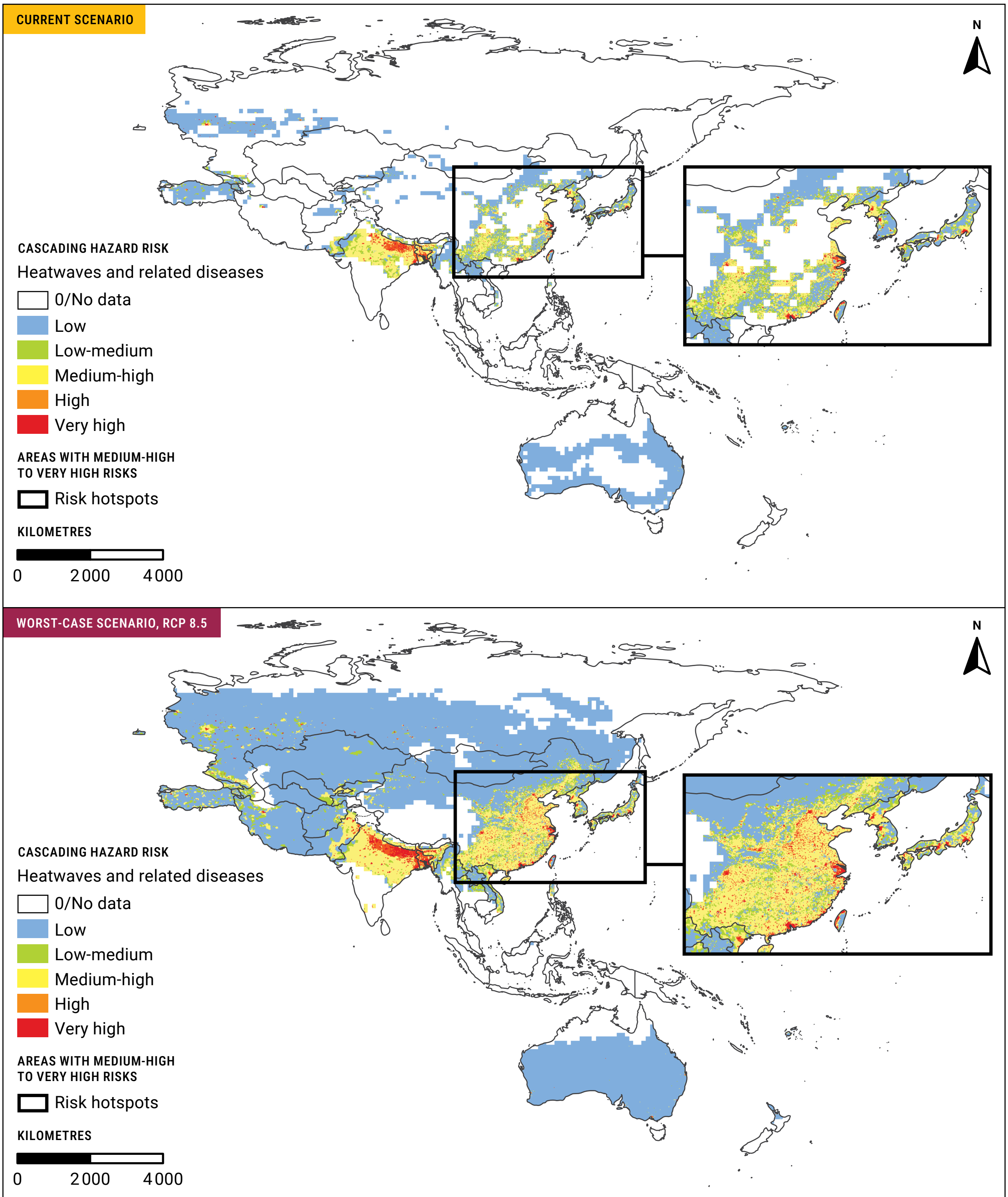
In 2019, this subregion was identified as a hotspot for the earthquake-prone 'Ring of Fire' and for tropical cyclones. However, with more variable climate, there is an additional risk from heatwaves, which directly affect human health and also have high economic and social costs. Of all the meteorological disasters, heatwaves have the most direct impacts on human health. However, as yet, there is no consensus around the definition of a heatwave. This *Asia-Pacific Disaster Report 2021* follows the World Bank definition where a heatwave is an extended period, 14 or more days in a year, of unusually high atmosphere-related heat stress with minimum temperatures of about 25°C. Figure 3-1 illustrates population exposure to heatwaves and related diseases under a current climate scenario (proxy taken as RCP 2.6) and the worst-case climate change scenario (RCP 8.5). In East and North-East Asia, almost 400 million more people will be exposed to heatwaves and related health hazards under the worst-case climate scenario (Figure 3-1).

BOX 3-1 Representative Concentration Pathways (RCPs)

RCPs are concentration pathways used in the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. They are four prescribed pathways for greenhouse gas and aerosol concentrations, together with land use change, that are consistent with a set of broad climate outcomes. The selection of these four pathways was a result of a number of different priorities. These included having scenarios that spanned the range of future emissions and concentrations projected in scientific literature, but also being sufficiently distinct from one another.

Source: Zeke Hausfather, "Explainer: The high-emissions 'RCP8.5' global warming scenario", CarbonBrief, 21 August 2019. Available at https://www.carbonbrief.org/explainer-the-high-emissions-rcp8-5-global-warming-scenario

FIGURE 3-1 Population exposure to heatwaves and related diseases under current and worst-case (RCP 8.5) scenarios in East and North-East Asia

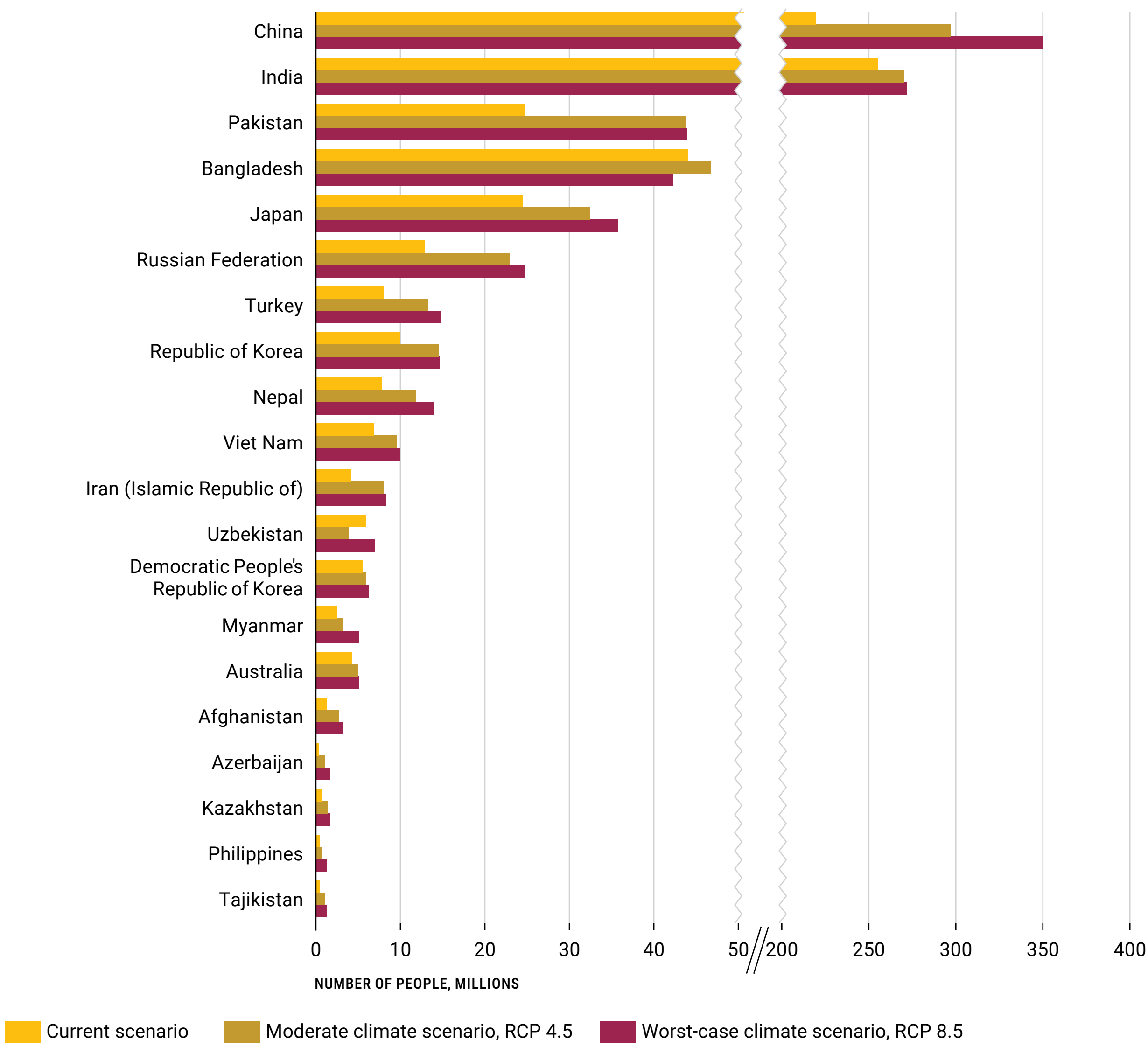


Sources: ESCAP calculations, based on Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

Note: 1. Cascading Hazard Risk is obtained from Projected Change in Spatial Variation for Maximum Number of Summer Days with Maximum Temperature More than 25°C by Population and Disability-Adjusted Life Years (DALYs).
2. Current scenario refers to RCP 2.6 in 2020-2039. The worst case scenario refers to RCP 8.5 in 2040–2059.
3. Projected Change in Spatial Variation for Number of Summer Days with Maximum Temperature More than 25°C ranges from 14 days to maximum number of days.
4. DALY indicators for heatwave-related diseases consist of cardiovascular diseases, respiratory diseases, skin diseases and road injury.

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

FIGURE 3-2 Population exposure to heatwaves and related diseases, 2020–2059

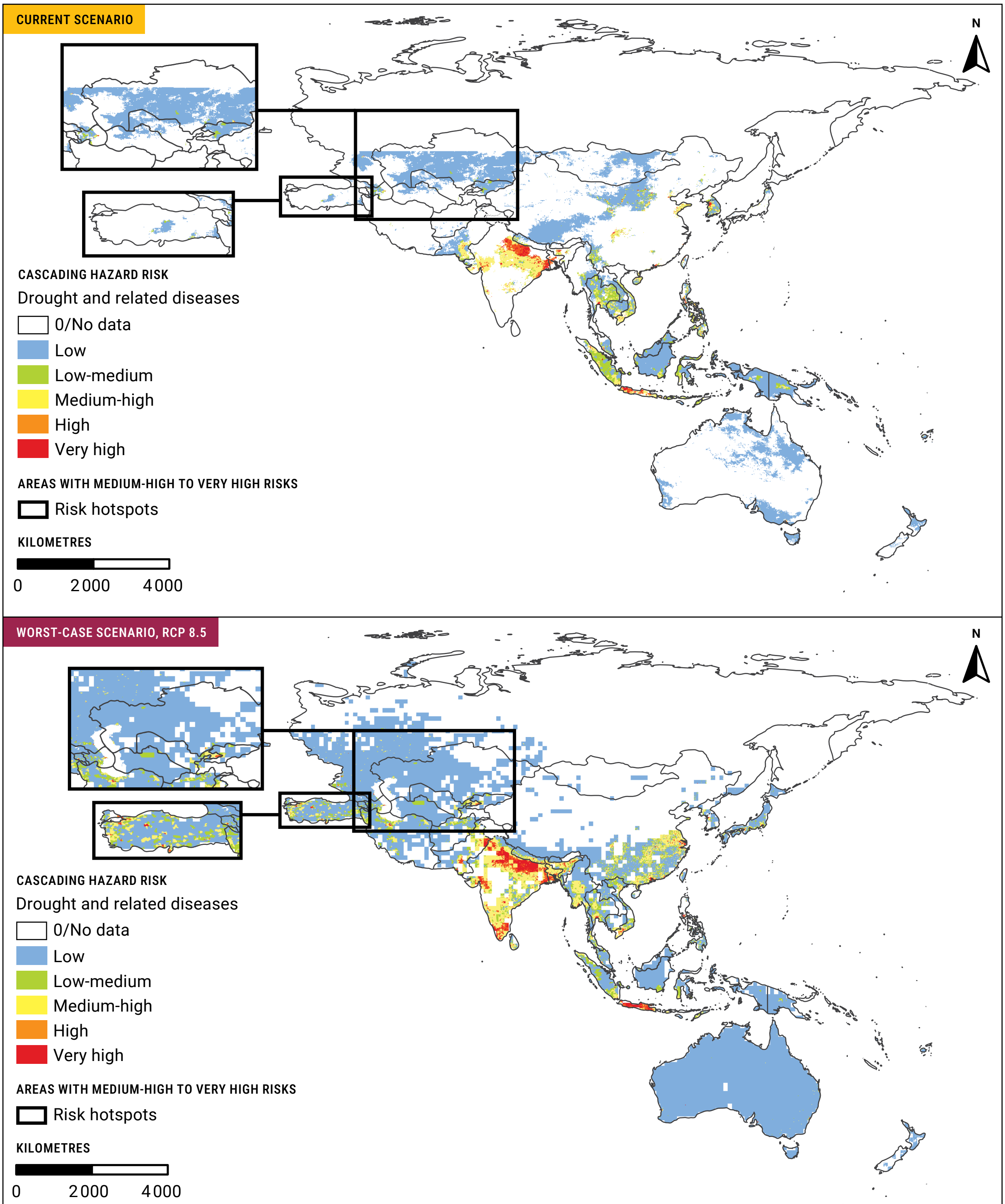


Source: ESCAP calculations, based on Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

North and Central Asia

In the *Asia-Pacific Disaster Report 2019*, North and Central Asia was identified as a hotspot for sand and dust storms. The subregion is also currently suffering from increasing COVID-19 cases (Chapter 1, Table 1-2). Furthermore, with a more variable climate, there is also the emerging risk from drought. Figure 3-3 locates the areas where more people are exposed to drought and diseases under the worst-case climate change scenario. The analysis shows that in Armenia, Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, and Uzbekistan, this exposure will increase from between 3–13 per cent. Other countries in the region are still exposed to these hazards, but the exposure may not increase with climate change. Uzbekistan faces the highest risk from future drought and drought-related diseases, with an expected 12 per cent increase in population exposure.

FIGURE 3-3 **Population exposure to drought and related diseases under current and worst-case (RCP 8.5) scenarios in North and Central Asia**



Sources: ESCAP calculations, based on 6-months Standardized Precipitation Index (SPI6) of Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), 2015; based on Climate Change Knowledge Portal, 2018; UN WPP Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

Note: 1. Cascading Hazard Risk is obtained from Projected Change in Spatial Variation for Maximum Number of Consecutinve Dry Days by Population and Disability-Adjusted Life Years (DALYs).
2. Current scenario referes to 2015. The worst case scenario refers to RCP 8.5 in 2040–2059.
3. The spatial variation of SPI6 ranges from - 0.8 to the minimum value (moderate to exceptional drought). Projected change in Spatial Variation for Maximum Number of Consecutive Dry Days ranges from 0 to maximum number of days.
4. DALY indicators for drought related diseases consist of nutritional and vitamin deficiencies.

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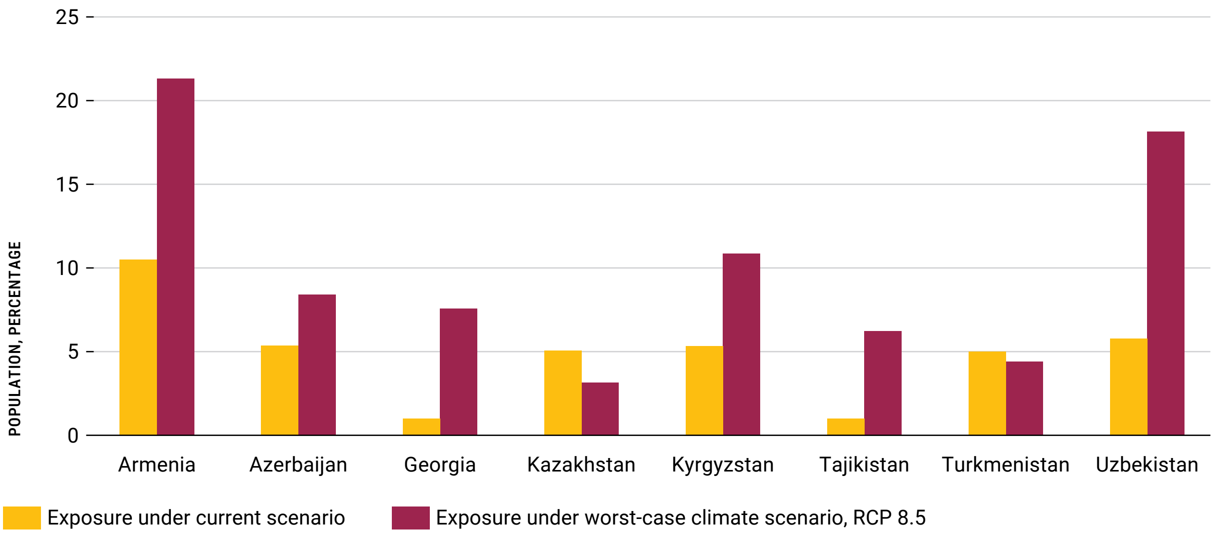
FIGURE 3-4 **Increase in population exposure to droughts and related diseases under current and worst-case (RCP 8.5) scenarios in North and Central Asia**



Source: ESCAP calculations, based on Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

South and South-West Asia

As one of the global epicentres of COVID-19, with almost 37 million cases (Chapter 1, Table 1-2), South and South-West Asia has suffered immensely from the convergence of the COVID-19 pandemic with various hydro-meteorological hazards. In this subregion, the problems are most severe in the Ganga-Brahmaputra-Meghna (GBM) basin, which is home to the largest concentration of poor people in the world (Figure 3-5), and will only increase with cascading risks. In the current scenario, around 290 million people in the GBM basin are being exposed to cascading risks from floods and related diseases, and almost 300 million more will be impacted under the worst-case climate change scenario (RCP 8.5) (Figure 3-7). In addition, this subregion is also suffering from increasingly frequent cyclones, both in the Bay of Bengal and in the Arabian Sea, which have been attributed to climate change.[107] Figure 3-5 and Figure 3-6 show this emerging hotspot, where some parts may also be located in the GBM basin.

BOX 3-2 Cyclone Tauktae — a manifestation of the emerging riskscape

In the midst of the devastating second wave of the pandemic, the powerful Cyclone Tauktae struck the west coast of India, killing more than 100 people and wreaking havoc between 12–19 May 2021. This was the deadliest tropical cyclone in the Arabian Sea to have made landfall over the last decade.

Out of the five cyclones formed annually in the Bay of Bengal, usually only one develops in the Arabian Sea. But the risk scenario is rapidly changing. A year ago, in the Bay of Bengal, cyclone Amphan intensified and turned into a super cyclone in 24 hours. A week later, cyclone Nisarga formed over the Arabian Sea and struck the western coast of India.

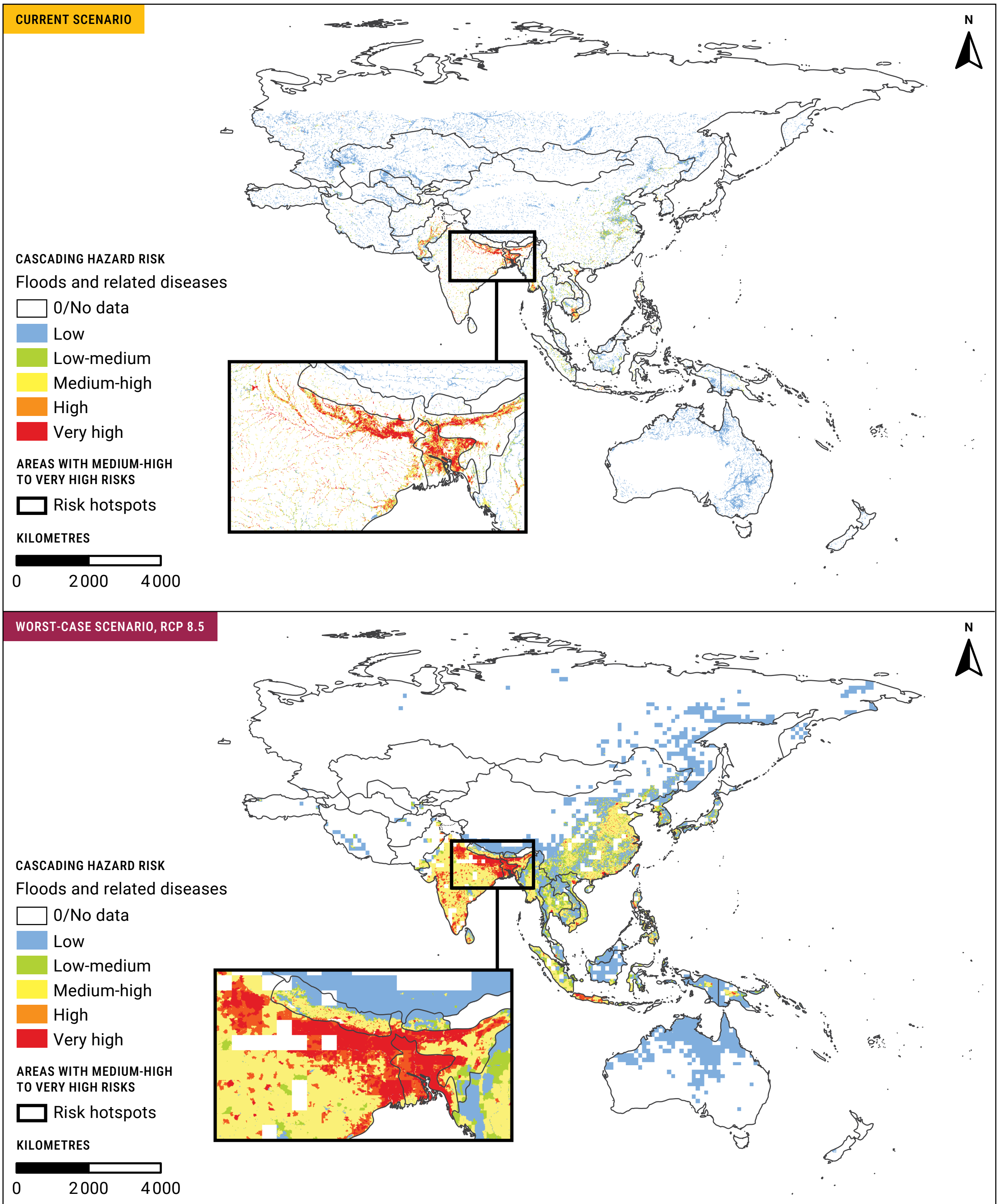
For more than a century, the western tropical Indian Ocean has been warming at a rate faster than any other region of the tropical oceans. It is the largest contributor to the increase in the global mean of sea surface temperatures (SST). Tropical cyclones draw their energy from warm waters and the Arabian Sea used to be a cool pool region. However, due to global warming, the Arabian sea is now a warm pool region,which leads to more intense cyclones. At the time of the cyclonegenesis process of Tauktae, the SSTs in the Arabian Sea were at 30–31°C which increased both the speed and the intensity of the cyclone.

The impacts arising from the intersections of cyclone Nisarga and Amphan in 2020, and cyclone Tauktae in 2021, with the COVID-19 pandemic, presents a complex and cascading risk scenario. Cyclone Nisarga struck during the first wave of the pandemic with limited pockets of the infections, but cyclone Tauktae hit during the second wave. Thus, managing such cascading risk scenarios is challenging. Tauktae struck while India continues to grapple with a major spike in coronavirus cases and an outbreak of black and white fungus, or mucormycosis, in the affected states. The cyclone forced officials to move hospitalized coronavirus patients, protect the critical supply chains of medical oxygen for specialized COVID-19 care centres and suspend vaccination campaigns, all of which may have lead to a spike in the already high number of infection cases. This was observed, in 2020, where hundreds of responders evacuating large number of at-risk communities, that were hit by cyclone Amphan and Nisraga, also subsequently tested positive for COVID-19.

Source: Sanjay Srivastava and others, "Cyclone Tauktae: a perfect storm of climate change and pandemic", blog, 28 May 2021. Available at https://www.unescap.org/blog/cyclone-tauktae-perfect-storm-climate-change-and-pandemic#.

107 "Arabian sea- hotbed of cyclones", Journals of India (India), 19 May 2021. Available at https://journalsofindia.com/arabian-sea-hotbed-of-cyclones/

FIGURE 3-5 **Population exposure to floods and related diseases under current and worst-case (RCP 8.5) scenarios in South and South-West Asia**

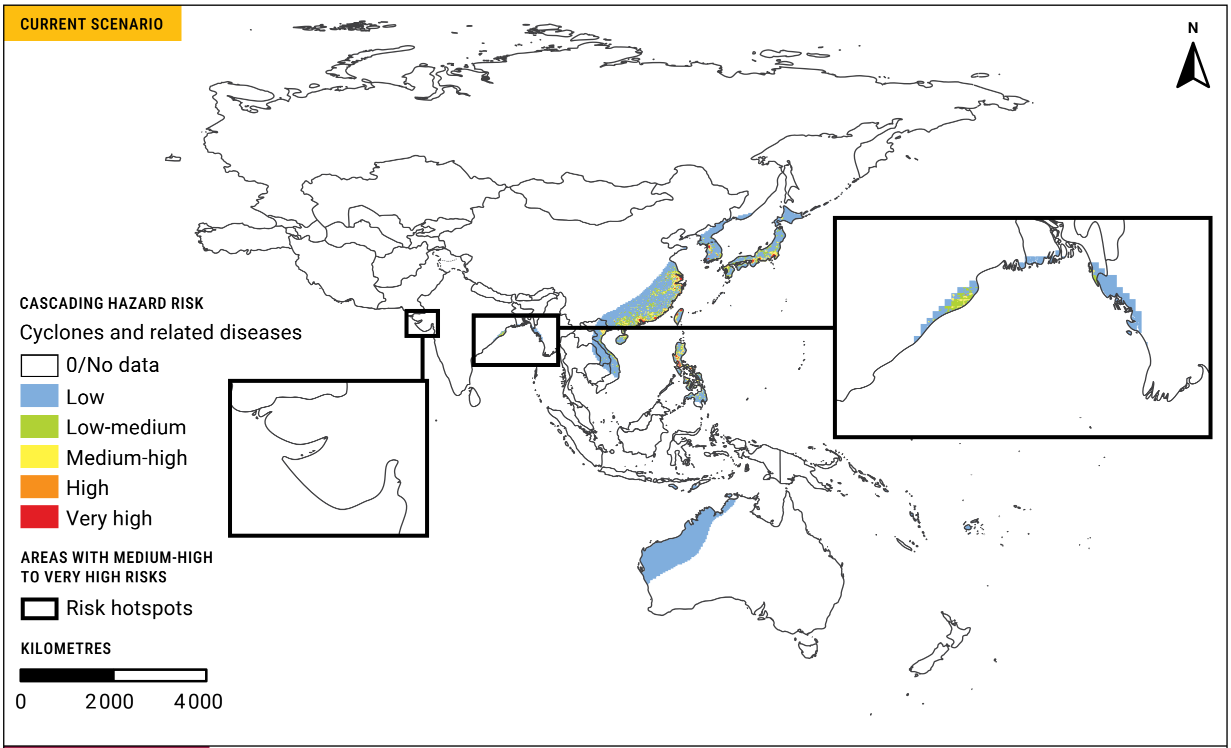


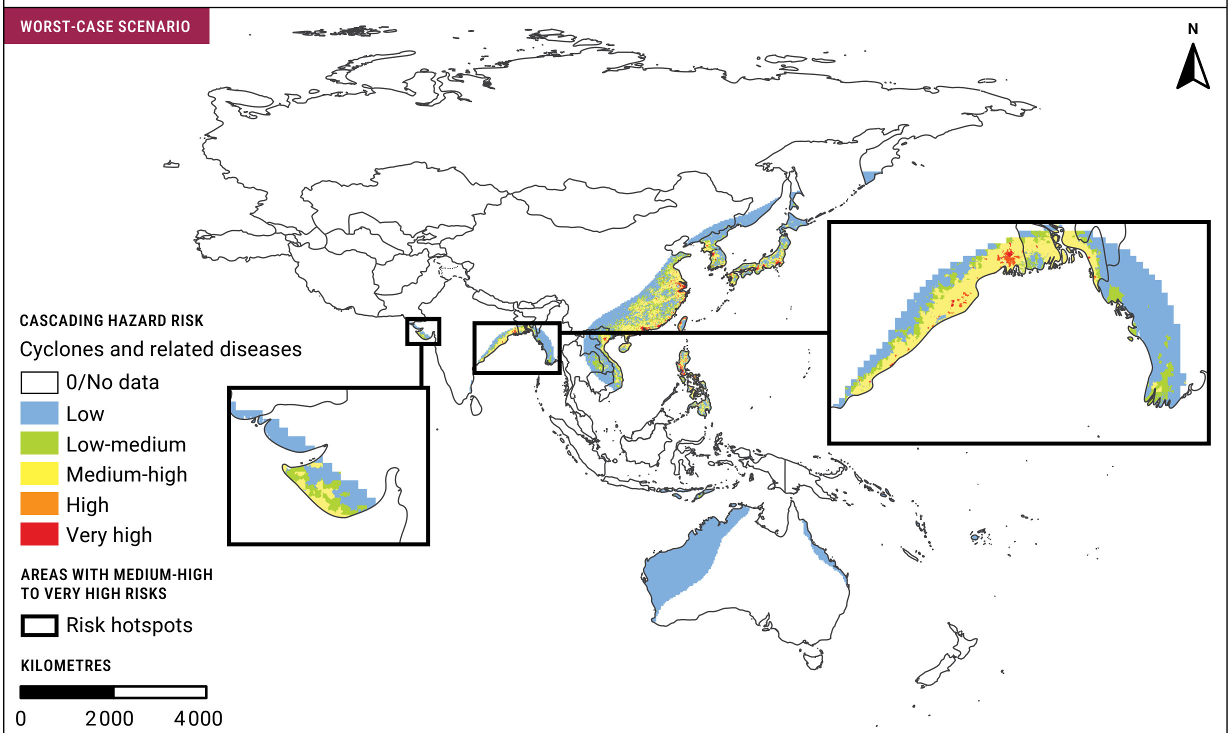
Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000-2019.

Note:
1. Cascading hazard risk for current scenario is obtained from Flood hazards 100 year return period by population and Disability-Adjusted Life Years (DALYs).
2. Cascading hazard risk for the worst case is obtained from Projected Change 2040-2059 in Spatial Variation for the 10-year return level of the maximum 5-day cumulative Precipitation under RCP 8.5 by population and Disability-Adjusted Life Years (DALYs).
3. Projected Change 2040–2059 in Spatial Variation for 10 year return level of the maximum 5-day cumulative Precipitation under RCP 8.5 ranges from 11mm tomaximum precipitation amount.
4. DALY indicators for flood-related diseases consist of diarrheal diseases, measles, hepatitis A, malaria, dengue and drowning.

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

FIGURE 3-6 **Population exposure to cyclones and related diseases under current and worst-case (RCP 8.5) scenarios in South and South-West Asia**





Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; UN WPP-Adjusted Population Density 2020, v4.11;and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

Note: 1. Cascading Hazard Risk is obtained from GAR Cyclone Wind by Population and Disability-Adjusted Life Years (DALYs).
2. Current scenario refers to GAR Cyclone Wind with 50 year Return Period. The worst case scenario refers to GAR Cyclone Wind with 100 year Return Period.
3. Cyclone data consists of all cyclone wind categories with a return period of 50 years and an intensity of 119 to more than 252 km/h.
4. DALY indicators for cyclone-related diseases consist of parasitic and vector diseases, and injuries.

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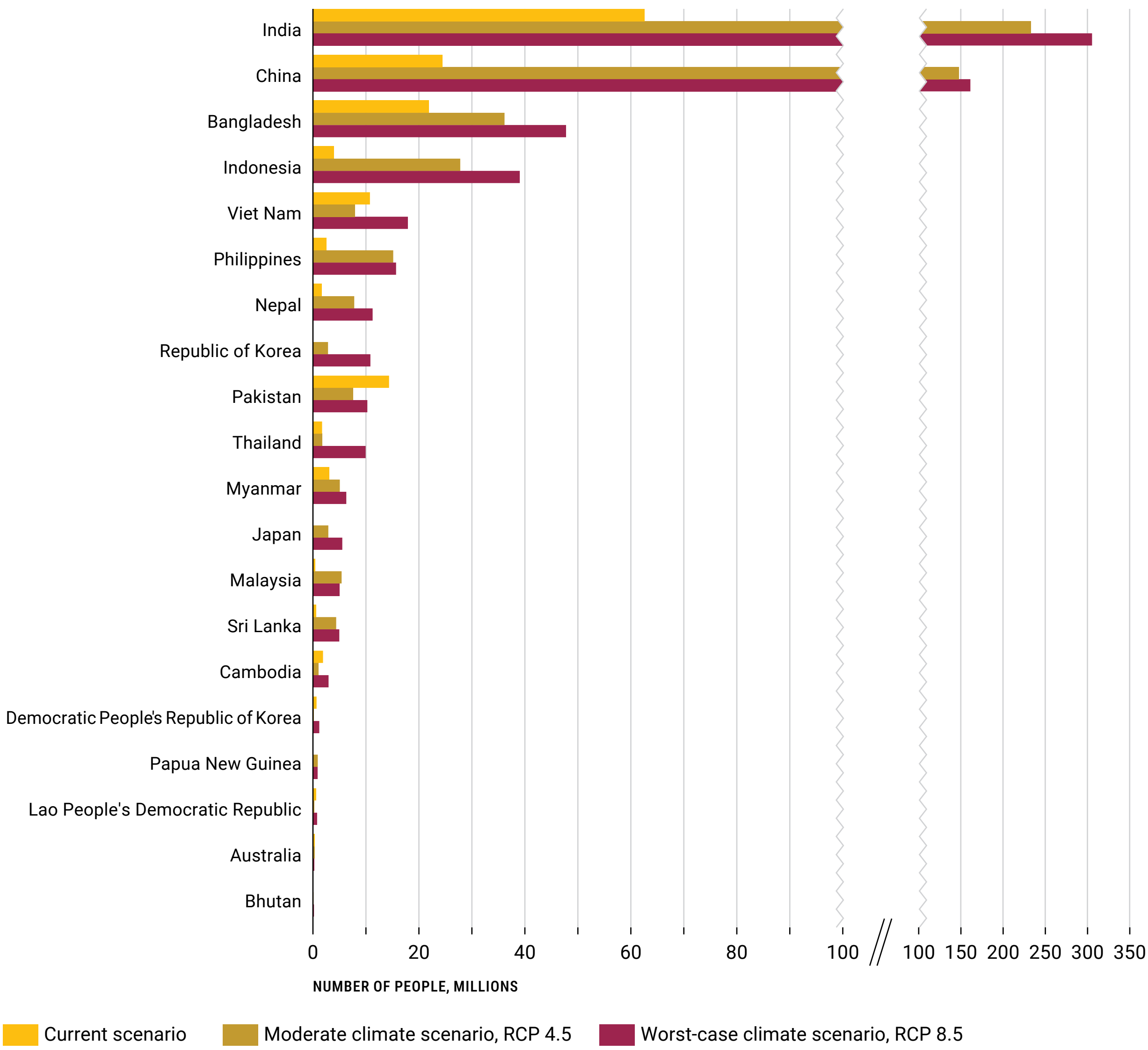
FIGURE 3-7 **Population exposure to floods and related diseases, millions, 2020–2059**

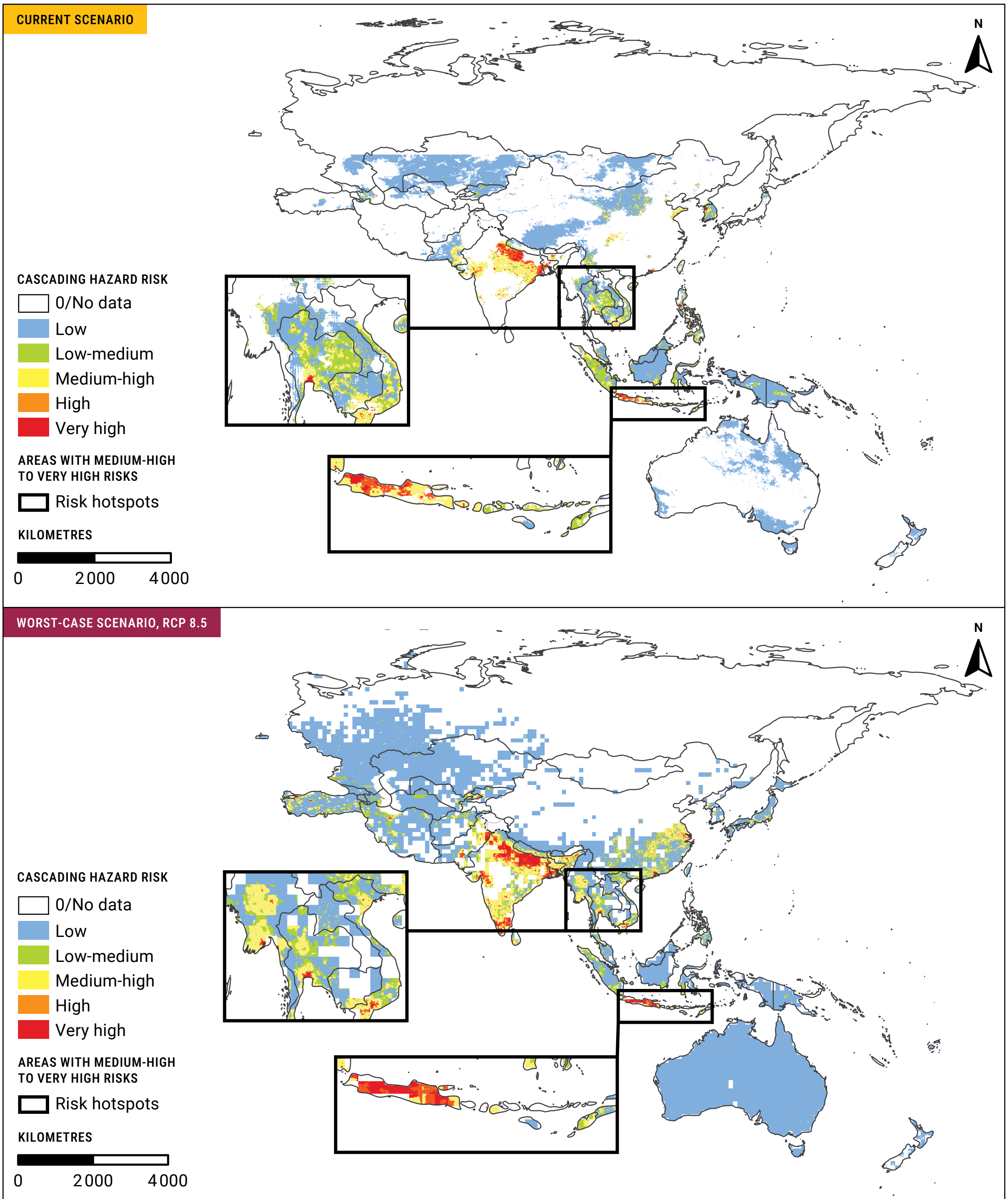


Source: ESCAP calculations, based on Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

South-East Asia

In 2019, South-East Asia was identified as an area of concern for transboundary river basins. Figure 3-8 locates the areas where more people will also be exposed to drought and related diseases under the worst-case climate change scenario. In Brunei Darussalam, the Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Timor-Leste, and Viet Nam, the population exposed to drought and related diseases is expected to increase by around 2–9 per cent. However, other countries, such as Thailand, will remain at risk with almost 14 per cent of the population being exposed to drought under the worst-case climate change scenario. With an almost 10 per cent increase in population exposure, both Myanmar and Viet Nam face the highest risk from future drought and drought-related diseases under the worst-case scenario (Figure 3-9). Almost daily, the subregion is also recording higher cases of COVID-19 with almost 4 million people being exposed to the pandemic (Chapter 1, Table 1-2).

FIGURE 3-8 Population exposure to drought and related diseases under current and worst-case (RCP 8.5) scenarios in South-East Asia



Sources: ESCAP calculations, based on 6-months Standardized Precipitation Index (SPI6) of Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), 2015; based on Climate Change Knowledge Portal, 2018; UN WPP Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000-2019.

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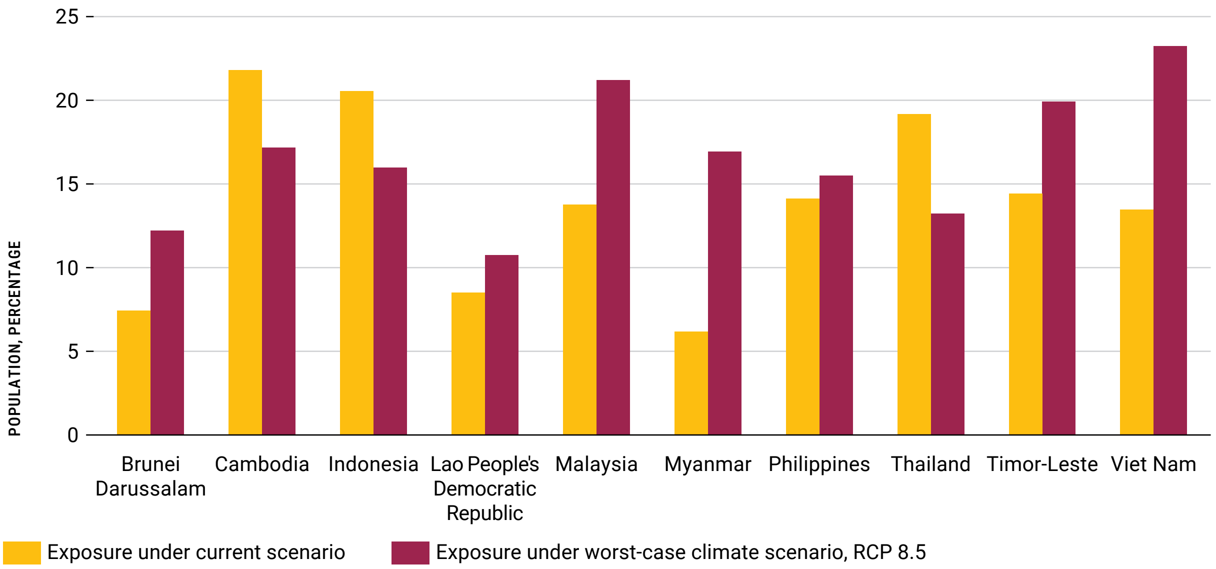
Note: 1. Cascading Hazard Risk is obtained from Projected Change in Spatial Variation for Maximum Number of Consecutinve Dry Days by Population and Disability-Adjusted Life Years (DALYs).
2. Current scenario referes to 2015. The worst case scenario referes to RCP 8.5 in 2040–2059.
3. The spatial variation of SPI6 ranges from - 0.8 to the minimum value (moderate to exceptional drought). Projected change in Spatial Variation for Maximum Number of Consecutive Dry Days ranges from 0 to maximum number of days.
4. DALY indicators for drought related diseases consist of nutritional and vitamin deficiencies.

FIGURE 3-9 Increase in population exposure to drought and related diseases under current and worst-case (RCP 8.5) scenarios in South-East Asia



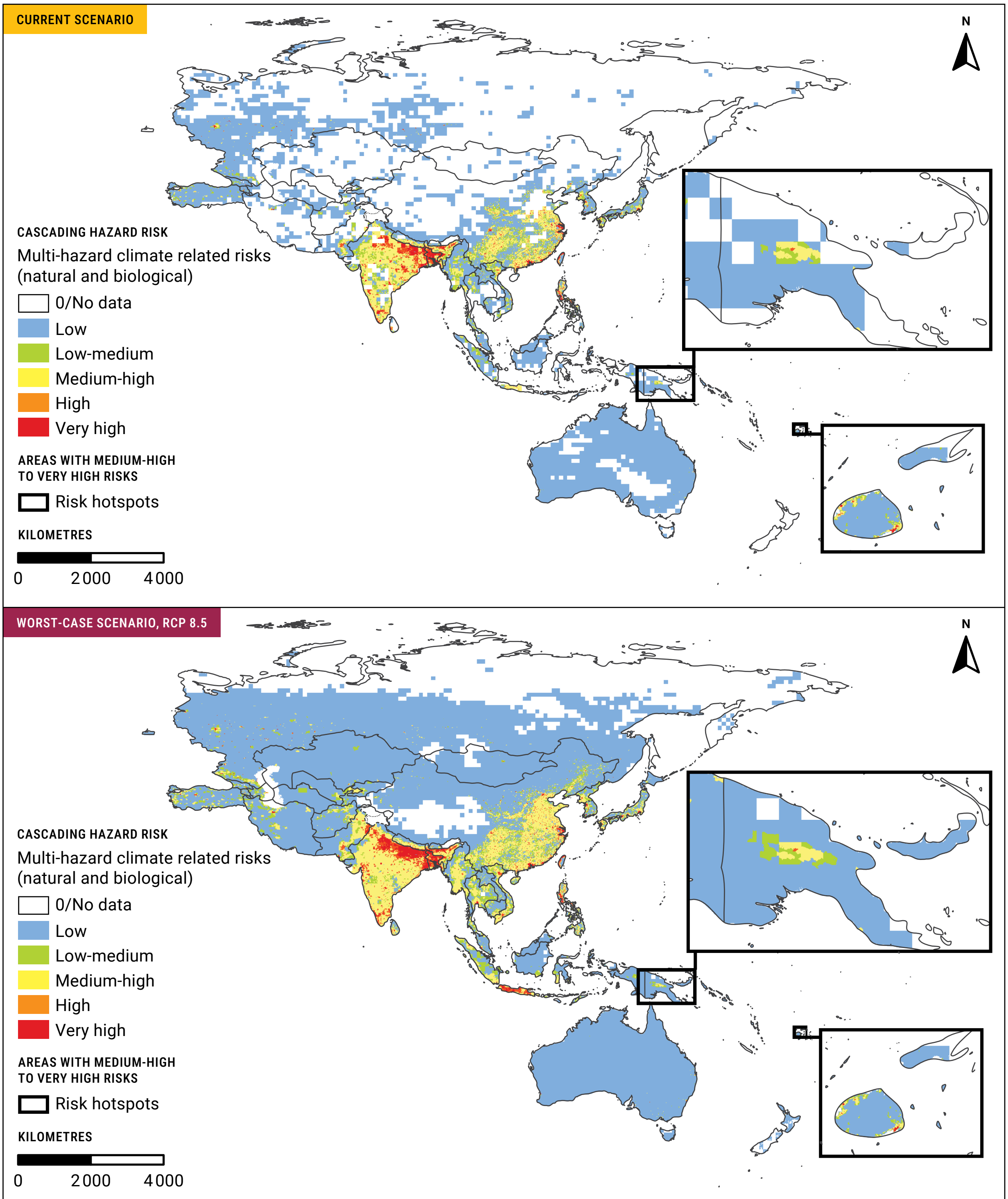
Source: ESCAP calculations, based on Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

Pacific small island developing States

As indicated in the *Asia-Pacific Disaster Report 2019*, the Pacific small island developing States are vulnerable to earthquakes and landslides. However, for this subregion, under all climate change scenarios there are also concerns about cyclone-related flooding and drought with related biological diseases. Figure 3-10 locates the areas where more people will be exposed to multiple hazards under both current and worst-case (RCP 8.5) climate scenarios. In Fiji, Papua New Guinea, Samoa, Micronesia, Solomon Islands and Kiribati, the population that will be exposed to multiple hazards is expected to be between 1–30 per cent. In particular, almost 30 per cent of the population of Fiji, and almost 15 per cent of the population of Papua New Guinea are at risk from multiple hazards occurring simultaneously. These areas are also suffering from an increase in COVID-19 cases (Figure 3-11). For example, the Western Highland, in Papua New Guinea, was identified as a hotspot with hospital systems being taxed to their limits.[108]

108 Natalie Whiting, "Concerns hundreds of COVID-19 cases missing from PNG's national tally", ABC News, 13 May 2021. Available at https://www.abc.net.au/news/2021-05-13/concerns-covid-19-cases-missing-from-png-s-national-tally/100128228 (accessed on 10 July 2021).

FIGURE 3-10 **Multi-hazard risks from climate-related disasters and diseases under current and worst-case (RCP 8.5) scenarios in the Pacific small island developing States**



Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

Note: 1. Cascading Hazard Risk is obtained from multi-hazard file that consists of highest intensity of GAR Cyclone Wind within 100 year return period; Climate projection data for flood, drought and heatwaves under RCP 4.5 in 2020–2039 and under RCP 8.5 in 2040–2059 by Population and DALYs for related multi-hazard.
2. Current scenario refers to RCP 4.5 in 2020-2039. The worst case scenario refers to RCP 8.5 in 2040–2059.

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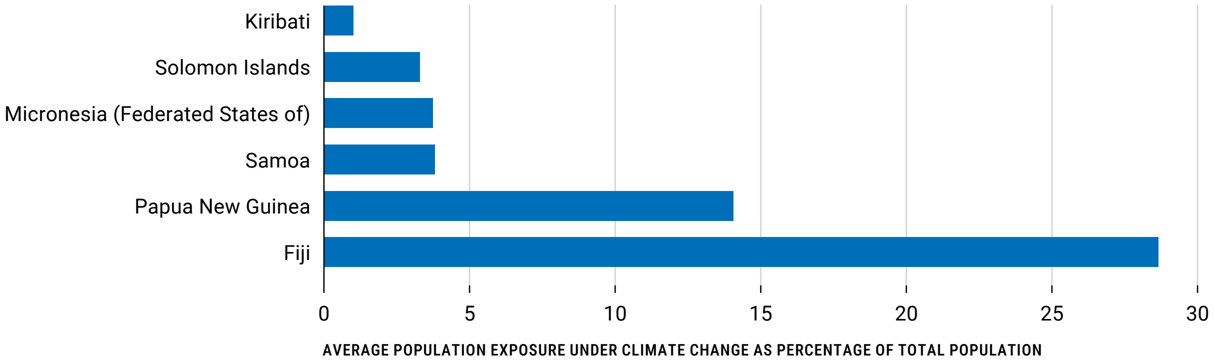
FIGURE 3-11 **Average population exposure to multiple hazards under moderate and worst-case climate change scenarios, percentage**



Source: ESCAP calculations, based on Climate Change Knowledge Portal, 2018; UN WPP-Adjusted Population Density 2020, v4.11; and Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

The economic cost of cascading hazards and climate change

As seen from the discussion above of the subregional hotspots, many parts of Asia and the Pacific are increasingly exposed to disasters resulting from climate change, with the number of hotspots increasing as well. ESCAP has estimated the cost of such disasters by calculating a 'climate change impact factor' (Table 3-1). Current annual losses from both hydro-meteorological and geophysical natural hazards are estimated to be around $780 billion. Under the moderate climate change scenario (RCP 4.5), these losses will increase to $1.1 trillion, and under the worst-case scenario (RCP 8.5) the increase will be around $1.4 trillion. This is in line with the most recent report from the McKinsey Global Institute, which estimates, on average, potential losses from climate-related risks in Asia to be between $1.2 trillion and $4.7 trillion.[109]

TABLE 3-1 **Average Annual Losses (AAL) from the new expanded riskscape under moderate (RCP 4.5) and worst-case (RCP 8.5) climate change scenarios**

Cascading hazards	Average annual loss (US$ billion)	Proportion of regional GDP (percentage)
Extensive risk – multi-hazard AAL including indirect losses from Earthquake, Tsunami, Tropical Cyclone and Floods	270.9	0.9
Drought AAL	404.5	1.3
Biological hazard AAL	104.7	0.3
Total – New Current Cascading Riskscape	780.1	2.5
Total – Under moderate climate change scenario (RCP 4.5)	1,163.4	3.7
Total – Under worst case climate change scenario (RCP 8.5)	1,444.7	4.2

In absolute terms, China, India, Japan, Indonesia, the Republic of Korea and the Russian Federation will suffer the greatest losses under RCP 8.5 (Figure 3-12). However, when assessed as a percentage of GDP, the Pacific small island developing States along with other lesser developed countries (Figure 3-13) are also extremely vulnerable. Vanuatu, for example, will lose an additional 4 per cent of its GDP, under the worst-case (RCP 8.5) climate scenario, from its current average annual loss of 19 per cent (Figure 3-14). The Pacific small island developing States are already the most ecologically fragile countries with high burdens of natural and biological hazards and are prone to facing some of the worst climate change outcomes.[110]

109 Jonathan Woetzel and others, "Climate risk and response in Asia: Future of Asia", McKinsey Global Institute (November 2020). Available at https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability/Our%20Insights/Climate%20risk%20and%20response%20in%20Asia/MGI-Climate-Risk-and-Response-in-Asia-Report-November-2020.pdf?shouldIndex=false.

110 World Health Organization, "Protecting the health of Pacific islanders from climate change and environmental hazards". Available at https://www.who.int/westernpacific/activities/protecting-the-islanders-from-climate-change-and-environmental-hazards.

FIGURE 3-12 Increase in Average Annual Losses (AAL) from cascading risks under current, moderate (RCP 4.5), and worst-case (RCP 8.5) climate change scenarios, US$ millions

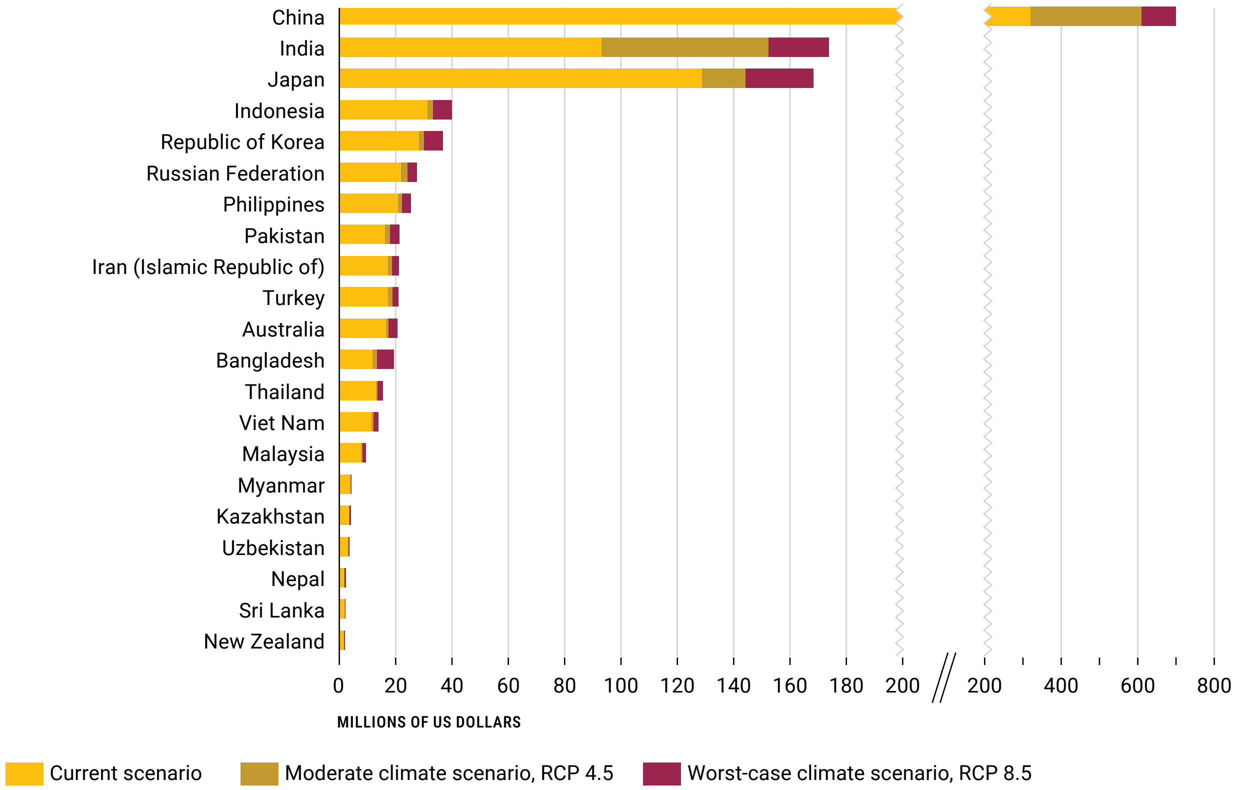


FIGURE 3-13 Increase in Average Annual Losses (AAL) as a percentage of GDP under current, moderate (RCP 4.5), and worst-case (RCP 8.5) climate change scenarios

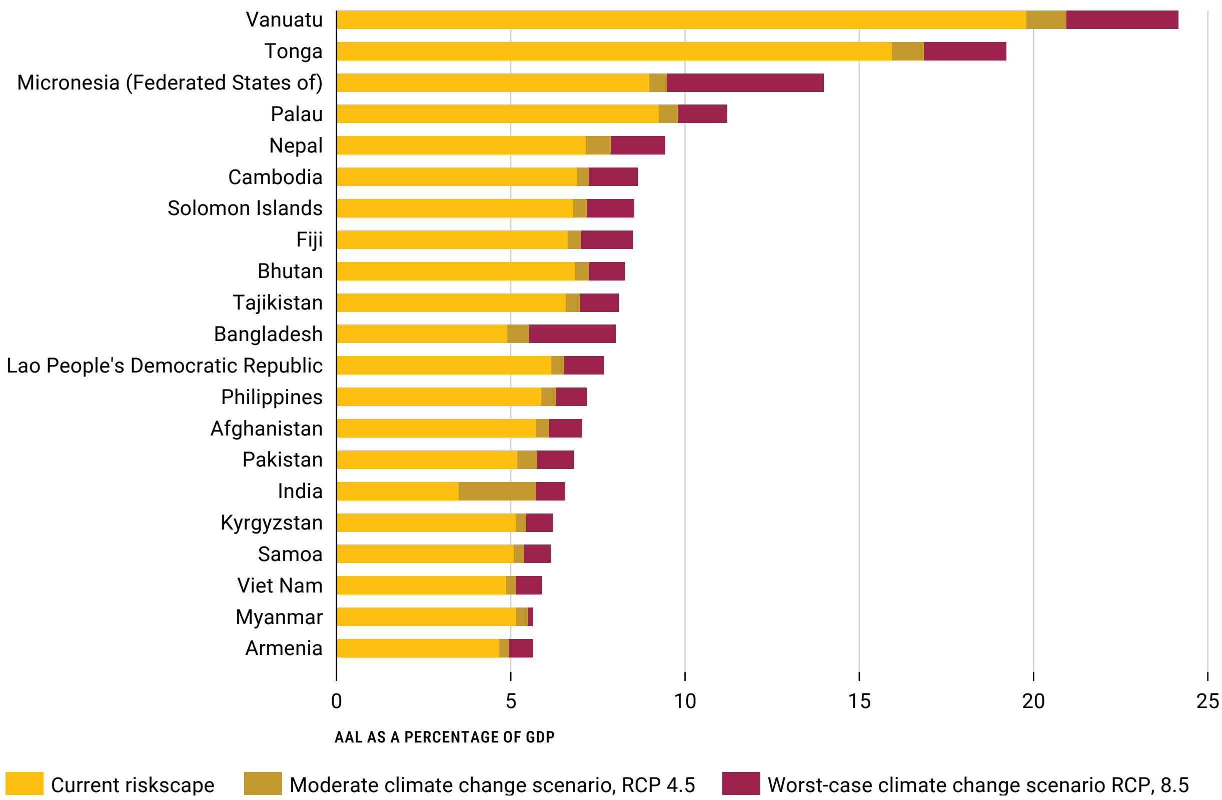
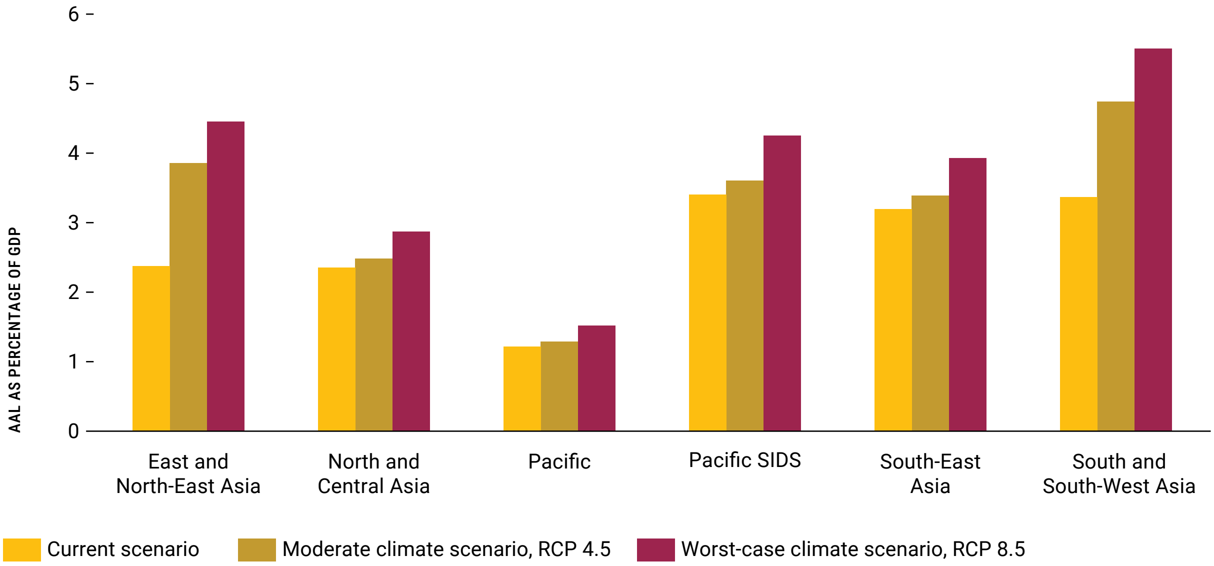


FIGURE 3-14 **Annual Average Losses (AAL) from cascading hazards as a percentage of subregional GDP**



Note: SIDS = small island developing States.

The risks to critical infrastructure

The *Economic and Social Survey of Asia and the Pacific 2021* notes that natural disasters have a more devastating impact on countries with low-quality infrastructure, and without good roads and telecommunications, disaster relief could be delayed and economic disruptions prolonged.[111] Especially for the poor, climate change is further likely to hamper access to services and critical infrastructure. This is partly because the poorest people live on marginal land, which is less likely to have services. In Bangladesh, for example, 15 per cent of the total land is subject to flooding, and most of the people living these areas are poor. In Tonga, people moving from the outer islands to the main one, as result of climate change, have settled in low-lying areas that are more vulnerable to floods.[112] In marginal areas, healthcare facilities will need to be strengthened to anticipate exposure to the impacts of climate change.

Healthcare infrastructure

Disasters impose multiple pressures on health systems and disrupt health services exposing people to greater risks in facilities with poor health conditions.[113] The impacts from COVID-19 highlight the urgent need to merge disaster risk reduction strategies into health preparedness systems, especially to support the most vulnerable populations. For example, amidst the pandemic, super-cyclone Amphan and cyclone Nisarga hit India, in May and June 2020, with floods from the monsoon season following closely. The simultaneous impacts created major challenges in imposing social-distancing measures in packed cyclone shelter facilities in the affected areas. With more than 6 million evacuees in the affected states in India, increasing space requirements from 3.5 to 5 square metres for social distancing has been extraordinarily challenging.[114]

111 United Nations publication, 2021.

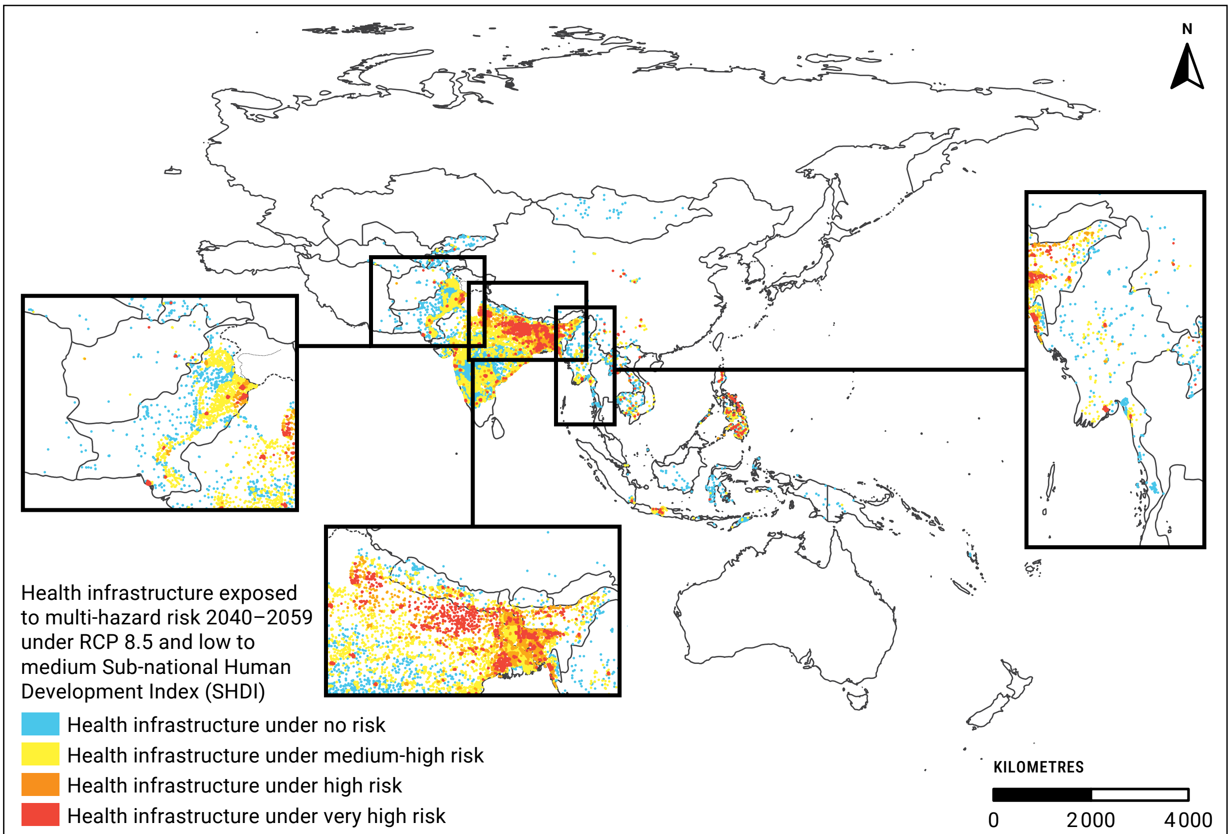
112 Intergovernmental Panel on Climate Change (IPCC), "Climate Change 2001: Impacts, Adaptation and Vulnerability", (New York, Cambridge University Press, 2001).

113 Sanaz Sohrabizadeh and others, "Systemic review of health sector responses to the coincidence of disasters and COVID-19", *BMC Public Health*, vol. 21, No. 709 (2021). Available at https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10806-9

114 "What impact will Cyclone Amphan have during COVID-19 times", *The Free Press Journal* (India), 19 May 2020. Available at https://www.freepressjournal.in/india/what-impact-will-cyclone-amphan-have-at-covid-19-times

Figure 3-15 indicates the healthcare facilities for people living in the marginal areas of the low or medium HDI countries and who are at risk from multiple hazards under RCP 8.5. In Myanmar, for example, 43 per cent of healthcare facilities are located in districts with extreme multi-hazard risks and where people live in poverty. The proportion is also high in Nepal, Afghanistan, Pakistan and India (Figure 3-16). To cope with cascading risks from natural and health hazards, healthcare infrastructure needs to be risk-informed, and health systems should be sufficiently resilient to adapt to changing climate, particularly when they serve poor and low-income populations.[115]

FIGURE 3-15 **Hospitals serving vulnerable people at risk from natural, biological and other health hazards under the worst-case (RCP 8.5) climate change scenario**



Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; Disability-Adjusted Life Years (DALYs) estimates 2000-2019; UN WPP Adjusted Population Density 2020, v4.11; Sub-national Human Development Index (SHDI) version 4.0, 2018; and The Humanitarian Data Exchange (HDX) Version 1.51.0.

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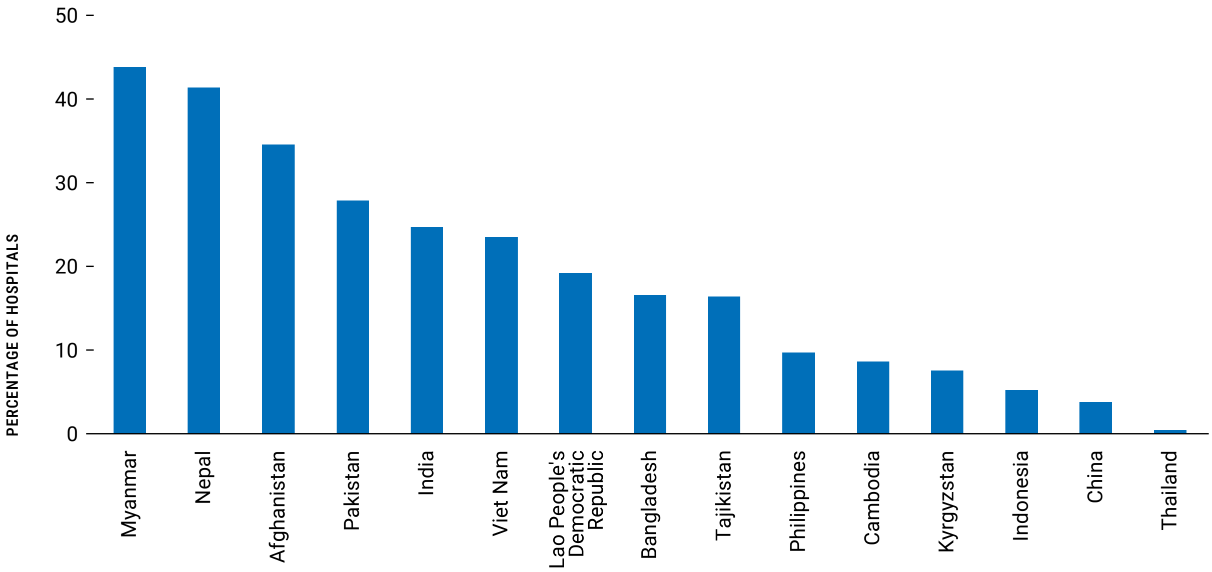
115 World Health Organization, "Strengthening Health Resilience to Climate Change", Technical Briefing for the World Health Organization Conference on Health and Climate. Available at https://www.who.int/phe/climate/conference_briefing_1_healthresilience_27aug.pdf (accessed on 26 February 2021).

FIGURE 3-16 **Percentage of hospitals serving poor people at risk from natural, biological and other health hazards under the worst-case (RCP 8.5) climate change scenario**



Electricity infrastructure

Extreme temperature and changes in precipitation can reduce the capacity of transmission lines, transformers and substations, as well as water volumes for hydropower.[116] The links between energy consumption and socioeconomic disadvantage, are generally underappreciated,[117] but shutoffs and power outages can clearly have a number of direct health impacts, in the most severe cases, leading to either hypothermia or heat stress. Interruptions in electricity and hot water services will worsen the situation for those with chronic health conditions, such as cardiovascular, respiratory, and renal diseases. Such patients are often forced to seek outside medical care during power cuts, resulting in increasing rates of hospitalization.[118]

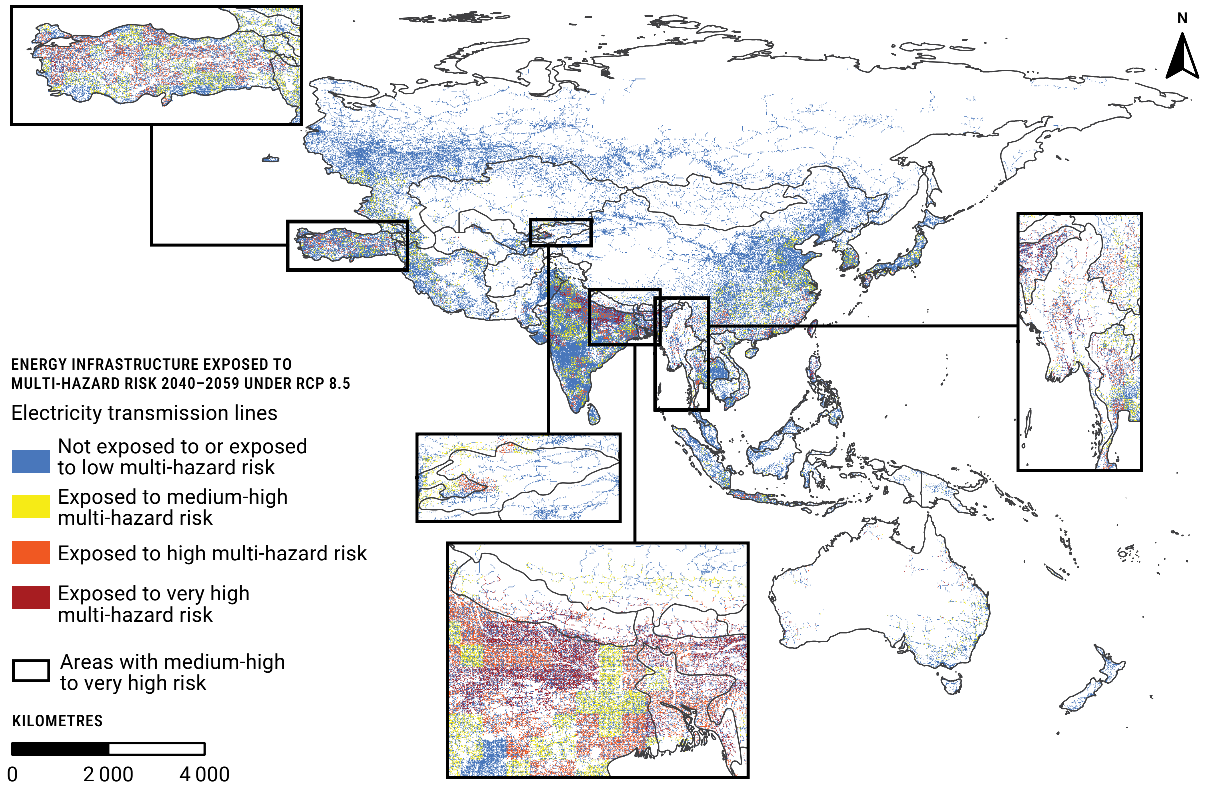
ESCAP has analysed the risk to electricity infrastructure in Asia and the Pacific using World Bank data on transmission and distribution lines. Overlaying the multi-hazard climate change risk on these data, enables identification of the most vulnerable areas. These include the GBM basin and parts of South-East Asia, Pakistan, Islamic Republic of Iran, Turkey, Kyrgyzstan and Kazakhstan (Figure 3-17). In Nepal, for example, almost 93 per cent of the electricity grid and 98 per cent of hydropower capacity are exposed to multiple risks, which threaten to have with dire implications for healthcare facilities and the communities that rely on them (Figure 3-18).

116 D. Stoms, "Energy Infrastructure Risks from Climate Change", California Energy Commission, Energy Research and Development Division", 6 May 2014. Available at https://www.epa.gov/sites/production/files/2016-02/documents/stoms-infrastructure-risks-presentation-2014-wkshp.pdf (accessed on 26 February 2021).

117 Sonal Jessel, Samantha Sawyer and Diana Hernández, "Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature", *Frontiers in Public Health*, vol. 7 (12 December 2019). Available at https://doi.org/10.3389/fpubh.2019.00357.

118 Chaamala Klinger, Owen Landeg andVirginia Murray, "Power Outages, Extreme Events and Health: A Systematic Review of the Literature from 2011–2012", *PloS Currents*, vol. 6 (2 January 2014). Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3879211/

FIGURE 3-17 **Electricity infrastructure exposed to multi-hazards under the worst-case (RCP 8.5) climate change scenario**



Sources: ESCAP calculations, based Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; and Global Electricity Transmission And Distribution Lines, 2020.

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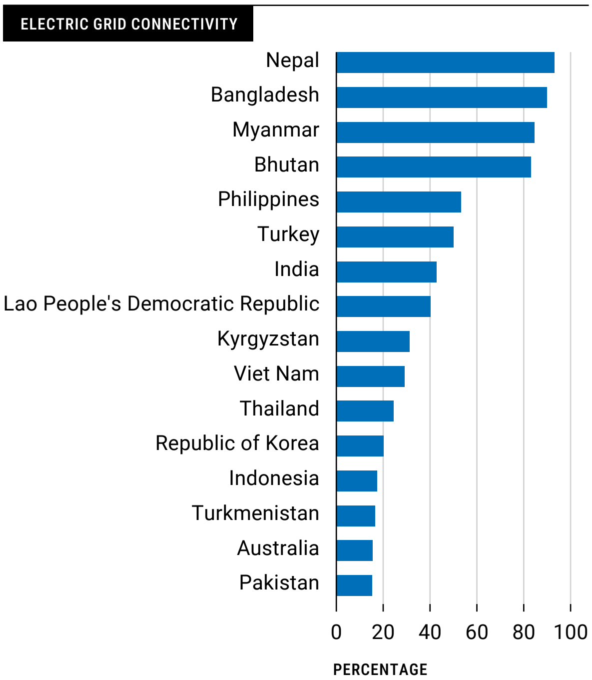
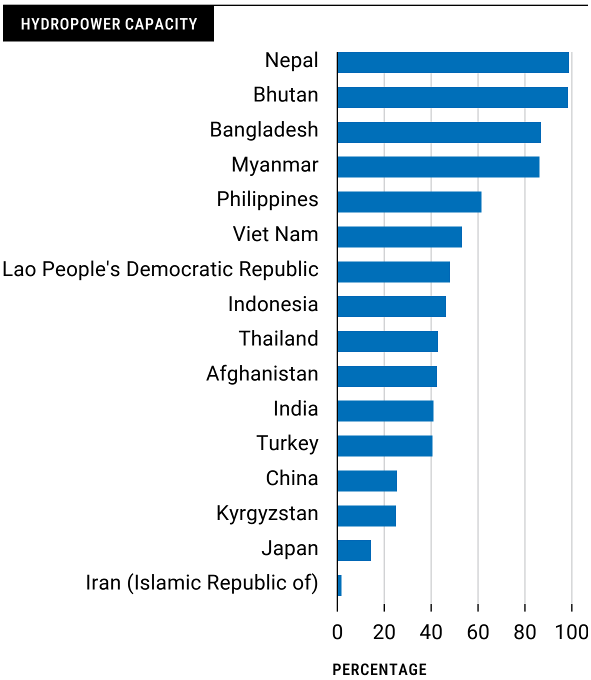
FIGURE 3-18 **Proportion of electrical grid and hydropower capacity at risk from multi-hazards under the worst-case (RCP 8.5) climate change scenario**





BOX 3-3

Sand and dust storms and human health

Mineral dust suspended in the atmosphere is associated with morbidity and mortality.[a] It can affect human health because of its physical, chemical and biological properties. Exposure to mineral dust can result in conjunctivitis and dermatological problems, while inhalation can cause respiratory illnesses, such as silicosis (otherwise known as desert lung syndrome). It can also act as a trigger for many other conditions like asthma, bronchitis, emphysema and chronic obstructive pulmonary disease.

The forthcoming report, *Sand and Dust Storms Risk Assessment in Asia and the Pacific*, being published by the Asia and the Pacific Centre for the Development of Disaster Information Management, has developed hazard maps for the risks to the human health sector from sand and dust storms. It is based on inhalation as the primary exposure pathway, generated according to WHO's Air Quality Guideline, 2005.[b]

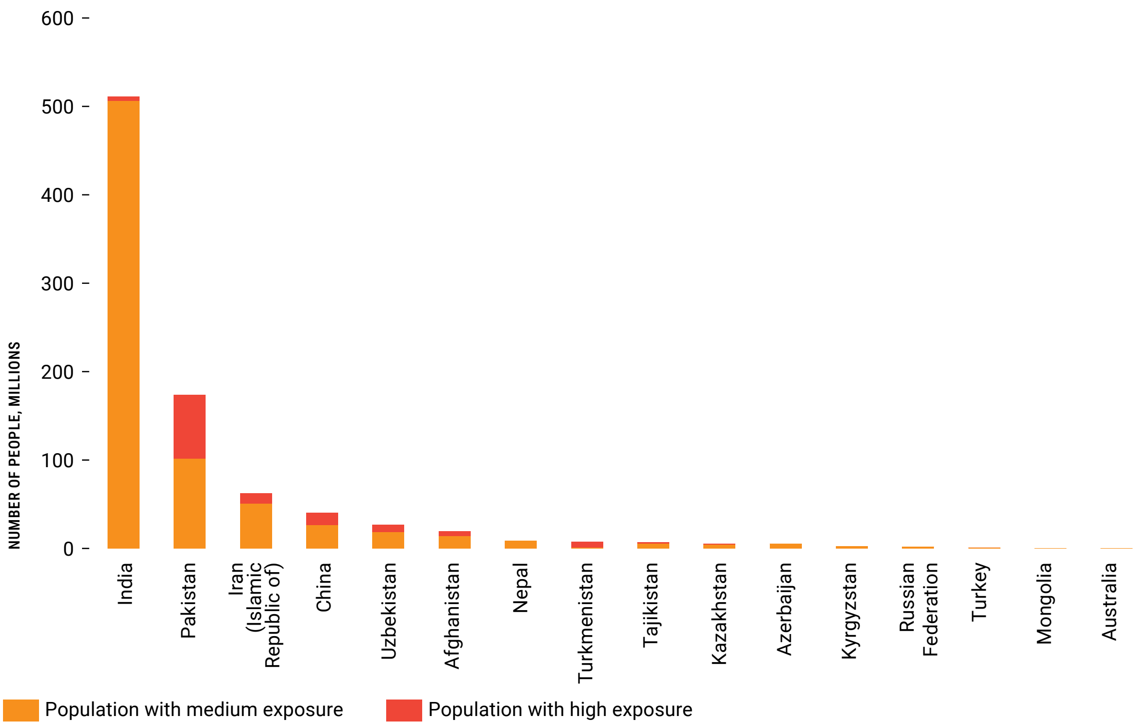
In the health sector, the sensitivity of the population to mineral dust depends on various factors including age, and pre-existing health conditions. In the report, sensitivity is assessed based on two factors: population under 14 years of age and above 65 years, and on the sub-national Human Development Index (SHDI). Resilience is assessed using the per capita rate of public and private expenditure on healthcare.

For health sector, the hazard map measures the number of days in which the average atmospheric dust concentration exceeds the WHO guideline of 50 μg/m^3 for PM10. High atmospheric concentrations of dust are prevalent in three areas: Kazakhstan, Uzbekistan and Turkmenistan in Central Asia; northern China; and in a range of countries in South-West Asia from the southern coastal parts of the Islamic Republic of Iran through southern Afghanistan and southern Pakistan into North-Western India.

Box continues on next page…

FIGURE

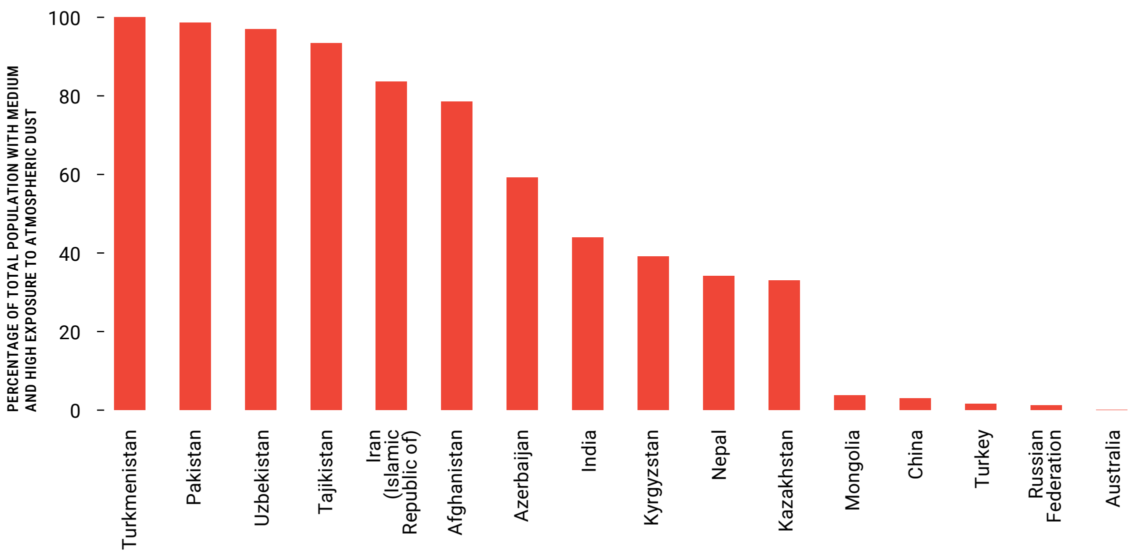
Number of people exposed to atmospheric dust



The figure above shows that in absolute terms, India has by far the largest population exposed to medium and high levels of poor air quality due to sand and dust storms (511 million people), followed by Pakistan (173 million people), the Islamic Republic of Iran (62 million people) and China (40 million people).

However, the perspective changes when the number of people are studied in proportional terms. The figure below indicates that Turkmenistan, Pakistan, Uzbekistan and Tajikistan have the highest proportions of their total populations, above 90 per cent, exposed to atmospheric dust. The Islamic Republic of Iran and Afghanistan both have about 80 per cent of their populations exposed to poor air quality due to sand and dust storms.

FIGURE **Population with medium and high exposure to atmospheric dust as a percentage of total population in Asia-Pacific countries**



Source: United Nations Economic and Social Commission for Asia and the Pacific and Asia Pacific Disaster Information Management Centre, "Sand and Dust Storms Risk Assessment in Asia and the Pacific" (forthcoming).

The findings of the report show that policy measures designed to mitigate sand and dust storm hazards for disaster risk reduction can be divided logically into those that aim to prevent wind erosion occurring in source areas, and those designed to manage the adverse impacts of small particles in the atmosphere and on its deposition. Effective control of sand and dust storm hazards should adopt an integrated multi-scale and multi-functional approach. This should comprise both technical solutions and behavioural approaches, based on the local context. A range of monitoring, forecasting, and early warning measures can also be implemented to mitigate the numerous effects of mineral dust.[d]

a United Nations Economic and Social Commission for Asia and the Pacific and Asia Pacific Disaster Information Management Centre, "Sand and Dust Storms Risk Assessment in Asia and the Pacific", (forthcoming).

b World Health Organization, "WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfer dioxide", Global Update 2005 (Geneva, 2006). Available at http://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf;jsessionid=2ED5379E9DEE48BAE0CBB8EE1E1E1729?sequence=1. 18.

c Medium exposure is defined as the number of days where dust concentration near the ground is higher than 50 µg/m3 and lasting between 81–238 days, and high exposure is defined as the number of days where the dust concentration is higher than 50 µg/m3 lasting being between 238–365 days.

d United Nations Economic and Social Commission for Asia and the Pacific and Asia Pacific Disaster Information Management Centre, "Sand and Dust Storms Risk Assessment in Asia and the Pacific" (forthcoming).

Out of the silos

The COVID-19 pandemic has been a stark reminder of the links and intersections between health and other natural hazards. Governments have, however, still generally treated various types of emergencies separately, often through different departments, each operating in its own 'silo', which has resulted in gaps in preparedness.

The Sendai Framework of Disaster Risk Reduction envisages, instead, a paradigm shift from managing disasters to managing risk, and thus broadens the scope to take account both natural and man-made hazards along with the related environmental, technological and biological hazards and risks.[119] During the General Assembly of the United Nations, held in September 2020, it was recommended that Member States apply the Sendai Framework to ensure a prevention-oriented and risk-informed approach to COVID-19 response and socioeconomic recovery. In this regard, the following chapter discusses how countries in Asia and the Pacific can respond by suggesting four priority areas for action.

119 Natalie Wright and others, "Health Emergency and Disaster Risk Management: Five Years into Implementation of the Sendai Framework", International Journal of Disaster Risk Science, vol. 11 (2020). Pp. 206–217. Available at https://doi.org/10.1007/s13753-020-00274-x.

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United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP) (2018). Asia-Pacific Energy Portal. Available at: https://asiapacificenergy.org/. Accessed in September 2018.

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CHAPTER 4

The scaled-up contours of a regional resilience response

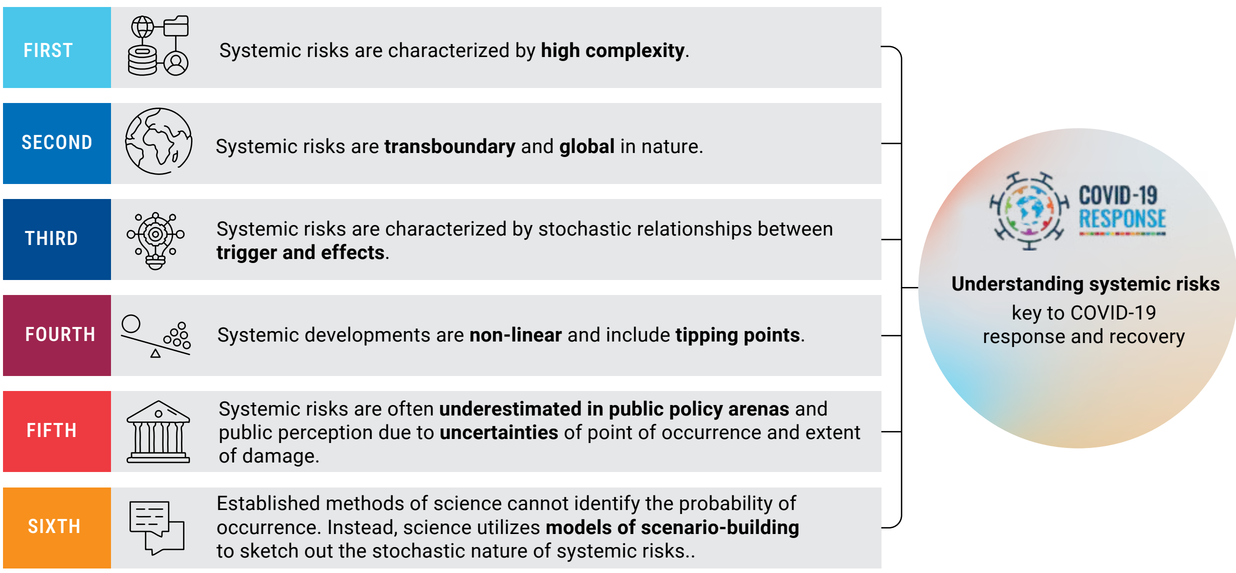
The COVID-19 pandemic has served as a wake-up call, a stark reminder that humanity will always remain vulnerable to powerful natural forces. How should countries in Asia and the Pacific respond? This report suggests four national priority action areas; envisage risk scenarios, investment in health and social protection, capitalize on frontier technologies, and target fiscal spending. It also highlights the importance of regional and subregional coordination and action.

Traditionally, risk is envisaged as the adverse effects resulting from the interaction between hazards, whether natural or caused by humans, with vulnerability, exposure, and adaptive capacity being included in risk assessments. But such traditional risk analyses do not take into account how, in our increasingly complex and fragile planet, all these hazards and impacts interconnect and overlap, with multiple cascading effects that spread across social, economic, and environmental domains, with potentially catastrophic outcomes.[120]

Indeed, most aspects of human societies can now better be considered in terms of systems. As the *Global Assessment Report on Disaster Risk Reduction*, 2019, notes, "In today's globalized economic system, networks of communication and trade have generated highly interdependent social, technical and biological systems." [121]

The COVID-19 pandemic is a dramatic example of a systemic risk, a hazard whose impacts have reverberated around the world bringing other systems close to collapse, with most of them being far removed from the biohazard origin.[122] Climate change too represents a huge risk to many systems, since it can cause extreme weather events and variations in climate that can trigger food and water shortages, forced migration, epidemics, and loss of biodiversity, all of which can even cascade into armed conflict. Characterized by deep uncertainties, systemic risks are both complex and heterogeneous and very unpredictable. They can be considered to have six unique characteristics (Figure 4-1).

FIGURE 4-1 **Six characteristics of systemic risk**



Source: Adapted from Ortwin Renn and others, "Systemic risks from different perspectives", *Risk Analysis*, vol. 0, No. 0, (2020). Available at https://onlinelibrary.wiley.com/doi/epdf/10.1111/risa.13657

120 *Global Assessment Report on Disaster Risk Reduction 2019* (United Nations publication, 2019). Available at https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019#:~:text=The%202019%20Global%20Assessment%20Report,the%20global%20disaster%20risk%20landscape.

121 Ibid.

122 The Global Assessment Report 2019 defines a 'systemic risk' as a risk that is endogenous to, or embedded in, a system that is not itself considered to be a risk and is therefore not generally tracked or managed, but which is understood through system analysis to have a latent or cumulative risk potential to negatively impact overall system performance when some characteristics of the system change.

Preparing for pandemics

The first global agreement of its kind to include biological hazards and the need to prepare for pandemics is the Sendai Framework for Disaster Risk Reduction (Box 4-1). Nevertheless, most countries failed to include pandemic response and preparedness in their legal, regulatory and policy frameworks.[123] As a result, the response to the pandemic has been erratic, ad hoc and inadequate.[124]

The World Health Organization had already advised governments to prepare health national adaptation plans (HNAPs) to inform their national adaptation plans and programmes of action. Although progress in this direction has been mixed, nevertheless, 43 countries in the region have climate strategies that include the health sector. Figure 4-2 presents an overview of current national strategies that include health. Only three countries have a formal HNAP; Bangladesh, Nepal and Sri Lanka, and an HNAP is drafted and awaiting finalization in an additional four: Bhutan, India, Indonesia and Thailand. These plans will be submitted as part of the formal national adaptation plans (NAPs) under the Paris Agreement. In addition, 13 Pacific countries, 5 South-East Asian countries, and the Maldives have developed national strategies to address health and climate change. For most Pacific countries, these have been systematically drafted and follow the same structure, and are called the national climate change and health action plans (NCCHAPs). Additionally, 24 countries have submitted nationally determined contributions (NDCs) and intended nationally determined contributions (INDCs) that include health sector adaptation, 16 countries have submitted National Adaptation Plans (NAPs)/ National Adaptation Programmes of Action (NAPAs) which include health strategies, and 4 countries have submitted national communications to the United Nations Framework Convention on Climate Change (UNFCCC) that include health adaptation measures.

National adaption strategies have identified nine principal areas for health-care adaptation: malnutrition and food security; disease surveillance and control; health services and assessment; awareness-raising and behaviour change; health infrastructure resilience; governance and coordination; research and knowledge; capacity of health-care sector workers; and environmental impacts on health. These should ensure that the health sector is not only well integrated into climate adaptation, but also safeguards the lives, health and well-being of the people most impacted by natural hazards.

For their health sectors, 34 countries, across the region, have identified disease surveillance and control as a priority, while 26 countries have emphasized research and knowledge, 23 countries have highlighted awareness-raising and behaviour change, 18 countries have noted governance and coordination, 14 countries have identified health infrastructure resilience, and 12 countries have emphasized nutrition and food security as priorities. No country in the region identifies all components as priority areas, but 22 countries do note at least five of them as priorities.

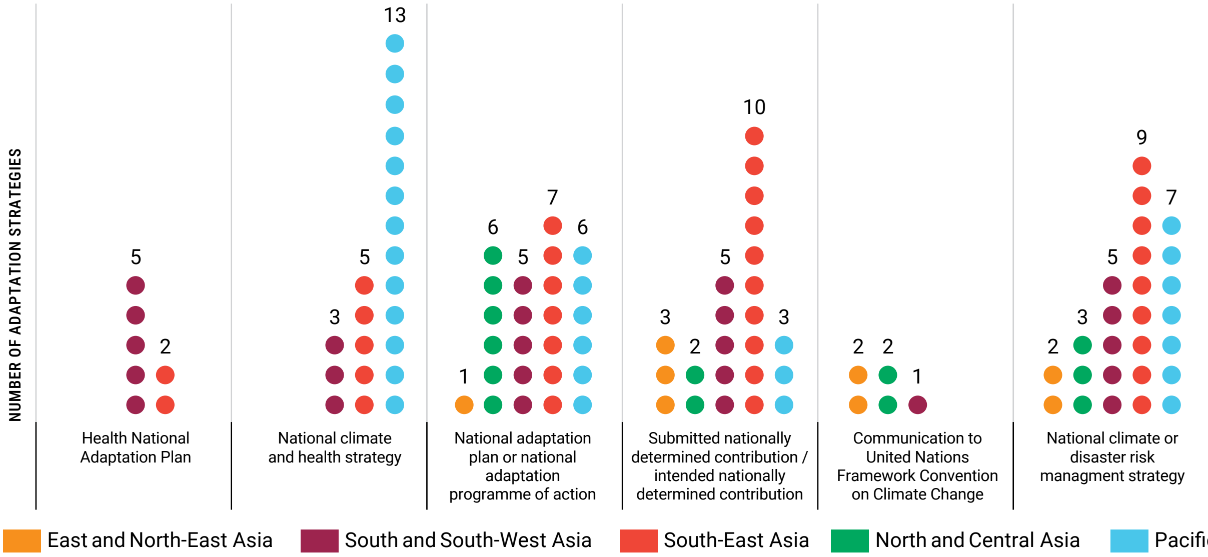
In this respect, the countries performing best in their adaptation plans and strategies are those in the Pacific, where every country covers at least five health priorities. Countries in South-East Asia, and in South and South-West Asia also have disease surveillance and control as their highest priority; since, under both climate change scenarios, their people are at serious risk from natural and biological hazards.

123 *Official Records of the General Assembly, Seventy-fifth Session* (A/75/226).

124 *Review of COVID-19 Disaster Risk Governance in Asia-Pacific: Towards MultiHazard and Multi-Sectoral Disaster Risk Reduction* (United Nations publication, 2020). Available at https://www.undrr.org/publication/review-covid-19-disaster-risk-governance-asia-pacific-towards-multi-hazard-and-multi.

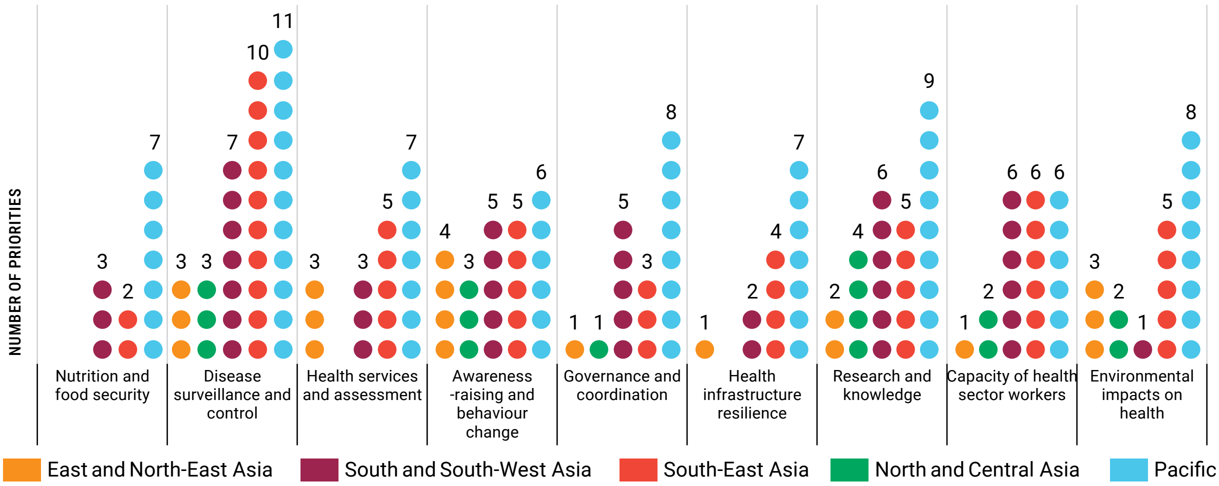
The COVID-19 stimulus efforts offered a golden opportunity to simultaneously address disaster, climate and health and the underlying risk drivers. ESCAP has analysed these measures and found some emphasis on green priorities, 111 'sweet-spot' measures that addressed both economic recovery and environmental protection. These measures covered such issues as energy, surface transport, air travel and tourism, land-use, water and waste, and disaster risk management (DRM). However, these measures were not generally part of coherent national plans for building back better. More than half were unplanned, and they were outnumbered by those that purely focused on the economy.[125] In many countries, the financial commitment for the health sector has been less than 10 per cent of the total stimulus spending. In addition, there have been no specific forward-looking allocations for climate adaptation or environmental protection.[126]

FIGURE 4-2 National adaptation strategies that include the health sector, by subregion



Source: ESCAP analysis of national adaptation strategies.
Note: Includes strategies that are under development.
Note: HNAP = health national adaptation plans; NAP = National Adaptation Plans; NAPA = National Adaptation Programmes of Action; NDC = nationally determined contributions; INDC = intended nationally determined contributions;

FIGURE 4-3 Priorities for the health sector identified by countries in national adaptation strategies, by subregion



Source: ESCAP analysis of national adaptation strategies.
Note: The number of countries with available information is 5 for East and North-East Asia, 4 for North and Central Asia, 8 for South and South-West Asia, 11 for South-East Asia and 12 for the Pacific.

125 United Nations Economic and Social Commission of Asia and the Pacific (ESCAP), *Are countries in the Asia Pacific region initiating a 'green recovery'? What more can be done?* Policy Brief, December 2020a. Available at https://www.unescap.org/sites/default/d8files/knowledge-products/UNESCAP%20Green%20Recovery%20Policy%20Brief.pdf

126 United Nations Economic and Social Commission of Asia and the Pacific (ESCAP), *Policy responses to COVID-19: Combating COVID-19 in Asia and the Pacific: Measures, lessons and the way forward*, Policy Brief, 15 May 2020b. Available at https://www.unescap.org/resources/policy-responses-covid-19-combating-covid-19-asia-and-pacific-measures-lessons-and-way (accessed on 26 March 2021).

BOX 4-1 **The Sendai Framework and the Bangkok Principles**

Over recent decades, the world has gained a better understanding of disaster risk. A major impetus in 2005 was the *Hyogo Framework for Action (2005–2015): Building the Resilience of Nations and Communities to Disasters*, which introduced a model for understanding risk in terms of hazard, vulnerability and exposure.

This was succeeded, in 2015, by the *Sendai Framework for Disaster Risk Reduction 2015–2030*, which, rather than managing disasters, put more emphasis on managing risk, and underlined the importance of involving many stakeholders at local, national, regional and global levels.[a] It also broadened the scope of disaster risk reduction to focus on both natural and man-made hazards and the related environmental, technological and biological hazards and risks.[b] The Sendai Framework points out that the nature and scale of risk has changed to such a degree that it cannot be addressed by established risk management institutions and approaches. For addressing the root causes of the risks, it presents a systems approach from global, to national, to local scale.

In 2016, implementation of the Sendai Framework was reinforced by the 'Bangkok Principles', which emerged from the International Conference on the Implementation of the Health Aspects of the Sendai Framework for Disaster Risk Reduction 2015–2030.[c] The Bangkok Principles recommend the measures to prevent, and/or reduce the risk of, health emergencies, such as pandemics. The seven recommendations cover:

1. *Integration* – Promote systematic integration of health into national and sub-national disaster risk reduction policies and plans, and include emergency and disaster risk management programmes in national and sub-national health strategies.
2. *Cooperation* – Enhance cooperation between health authorities and other relevant stakeholders to strengthen country capacity for disaster risk management for health, implement the International Health Regulations (2005), and build resilient health systems.
3. *Investment* – Stimulate people-centred public and private investment in emergency and disaster risk reduction, including in health facilities and infrastructure.
4. *Training* – Integrate disaster risk reduction into health education and training, and strengthen capacity building of health workers in disaster risk reduction.
5. *Data* – Incorporate disaster-related mortality, morbidity and disability data into multi-hazard early warning systems, health indicators and national risk assessments
6. *Collaboration* – Advocate for, and support, cross-sectoral, transboundary collaboration including information sharing, and science and technology for all hazards, including biological hazards.
7. *Policies* – Promote coherence and further development of local and national policies and strategies, legal frameworks, regulations, and institutional arrangements.

The principles point out that health emergencies have many commonalities with other natural disasters, since they need to be addressed with assessments, surveillance and early warning systems, resilient infrastructure, and coordinated incident management that extends across national borders. The Bangkok Principles emphasize the need for coordination, calling for an interoperable, multi-sectoral approach to promote systematic cooperation that integrates health with other disaster risk management approaches.[d]

a United Nations, *Sendai Framework for Disaster Risk Reduction*, 2015. Available at https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

b Marc Gordon and Scott Williams, "Shifting the Paradigm: Introducing Global Risk Assessment Framework (GRAF)", United Nations Office for Disaster Risk Reduction, 17 April 2020. Available at https://www.preventionweb.net/news/view/71352

c United Nations Office for Disaster Risk Reduction, World Health Organization and Royal Thai Government, The International Conference on the Implementation of the Health Aspects of the Sendai Framework for Disaster Risk Reduction 2015–2030, Bangkok, Thailand, 10–11 March 2016. Available at https://www.unisdr.org/conferences/2016/health

d Ibid.

National policy actions to address the new riskscape

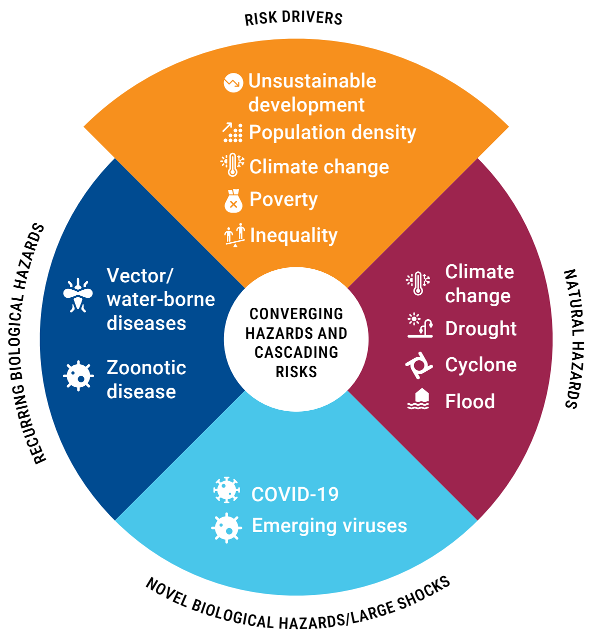
Faced with ongoing biological and other natural hazards, and the increasing impacts of climate change, how can governments in the region best respond? This report suggests four priorities for action: envisage risk scenarios; invest in health and social protection; apply emerging technologies; and target additional fiscal spending.

1. Envisage risk scenarios

Disaster risk management and early warning systems need to capture systemic risks. Given the correlations and dependencies of multiple risks and actors, the best approach is to envisage a series of scenarios, each with different interlinkages and relationships (Figure 4-4). Planners can develop composite risk matrices to identify and stratify vulnerable populations, and their varying needs and capacities, so as to arrive at comprehensive risk assessments and take targeted actions.

In 2020, ESCAP developed a prototype of composite matrices that placed districts or areas into appropriate risk zones, incorporating risks from endemic, natural, and biological hazards. The methodology, piloted for Bangladesh and India, integrated short-term, medium-term, and long-term risk data from diverse sources and highlighted the states that were most exposed to cascading disasters, including monsoon floods that occurred amid COVID-19, along with the endemic risk drivers of poverty, inequality, and population density.

FIGURE 4-4 **Planning scenarios for the intersection of converging hazards and cascading risks**



Source: United Nations, Economic and Social Commission of Asia and the Pacific, "Weaving a stronger fabric: Managing cascading risks for climate resilience", Policy Brief, 26 January 2021b. Available at https://www.unescap.org/kp/2021/weaving-stronger-fabric-managing-cascading-risks-climate-resilience

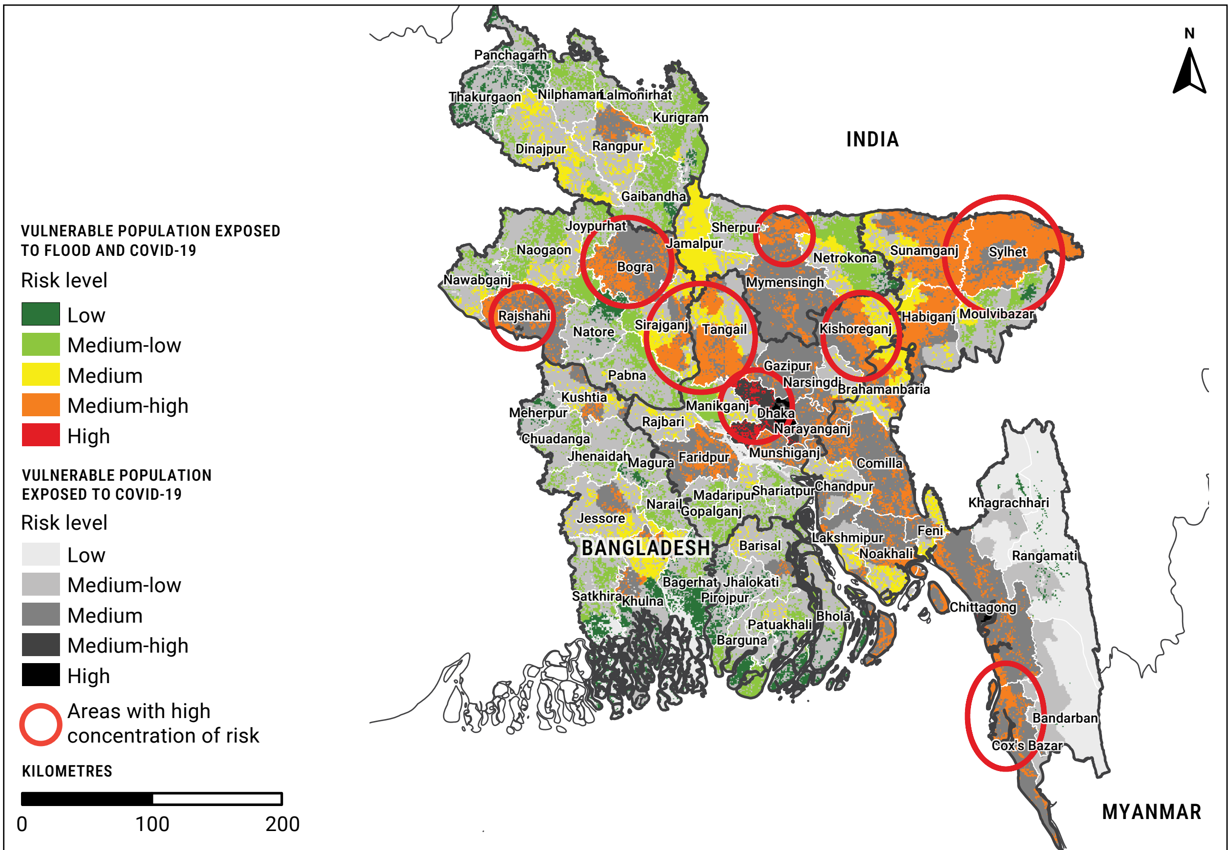
BOX 4-2 **Building back better after the Indian Ocean tsunami**

The 2004 Indian Ocean tsunami transformed disaster management worldwide by introducing the paradigm: *Build back better*. This had three key lessons:

1. *Prepare better for future crises* – In this case, for example, through early warnings of tsunamis. It is estimated that over the next 100 years the Indian Ocean Tsunami Warning system will, on average, help save 1,000 lives per year.[a]
2. *Build dedicated institutions* – These include national disaster management authorities, ministries, and an exclusive department for disaster-related governance.
3. *Empower communities* – Communities should be at the centre of the recovery and reconstruction and be in a strong position to respond to disasters themselves.

a *Asia-Pacific Disaster Report 2015: Disasters Without Borders*, (United Nations publication, 2015). Available at https://www.unescap.org/publications/asia-pacific-disaster-report-2015-disasters-without-borders

FIGURE 4-5 **Vulnerable populations in Bangladesh**



Sources: ESCAP calculations based on UN WPP-Adjusted Population density 2020, v4.11; Sub-National Human Development Index (SHDI) 2018; Institute of Epidemiology, Disease Control and Research COVID-19 Cases, 9 August 2020; and UNOSAT-UNITAR analysis on NOAA-20 (VIIRS) Imagery, 20 June - 19 July 2020.
Map source:Coastline data from UNmap, 2020.
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 matrix for Bangladesh, for example, showed that, in 2020, 15 districts with a population of almost 12 million were at the highest risk from cascading disasters (Figure 4-5). The 12 million people who faced the highest risk were served by around 610 hospitals, almost 40 per cent of which were exposed to heavy floods in 2020. The matrix further predicted that immediate intervention would be needed for refugee settlements in Cox's Bazaar. Subsequently, the Government responded to these pressures and relocated many refugee camp families to a permanent settlement and, in partnership with local and international organizations, took the necessary precautions and ensured surveillance that helped contain the spread of the virus within the camps.

2. Capitalize on frontier technologies

In their race to control the COVID-19 epidemic and protect their people, countries have increasingly invested in 'frontier technologies', taking advantage of scientific advances and adapting innovation to local exigencies. The effectiveness has differed according to the spread of the infection and the timing, as the virus has typically been transmitted in waves, or centred around specific location clusters. Nevertheless, during the early stages of the pandemic, countries with past experience of the severe acute respiratory syndrome (SARS) appeared to be better prepared, basing their responses on surveillance, testing, contact tracing, and strict quarantine.

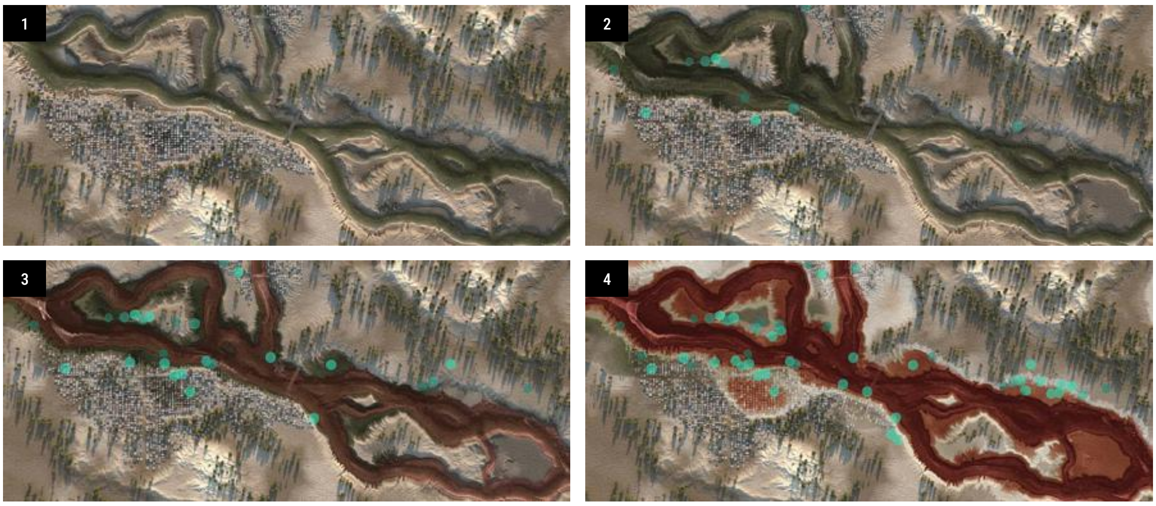
Throughout the course of the pandemic, artificial intelligence and the manipulation of big data have enabled better understanding of the transmission mechanisms. Advanced modelling techniques have been used for early detection, rapid diagnostics, and the prevention of virus spread, as well as for managing critical supplies and delivering equipment. While such technologies have been used effectively in Australia, China, New Zealand, the Republic of Korea, and Singapore, other less technologically advanced, middle-income countries have also been able to effectively use such technologies.

BOX 4-3 AI-based next generation flood forecasting

Building on the work on flood forecasting in previous years, Google extended, just in time for the 2020 monsoon season, its AI-based next generation flood forecasting work in India and Bangladesh. Using Google AI technology to optimize the targeting of every alert the two Governments send out, it is estimated that over 200 million people across more than 250,000 square kilometres will have benefitted from the early warning system. The new forecasting model allows to double the lead time of many of the alerts in the past by providing more notice to governments and giving tens of millions of people an extra day or so to prepare. It also provides people with information about flood depth; when and how much the flood waters are likely to rise. The information is provided through mobile phones in different formats, so that people can both read their alerts and see them presented visually and in their local languages.

An AI-enabled new approach for inundation modelling, called a *morphological inundation model*, which combines physics-based modelling with machine learning (ML) has been introduced to create more accurate and scalable inundation models in real-world settings. Additionally, a new *alert-targeting model* allows identifying areas at risk of flooding at unprecedented scale using end-to-end machine learning models and data that is publicly available globally. The next generation of flood forecasting systems, called Hydronet, presents a new architecture specially built for hydrologic modelling across multiple basins, while still optimizing for accuracy at each location. This is an important technological breakthrough that will enhance predictive capacity and overall outreach of flood forecasting.

FIGURE A Inundation modelling estimates what areas will be flooded and how deep the water will be



Source: Sella Nevo, "The technology behind our recent improvements in flood forecasting", Google AI Blog, 3 September 2020. Available at https://ai.googleblog.com/2020/09/the-technology-behind-our-recent.html.

New technologies need to be combined with social organization and mobilization, that is, promoting social distancing and hygiene combined with efficient test-isolate-treat regimes. In 2021, these techniques were difficult to apply in densely populated urban slums of many countries in the region. Nevertheless, frontier technologies were able to support official actions and local community surveillance by offering 'ears to the ground', for example, checking for unintended consequences of official action and taking corrective steps. The value of community action empowered by new technologies was also demonstrated in the early stages of the pandemic in Asia's largest slum, Dharavi in Mumbai. The Dharavi model takes a "chasing the virus" approach, through micro-mapping, robust surveillance, public-private partnerships, community engagement, and proactive leadership, that are key components of effective disaster management. The model was successful during the first wave of the virus in 2020.

In the complex risk environments during the pandemic, social media has helped improve communication between health experts, governments, and at-risk communities. In Indonesia, for example, particularly in rural and sub-urban areas, religious leaders have used social media to raise awareness about the risks of COVID-19 among their followers. Social media also helped authorities transmit real-time and actionable information. At the global level, this is available through the WHO's Situation Dashboard whose Arc Geographic Information System (ArcGIS) platform has provided the latest location-specific updates on the outbreak, including the numbers of infected people and deaths. The dashboard has also been adopted and modified at the country level in combination with relevant surveillance management systems.

Government agencies, across Asia and the Pacific, have also increasingly invested in the collection of big data and the production of integrated risk mapping of multiple hazards. This has proven to be effective in previous complex and dynamic disasters. With some adaptation, governments were then able to highlight the incidence of COVID-19 and predict the spread of the virus, thereby revealing the connections between cases and clusters of infections and identifying 'super-spreaders' or super-spreading events. With continued investments in these techniques, the ability of officials to make critical, risk-informed interventions, by imposing lockdowns in hotspots, for example, and insulating other provinces and cities from the spread of the virus, will increase in accuracy and timeliness. The resulting cluster-containment response strategies have proven effective in restricting the spread of COVID-19, especially within vulnerable communities.

3. Invest in health and social protection

Governments will want to select their own priorities for investing in health adaptation. In Asia and the Pacific, these include nutrition and food security, health infrastructure resilience, and governance and coordination. But, governments across the region will need to focus more on the health sector. India, for example, has announced a National Digital Health Mission (NDHM) as part of AatmaNirbhar Bharat Abhiyaan: A Campaign for Self-Reliant India. The NDHM aims to provide universal health cover, including digital services, to all citizens. This will involve gathering health-related data while ensuring confidentiality (Figure 4-6).[127] This system assigns a unique ID to each person and holds the individual's electronic medical records. It also holds registers of health facilities and doctors.[128] The pandemic has thus clearly demonstrated the value of digital health systems, though their legal and privacy issues need to be carefully addressed.

FIGURE 4-6 India's Digital Health Framework

1	Promoting medical research along with health data analytics.
2	Promoting the adoption of open standards by all the actors in national digital health ecosystem, for developing several digital health systems that span across the sector from wellness to disease management.
3	Creating and managing digital health data and the relevant infrastructure required.
4	Creating a system of individual patient digital health records which can be easily accessed by health professionals through patient consent.
5	Promoting and making use of the already existing health information systems.

Source: Adapted from Government of India, *National Digital Health Blueprint, Ministry of Health and Family Welfare*, 15 July 2019. Available at https://www.nhp.gov.in/NHPfiles/National_Digital_Health_Blueprint_Report_comments_invited.pdf

127 Government of India, *National Digital Health Blueprint, Ministry of Health and Family Welfare*, 15 July 2019. Available at https://www.nhp.gov.in/NHPfiles/National_Digital_Health_Blueprint_Report_comments_invited.pdf

128 Make in India, "National Digital Health Mission". Available at https://www.makeinindia.com/national-digital-health-mission.

The shock of the pandemic has also highlighted the importance of social protection that encompasses disaster preparedness. Over the years, governments have tried to ensure that social protection is more shock-responsive. But the scale of the economic impact of the pandemic, has brought to the fore the need for social protection that is not just shock-responsive but shock-prepared.

The measures needed to offer social protection that is shock-prepared include: (1) Using emerging technologies to support resilience, and ensuring that routine social protection programming is based on a solid understanding of the risks, shocks and stressors, including cascading hazards; (2) Preparing to scale up existing programmes or activating new emergency programmes to accommodate populations and needs; and (3) Aligning existing social protection programmes with scalable measures for disaster preparedness.

Such measures require a comprehensive portfolio of investments by promoting a culture of prevention that builds inclusiveness and resilience. The aim of building on existing achievements, should be on universal social protection throughout people's life cycles. Equally important are risk-informed investments in health and education infrastructure and service delivery.

For example, India's pioneering biometric ID system, Aadhaar, was used to digitally transfer $1.5 billion into the bank accounts of 30 million people, including many migrant workers who were forced to return to their villages when the country entered a sudden lockdown.[129] However, this does require the system to have been largely set up before the crisis. In this case, since 1 billion accounts were linked to people's Aadhaar identity numbers, the Government was able to transfer funds to those in need with remarkable efficiency. An Aadhaar-based biometric fingerprint is also mandatory for the drive to rapidly vaccinate India's 1.3 billion people.

During a pandemic, digital transfers have the further advantage of limiting personal contact and crowding while people collect their payments. Countries, such as India and Thailand, that have national IDs of citizens linked to their bank accounts, can implement government-to-person (G2P) rapid disbursements while observing social distancing.

4. Target additional fiscal spending

Government will need to boost resilience through targeted more forward-looking fiscal spending. How much will this cost? Prior to the pandemic there were a number of estimates of the costs of building greater resilience to climate change. However, the costs of protection from biological hazards must also be added to these cost estimates. Table 4-1 presents an overview of the earlier studies.

Previous studies have also explored how climate adaptation costs break down across different sectors. One clear finding from these studies is the importance of infrastructure spending. As indicated in Figure 4-7, studies by the UNFCCC and the IPCC report, *Economics of Adaptation to Climate Change*, both find that a high proportion of the costs of adaptation are for infrastructure, followed by measures in coastal zones, water supply and flood protection.

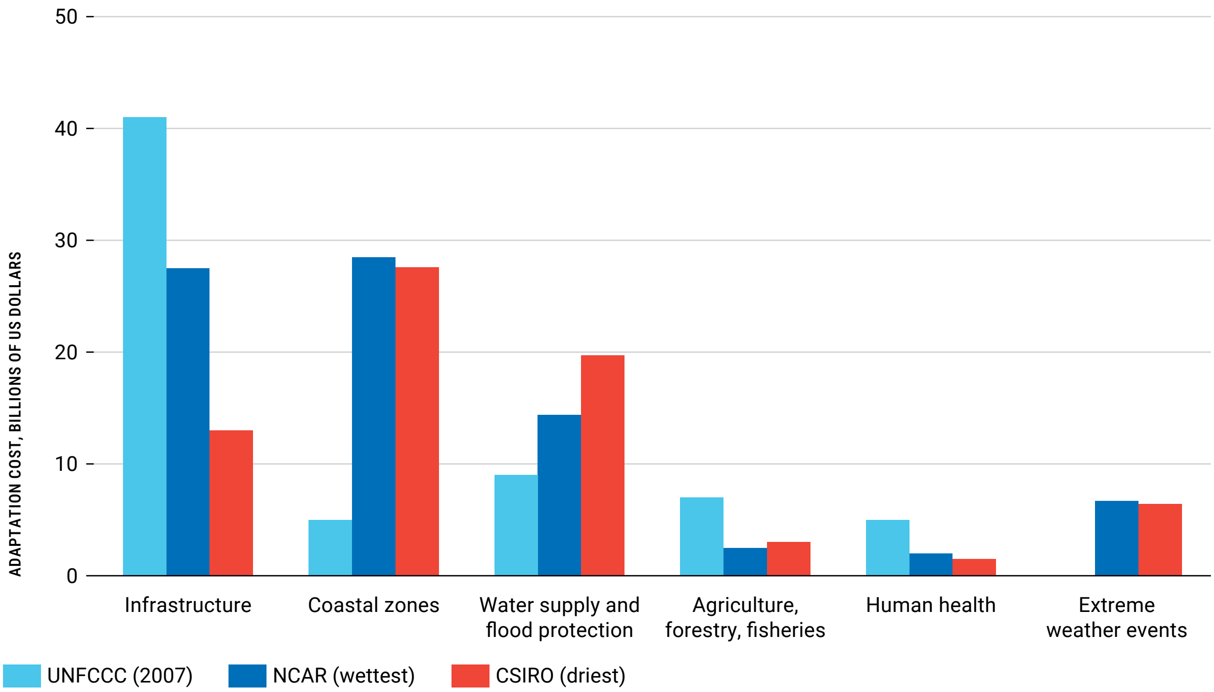
Investing in infrastructure resilience is particularly important in Asia and the Pacific, where critical infrastructure is often located in multi-hazard hotspots. 28 per cent of energy power plants, 34 per cent of ICT fibre-optic cables, 42 per cent of road infrastructure, 32 per cent of airports and 13 per cent of ports are located in multi-hazard hotspots.

129 "Covid-19 spurs national plans to give citizens digital identities", *The Economist* (7 December 2020). Available at https://www.economist.com/international/2020/12/07/covid-19-spurs-national-plans-to-give-citizens-digital-identities.

TABLE 4-1 Cost estimates for climate adaptation, infrastructure resilience and sustainable development

Study	Cost estimate	Scale
World Bank, Economics of Adaptation to Climate Change (2010)[130]	$70 - $100 billion a year for climate change adaptation	Global
World Bank, Economics of Adaptation to Climate Change (2010)	$17.9 - $25.7 billion	East Asia and the Pacific
Global Centre on Adaptation, State and Trends in Adaptation Report (2020)[131]	$300 billion a year by 2030 for climate change adaptation	Global
UNEP, Adaptation Finance Gap Report (2016)[132]	$280 - $500 billion a year by 2050 for climate change adaptation	Global, developing countries only
UNFCCC, Investment and Financial Flows to Address Climate Change (2007)[133]	$28 - $67 billion per year, up to 2030, for climate change adaptation	Global
Asian Development Bank, Meeting Asia's Infrastructure Needs (2017)[134]	$240 billion per year from 2016–2030 for climate-proofing infrastructure	45 developing member countries of ADB
ESCAP, Economic and Social Survey of Asia and the Pacific (2019)[135]	$182 billion per year up to 2030, for climate proofing infrastructure to meet the SDGs	Asia-Pacific region

FIGURE 4-7 Adaptation cost estimates by United Nations Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change



Source: Adapted from Intergovernmental Panel on Climate Change, *AR5 Synthesis Report: Climate Change 2014* (Geneva, 2014).
Note: This figure compares the results from three models taken from UNFCCC and the IPCC report, *Economics of Adaptation to Climate Change*. From the IPCC report, NCAR and CSIRO are two models that present costs under a wetter or drier climate change scenario. CSIRO refers to the Commonwealth Scientific and Industrial Research Organization model; NCAR is the National Centre for Atmospheric Research model.

130 World Bank, *Economics of Adaptation to Climate Change: Synthesis Report* (Washington, D.C., World Bank, 2010).
131 Global Center on Adaptation, *State and Trends in Adaptation Report 2020*, vol. 1 (2020).
132 United Nations Environment Programme (UNEP), *Adaptation Finance Gap Report 2016* (Cophenhagen, 11 May 2016)
133 United Nations Framework Convention on Climate Change (UNFCCC), *Investment and Financial flows to Address Climate Change* (October 2007).
134 Asian Development Bank, *Meeting Asia's Infrastructure Needs* (Manila, February 2017).
135 *Economic and Social Survey of Asia and the Pacific 2019: Ambitions beyond Growth* (United Nations publication, 2019).

All studies emphasize the importance of infrastructure, but they vary significantly in indicating the total amount of investment required for strengthening resilience. Furthermore, none of these estimates have factored in the costs of addressing biological hazards. Based on methodologies in earlier studies, ESCAP has therefore used the calculations of the Average Annual Losses (AAL) for natural and biological hazards (Chapter 1), to estimate the full cost of adaptation under climate scenario RCP 8.5, for each country in Asia and the Pacific. Following a World Bank study, the cost of climate proofing, for example, is taken to be 20 per cent of the financial exposure to climate-related hazards.[136] The Pacific small island developing States are an exception where the exposure is taken to be 40 per cent, given the higher infrastructure losses during disasters.[137] Similarly, following a UNFCCC study, the health-related costs of adaptation are equivalent to one-third of health-related losses.[138] For financial exposure and total losses, the proxy used is the average annual loss.

On this basis, Table 4-2 presents the annual cost of adaptation for natural and other biological hazards under RCP 8.5. Even when biological hazards are added, the cost of adaptation under the most severe climate change scenario for the Asia-Pacific region is only one-fifth of the annualized losses from natural hazards for the region. The total cost is $270 billion, of which $68 billion is required for adapting to biological hazards. This is equivalent to 0.85 per cent of regional GDP for the total adaptation cost, and 0.22 per cent of GDP for the biological hazard adaption cost. Around 70 per cent of these costs are in East and North-East Asia at $190 billion. There are also clear differences between the costs of dealing with biological hazards and climate-related hazards. The greatest biological costs are in China.

TABLE 4-2 **Annual adaptation cost under RCP 8.5 by subregion, billions of US dollars**

Subregion	Climate-related hazard AAL (flood, tropical cyclone, drought)	Adaptation cost for climate-related hazards	Biological hazard AAL	Adaptation cost for biological hazards	Total climate adaptation cost
East and North-East Asia	640	130	180	61	190
North and Central Asia	9.2	1.8	0.66	0.22	2.1
South and South-West Asia	230	47	13	4.4	51
South-East Asia	102	20	5.9	2.0	22
Pacific	21	4.5	2.2	0.74	5.2
Total	1 000	200	200	68	270

These costs need to be considered alongside the capacities to pay. Figure 4-8 shows that the costs of adapting to climate change as a percentage of GDP varies from almost 1.4 per cent for the Pacific SIDS, to less than 1.0 per cent for South-East Asia, North and Central Asia, and the entire Pacific subregion. It also shows the variations investment in adaptation for biological hazards as a proportion of GDP. This additional new adaptation cost will be highest in East and North-East Asia, whereas in the Pacific SIDS the majority of investment should still go toward adapting to climate-related hazards.

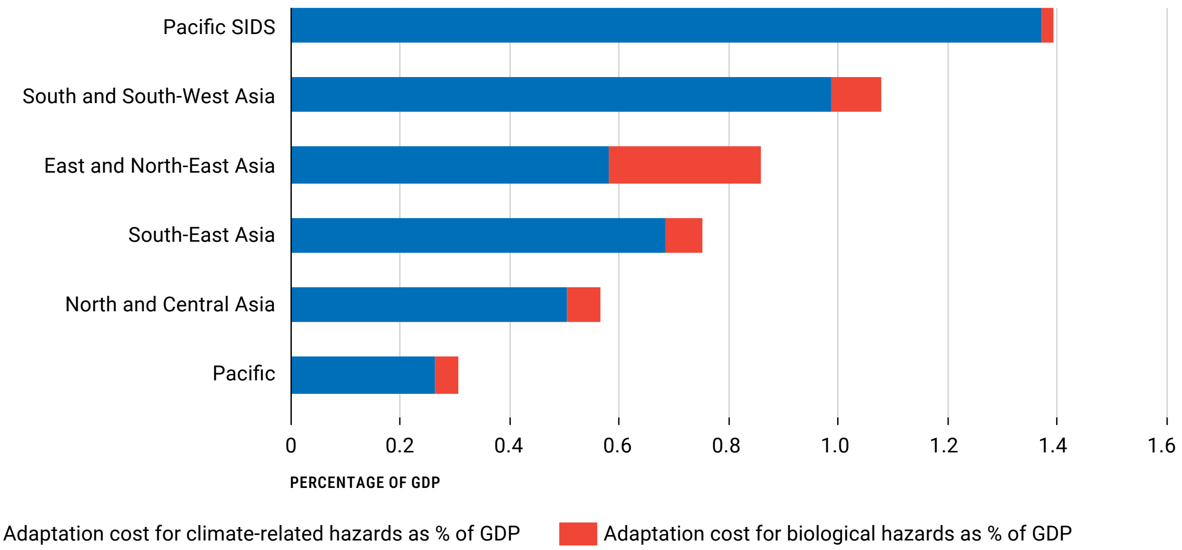
136 World Bank, *An Investment Framework for Clean Energy and Development* (Washington, D.C., World Bank, 2006).

137 *Economic and Social Survey of Asia and the Pacific 2019: Ambitions beyond Growth* (United Nations publication, 2019).

138 Brian Lipinski and Heather McGray, "Summary of studies estimating the cost of climate change adaptation in the developing world", World Resources Institute (WRI), January 2010. Available at https://pdf.wri.org/cost_of_adaptation_in_the_developing_world.pdf

Figure 4-8 and Figure 4-9 show how the results break down for individual Pacific SIDS, and for the least developed countries (LDCs), where economic assets are very exposed to natural hazards. Vanuatu has the region's highest cost at more than 8 per cent of GDP. But the costs are also high in Tonga, Micronesia and Palau. For each of these countries, the highest costs are for adapting to climate-related hazards. Of the LDCs, Vanuatu stands out as having the highest cost, but all except Timor-Leste have an adaptation cost that exceeds 1 per cent of GDP.

FIGURE 4-8 Subregional adaptation costs for climate-related hazards and biological hazards, percentage of GDP



Source: ESCAP calculations based on the Asia-Pacific SDG Gateway. Available at https://data.unescap.org/home.
Note: Pacific SIDS = Pacific small island developing States.

Given these new adaptation cost estimates, governments need to revise their own calculations and correspondingly modify their nationally determined contributions (NDCs) and intended national determined contributions (INDCs). Table 4-3 compares new estimates with the submitted NDCs and INDCs, which include cost estimates for climate change adaptation, for the 11 Asia-Pacific countries. The data indicates that Bangladesh, Cambodia, the Lao People's Democratic Republic, Solomon Islands and Vanuatu would all need to increase their estimates. The analysis is limited, but does suggest that a number of governments will need to increase their fiscal spending.

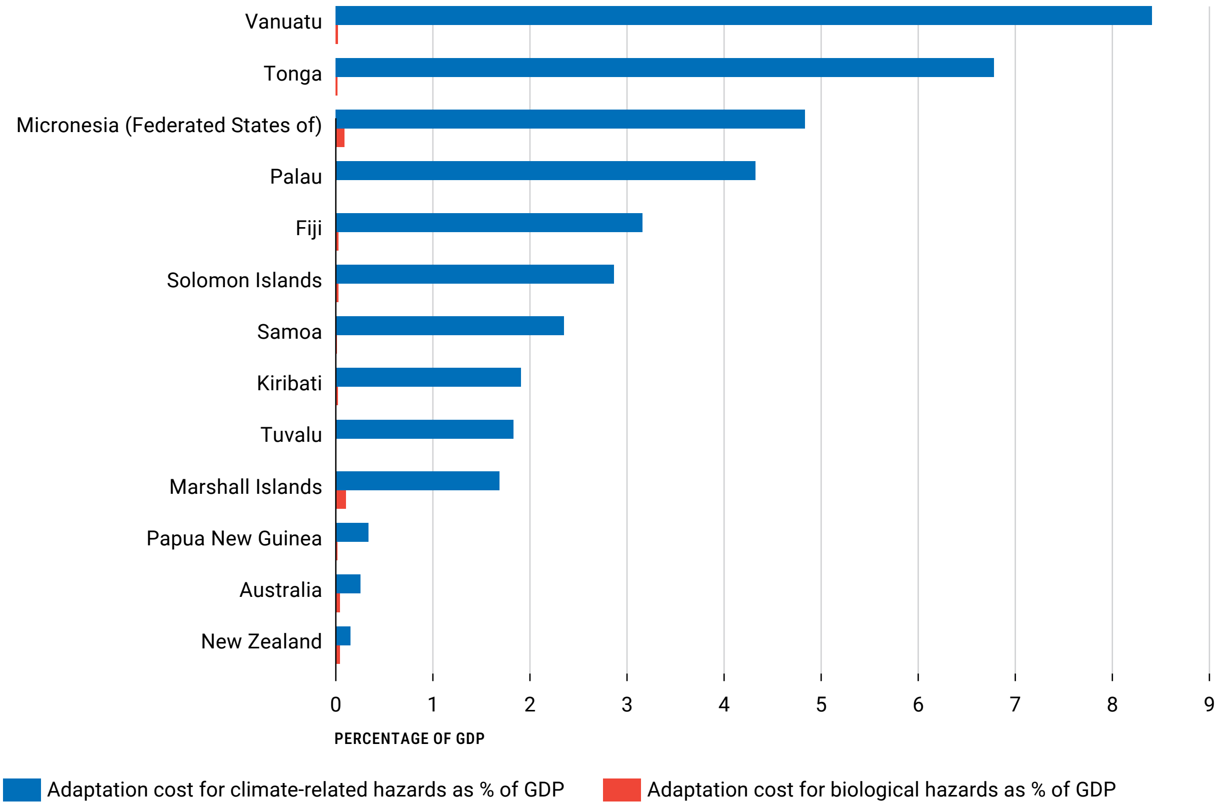
BOX 4-4 The Pacific Disaster Risk Financing and Insurance Program

To build financial resilience to disasters in Pacific island States, the Pacific Disaster Risk Financing and Insurance Program implements market-based, sovereign, catastrophe risk insurance solutions. These instruments cover liquidity during tropical cyclones, earthquakes and tsunamis. In addition, the Program provides technical assistance on public finance management of natural disasters, especially on post-disaster budget mobilization and execution.

This is a joint initiative of the World Bank Group, and the Secretariat of the Pacific Community with funding support from the Government of Japan. A milestone achievement by the Program was the catastrophe risk insurance received by Tonga following tropical Cyclone Ian in January 2014. Within two weeks of the event, Tonga received $1.27 million from the insurance policy. The amount was equivalent to nearly half of the Tonga National Reserve Funds, providing substantial support for disaster recovery.[a]

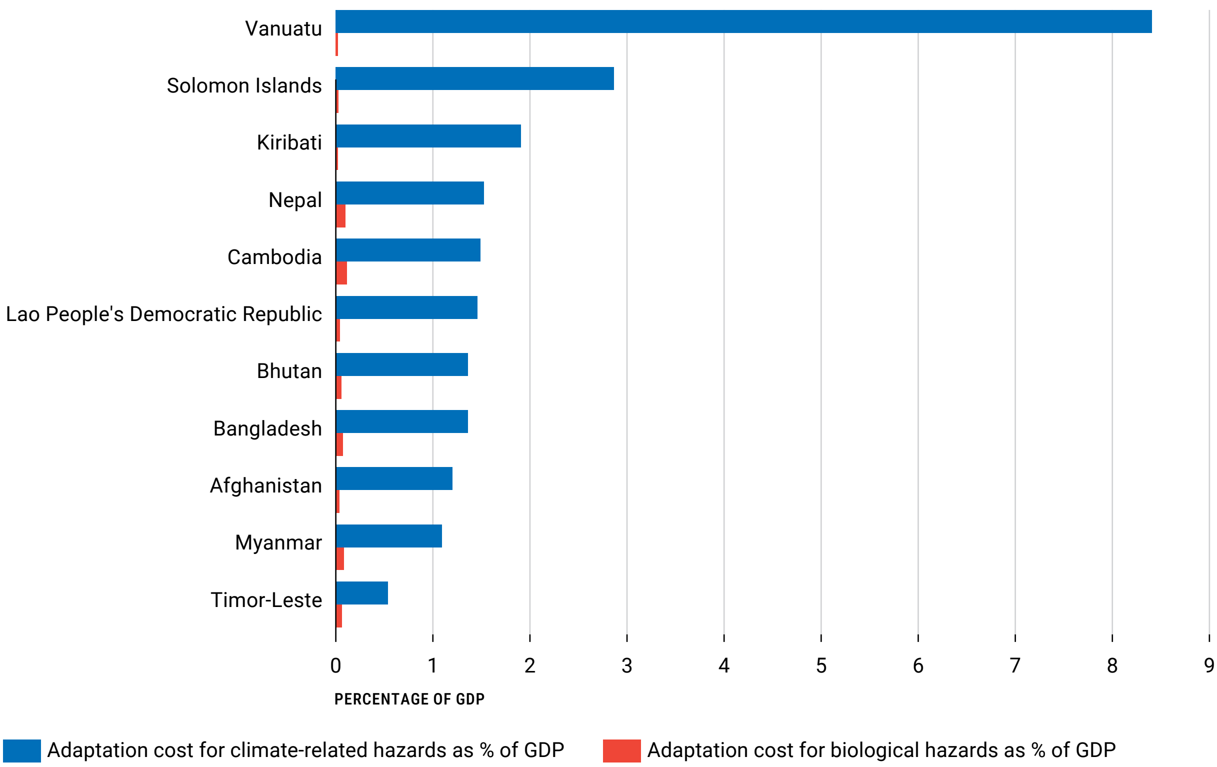
a World Bank Group and others, Pacific Catastrophe Risk Financing and Insurance Program. Available at https://www.gfdrr.org/sites/default/files/publication/PCRAFI_Program%20Pager_FINAL%20VERSION.pdf

FIGURE 4-9 **Adaptation costs under RCP 8.5 for countries in the Pacific, as a percentage of GDP**



Source: ESCAP calculations based on the Asia-Pacific SDG Gateway. Available at https://data.unescap.org/home.

FIGURE 4-10 **Adaptation costs under RCP 8.5 for the Least Developed Countries, percentage of GDP**



Source: ESCAP calculations based on the Asia-Pacific SDG Gateway. Available at https://data.unescap.org/home.

TABLE 4-3 **Estimated adaption costs compared with intended national determined contributions (INDCs)**

Country	Adaptation cost per year in INDCs, billions of US dollars	Adaptation cost per year in ESCAP analysis, billions of US dollars
Afghanistan	1.08	0.25
Bangladesh	2.67	3.86
Cambodia	0.20	0.40
Georgia	0.20	0.11
Kiribati	0.01	0.00
Kyrgyzstan	0.13	0.07
Lao People's Democratic Republic	0.19	0.27
Mongolia	0.52	0.10
Solomon Islands	0.01	0.04
Turkmenistan	0.70	0.08
Vanuatu	0.01	0.07

Source: ESCAP calculations based on World Bank INDC portal data.
Note: The higher cost estimates for each country are shown in grey.

Governments should pay particular attention to the health sector. Numerous measures indicate that there is a significant investment gap in this sector, even without taking into account the impacts of climate change and biological hazards. For example, ESCAP calculated, in 2019, that an additional investment of $158 billion per year over the period 2016–2030,[139] will be required to achieve universal health coverage (a target of SDG 3) across 19 Asia-Pacific countries. Once the need to climate-proof this investment is added, the investment gap will increase even further. As indicated earlier in this chapter, the total costs for adapting to biological hazards, under an RCP 8.5 climate scenario, were estimated to be $68 billion a year for the region.

To increase adaptation spending, governments will need to diversify their sources of finance. In addition to those used for normal public spending, these can include new climate finance instruments, such as climate resilience bonds, debt-for-resilience swaps, and debt relief initiatives. Governments can also share the costs with the private sector through public-private partnerships, and here innovative instruments of parametric insurance have gained some traction.

The financial sector can support such investment with risk-sharing instruments, like parametric insurance, which are issued rapidly and automatically once a pre-defined physical or meteorological parameter is reached.[140] Examples of parametric insurance are in Box 4-4 for Pacific small island developing States and Box 4-6 for the Philippines.

In addition, private- and public-sector investors must take into account disaster and climate risks as contingent liabilities in their balance sheets and financial planning on an annualized basis.[141] This need was highlighted at the International Workshop on Disaster Resilient Infrastructure 2019, organized in New Delhi by the India National Disaster Management Authority.[142]

139 *Economic and Social Survey of Asia and the Pacific 2019: Ambitions beyond Growth* (United Nations publication, 2019).

140 Marsh and McLennan Companies, *Global Risks for Infrastructure: The Climate Challenge*, 2020. Available at https://www.mmc.com/content/dam/mmc-web/insights/publications/2020/august/Global-Risks-for-Infrastructure_The-Climate-Challenge_Final.pdf

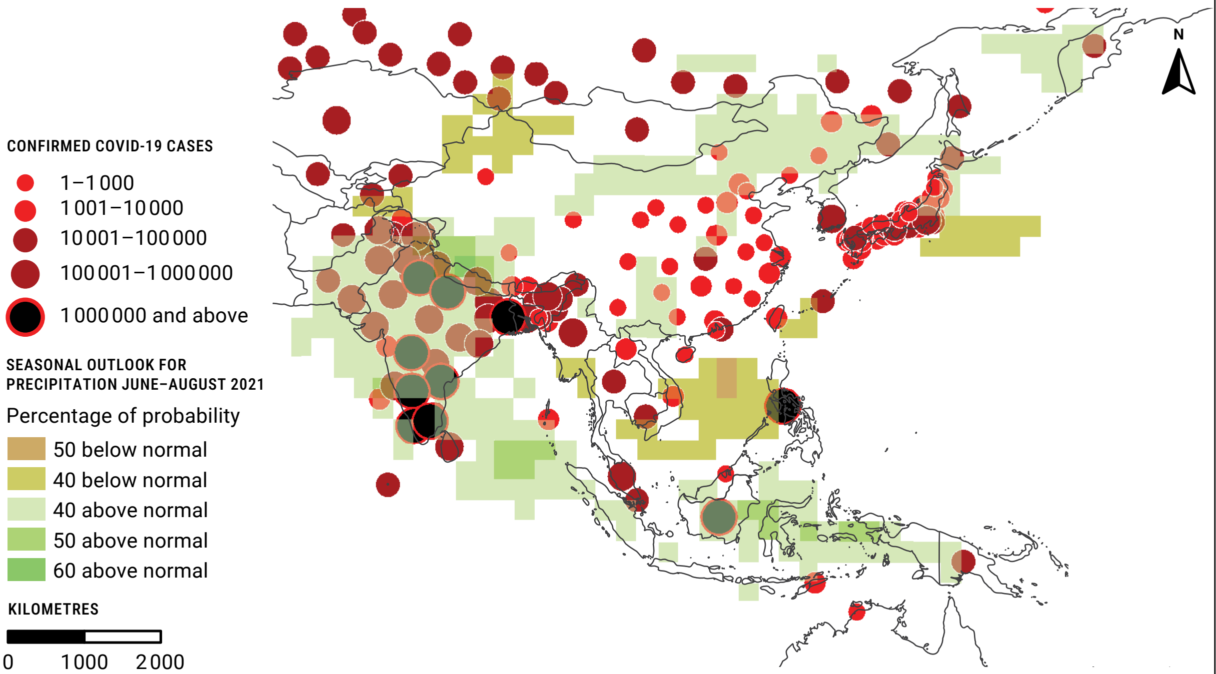
141 Coalition for Disaster Resilient Infrastructure, "Second International Workshop on Disaster Resilient Infrastructure", Workshop Summary, New Delhi, 19–20 March 2019. Available at https://cdri.world/node/155

142 The workshop was organized by National Disaster Management Authority of India in collaboration with the United Nations Office for Disaster Risk Reduction (UNDRR), in partnership with the Global Commission on Adaptation, The World Bank and United Nations Development Programme (UNDP).

BOX 4-5 **Forecasting cascading risk scenarios at different time scales**

The Asia-Pacific Disaster Resilience Network's (APDRN) predictive analytics solution, for example, captures cascading risk scenarios at the regional level as well as zooms in on South Asia where the intersection of the COVID-19 pandemic and extreme weather events is likely to intensify in the coming months. The solution is derived from integration of the WMO seasonal outlook for June, July and August 2021, issued in April with the COVID-19 cases on the ground (Figure A). During this period, above-normal precipitation is expected in Pakistan, India, Nepal, and in the north-eastern parts of China near the border with the Russian Federation.

FIGURE A **Convergence of precipitation anomaly with COVID-19 in Asia for June–August 2021**

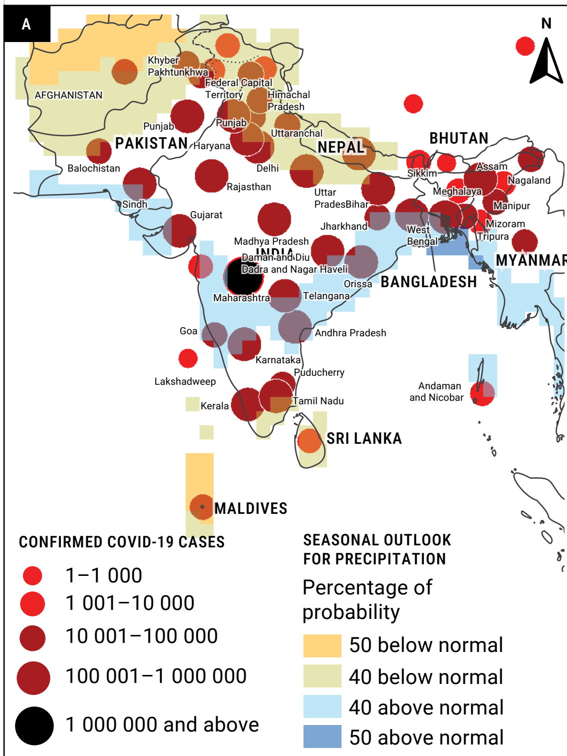


Sources: ESCAP, based on Johns Hopkins University Coronavirus COVID-19 Cases V2, 12 May 2021 and WMO Asia Pacific Seasonal Outlook Precipitation Data for June to August 2021.Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Further, in South Asia in mid-2020 when COVID-19 was spreading rapidly, the most immediate concern was the June–September monsoon. The APDRN indicated the hotspots for floods and droughts. Climate-related disasters have different risk pathways than COVID-19 but can intersect and converge with the pandemic in complex and destructive ways. Many communities are exposed to both, with extensive long-term consequences, in particular, causing damage to people's health and livelihoods and limiting their prospects of escaping poverty.[a]

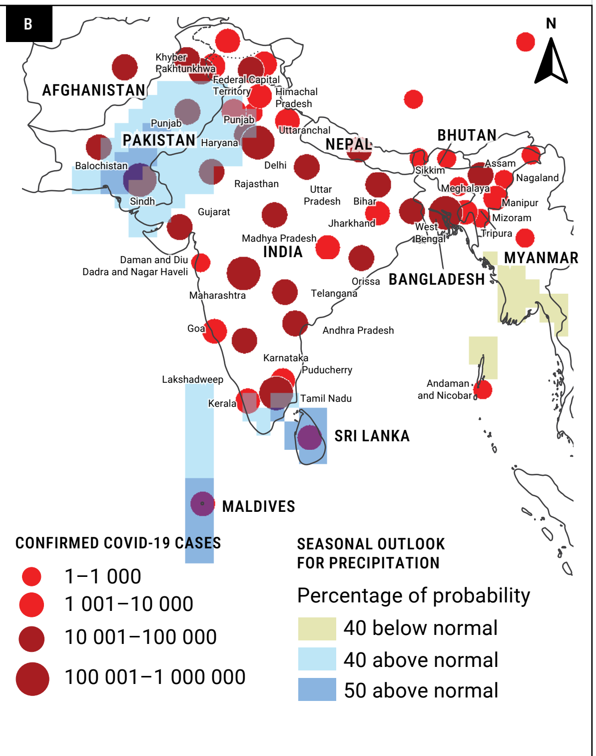
Several flood-prone areas of the subregion were expected to receive above-normal precipitation (north-western and southern parts of the subregion during the summer monsoon season of 2020, northern Bay of Bengal last winter, and upstream of the Ganges River Basin, in Nepal, from June to September this year). Some of these areas coincide with where the COVID-19 pandemic has rapidly increased, and thus potential convergence of water-related hazards with the pandemic were identified. The analysis of possible convergence of hazards provides advance information for all stakeholders to be better prepared. *Box continues on next page…*

FIGURE B **Convergence of precipitation anomaly with COVID in South Asia for (a) June-September 2020, (c) October–December 2020, and (d) June–September 2021**



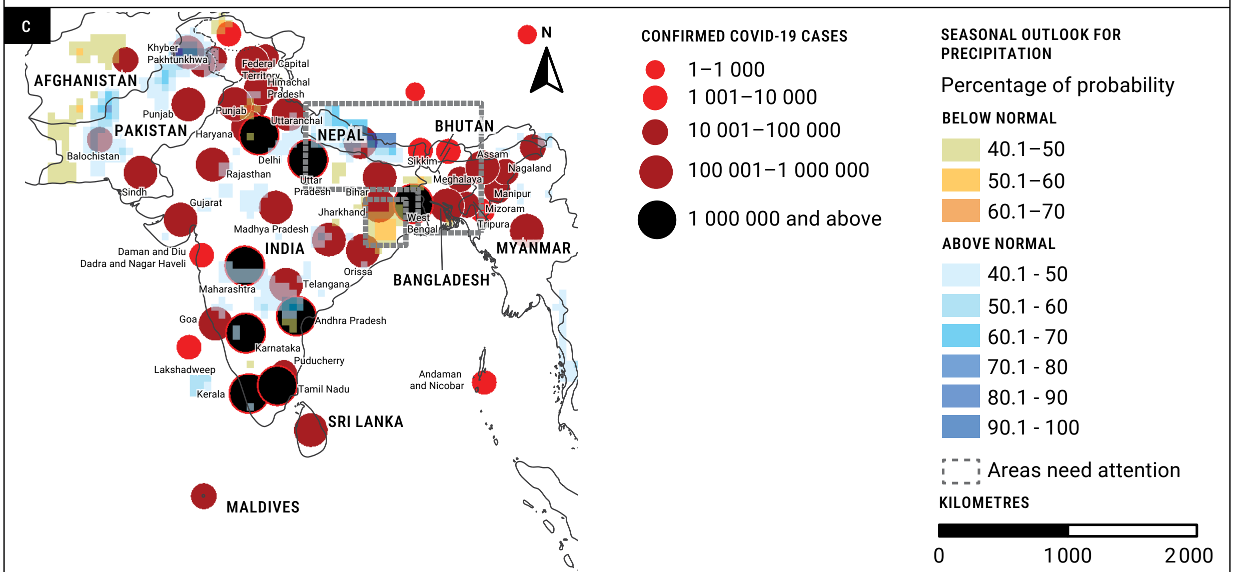
Sources: ESCAP, based on ESRI and John Hopkins University Coronavirus COVID-19 Cases V2, 19 October 2020 and SASCOF Seasonal Outlook Precipitation Data for October, November and December 2020.

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



Sources: ESCAP, based on ESRI and John Hopkins University Coronavirus COVID-19 Cases V2, 14 July 2020 and SASCOF Seasonal Outlook Precipitation Data for June, July, August and September 2020.

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



Sources: ESCAP, based on SASCOF Seasonal Outlook Precipitation Data for June to September 2021; ESRI and John Hopkins University Coronavirus COVID-19 Cases V2, 12 May 2021.

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

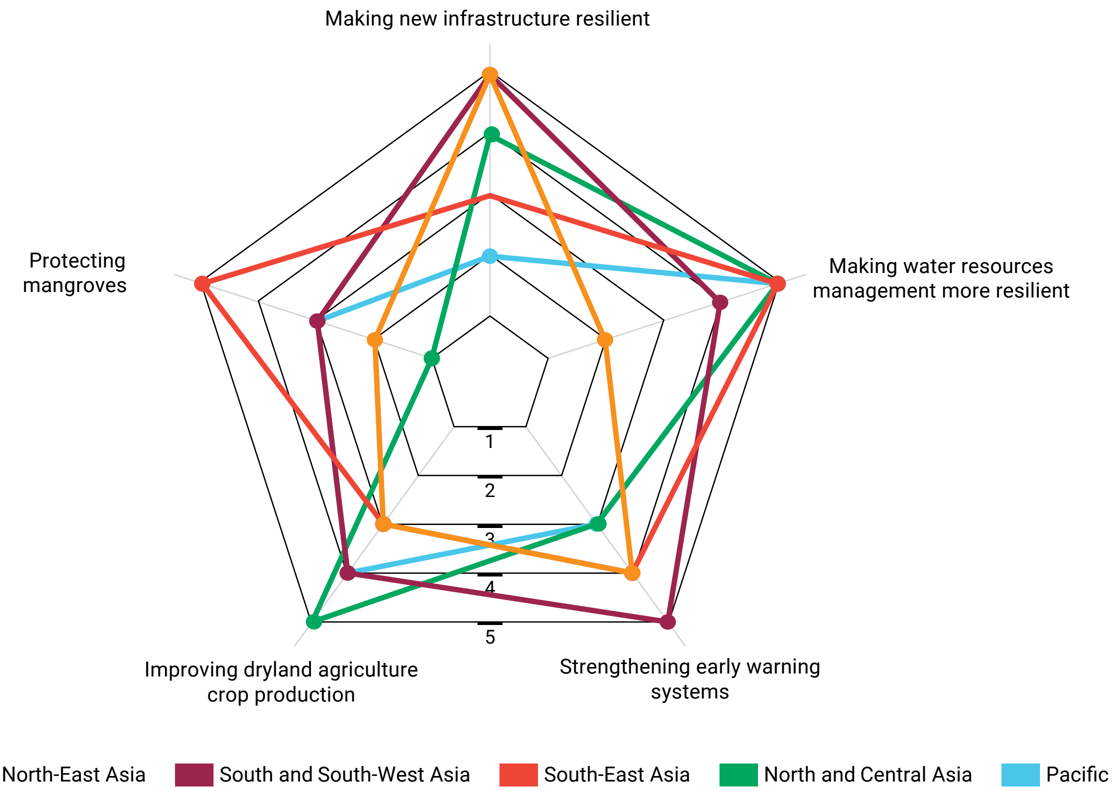
a United Nations, Economic and Social Commission of Asia and the Pacific, "Weaving a stronger fabric: Managing cascading risks for climate resilience", Policy Brief, 26 January 2021b. Available at https://www.unescap.org/kp/2021/weaving-stronger-fabric-managing-cascading-risks-climate-resilience

Scaling up subregional cooperation

To support the above mentioned four national policy actions, there are also opportunities to facilitate and reinforce these efforts at the subregional and regional levels. For example, policy coherence, integrated multi-hazard early warning systems, climate adaptation and resilience and investing in health infrastructure form the key components of climate disaster and health resilience. Given the diversity and specific risk profiles, each subregion will have its own adaptation priorities, as illustrated in Figure 4-10 based on categories established by the Global Commission on Adaptation: early-warning systems; climate-resilient infrastructure; improved dryland agriculture crop production; mangrove protection, and water security.[143] This prioritization of adaptation measures should take into account the specific risk profiles while making decisions on adaptation investments (Table 4-4).

In East and North-East Asia, the adaptation priorities are to make new infrastructure more resilient and strengthen early warning systems. In South and South-West Asia, the highest priorities are to strengthen early warning systems and make new infrastructure more resilient, followed by resilient water resource management by improving drylands and protecting mangroves. In South-East Asia, however, the key priorities are to protect mangroves and make water resource management more resilient, thereby reflecting the increasing impacts of drought, floods and cyclones in the region.[144] In North and Central Asia, the key priorities are to make water resource management more resilient and to improve dryland agriculture. For the Pacific subregion, making water resource management more resilient, improving dryland agriculture crop production and as protecting mangroves are identified as high priority adaptation measures.

FIGURE 4-11 Adaptation priorities for ESCAP subregions



Source: ESCAP calculations based on data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be; World Bank, "World Bank Open Data". Available at https://data.worldbank.org/ ; Asia-Pacific SDG Gateway. Available at https://data.unescap.org/home.

143 Global Commission on Adaptation, *Adapt now: A global call for leadership on climate resilience*, 13 September 2019. Available at https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/ (accessed on 26 March 2021).

144 *Ready for the Dry Years: Building resilience to drought in South-East Asia* (United Nations publication, 2021a).

TABLE 4-4 Adaptation costs and priorities by ESCAP subregions

Subregions	Adaptation Cost (billions of US dollars, percentage of GDP)	Adaptation Priorities (highest to lowest, 5 being highest priority)
East and North-East Asia	190 (0.9%)	5 - Making new infrastructure resilient 4 - Strengthening early warning systems 3 - Improving dryland agriculture crop production 2 - Making water resources management more resilient, protecting mangroves
North and Central Asia	2.1 (0.6%)	5 - Making water resources management more resilient, Improving dryland agriculture crop production 4 - Making new infrastructure resilient 3 - Strengthening early warning systems
South and South-West Asia	51 (1.1%)	5 - Making new infrastructure resilient, and strengthening early warning systems 4 - Making water resources management more resilient, and improving dryland agriculture crop production 3 - Protecting mangroves
South-East Asia	22 (0.8%)	5 - Making water resources management more resilient, and protecting mangroves 4 - Strengthening early warning systems 3 - Making new infrastructure resilient and improving dryland agriculture crop production
Pacific small island developing States	0.5 (1.4%)	5 - Making water resources management more resilient 4 - Improving dryland agriculture crop production 3 – Strengthening early warning systems, and protecting mangroves 2 - Making new infrastructure resilient

The opportunities for scaling up subregional cooperation are considered below.

South-East Asia

In South-East Asia, 110 million people are exposed to drought and the biological hazards related to it. As of 2020, five of the ten ASEAN member states have more than 30 per cent of the total employed population working in the agricultural sector. In these circumstances, droughts generally have a major impact, so it is important to build resilient water resources and improve dryland agriculture. Furthermore, with 42 million people exposed to cyclones and its related biological hazards, it is also vital to have robust early warning systems.

As part of the effort to mobilize region-wide action, ASEAN and ESCAP has jointly produced the *Ready for the Dry Years* publication series. This publication provided the evidence base for the negotiations of the Association of Southeast Asian Nations Declaration on the Strengthening of Adaptation to Drought, which was adopted at the 37th Association of Southeast Asian Nations Summit.

In follow-up, the two secretariats working in partnership are supporting the development of a regional roadmap/regional action plan. National case studies will be prepared for two pilot countries: Cambodia and Thailand. In addition, the secretariat is working with the Brunei Climate Change Secretariat on a joint secretariat/Regional Integrated Early Warning System for Africa and Asia; a technical assistance project with a focus on improving climate adaptation, resilience and disaster preparedness in Brunei Darussalam.

The ASEAN Committee on Disaster Management and the ESCAP secretariat reinforced this cooperation by using the *Ready for the Dry Years* publication series to mobilize cross-sectoral support for drought action across agriculture, disaster management, energy, environment, finance, planning, science, and technology. Additionally, the adoption of the Declaration at the 37th ASEAN Summit was facilitated by strong partnerships in South-East Asia between the United Nations, ASEAN, national governments and other stakeholders, and structured through the Comprehensive Partnership and the Plan of Action.

BOX 4-6 **Philippines Natural Disaster Risk Insurance Policy**

The Philippines Natural Disaster Risk Insurance policy, supported by the World Bank, was started in 2017 and was renewed and boosted in 2018. Under this policy, the World Bank has entered into an agreement with private investors to provide cover against disaster and severe climate events to government agencies in 25 participating provinces. These provinces are provided with $390 million in insurance against typhoon and earthquake events. Insurance payouts are initiated by pre-defined parametric triggers. The Philippines Government Service Insurance System provides the insurance coverage. In effect, the policy provides prompt liquidity support to the Government to catalyse disaster recovery measures.[a]

a World Bank, "World Bank doubles Philippines natural disaster risk insurance with US$ 390 million in coverage", press release, Manila/Washington D.C., 16 January 2019. Available at https://www.worldbank.org/en/news/press-release/2019/01/14/world-bank-doubles-philippines-natural-disaster-risk-insurance-with-us390-million-in-coverage.

East and North-East Asia

In East and North-East Asia, around 260 million people are vulnerable to heatwaves, 196 million to cyclones and 68 million to drought and its associated biological hazards. In March 2021, amid the COVID-19 pandemic, North and East Asia was hit by the worst sand and dust storms (SDS) in a decade. In East Asia, a global temperature rise of 1.5°C, above pre-industrial levels between 2030 and 2052, will expose 48 million people to water scarcity. These climate hazards will severely impact countries, such as the Republic of Korea, where more than half the employed population works in agriculture. Hence, the importance of investing in early warning systems, appropriate land management for improved agricultural production and water resource management.

Since 1993, the North-East Asian Subregional Programme for Environmental Cooperation has served as a comprehensive intergovernmental cooperation framework in North-East Asia with membership of six countries: China, the Democratic People's Republic of Korea, Japan, Mongolia, the Republic of Korea and the Russian Federation. The framework has pursued a multi-disciplinary and multi-sectoral approach to address subregional environmental challenges. In this regard, desertification and land degradation is one of the five programmatic areas of the Strategic Plan 2021–2025.

There is thus scope to scale up the programme's work on desertification and land degradation and its interlinkage with climate change through strengthened subregional cooperation. As a first step, a study will contribute to enhanced scientific understanding of risk management and implementation of early warning systems. The study will also provide pathways for the necessary acceleration of adaptation actions. This includes building individual and institutional capacity to address implementation gaps and accelerating knowledge transfer on enabling financial mechanisms.

South and South-West Asia

As the subregion became the world's epicentre of the pandemic, the intersection of the COVID-19 pandemic with extreme climate events, acutely highlighted the urgency of subregional actions. Although the respective frameworks of the South Asian Association of Regional Co-operation and Economic Co-operation Organization frameworks are already aligned with the Sendai Framework for Disaster Risk Reduction, they do not address cascading risks.

Recognizing the need to do so, Ministers dealing with environment and disaster management in five South Asian countries, namely Afghanistan, Bangladesh, India, the Maldives, and Pakistan met at a Special High-Level Event on Disaster and Climate Resilience in South Asia, held virtually on 4 December 2020. In the meeting, they called on the secretariat to shape a longer-term, holistic, coordinated and more strategic approach to building disaster and climate resilience and to develop a new regional framework for managing cascading risks from natural and other biological hazards through cooperation with subregional bodies. Accordingly, and working in partnership with the relevant subregional organizations, the secretariat plans to provide support for a scale-up of the subregion's frameworks to encompass cascading risks.

North and Central Asia

In North and Central Asia, where large proportions of the populations depend on agriculture, around 22 million people are exposed to heatwaves and related biological hazards and 5 million are exposed to drought and food insecurities. Furthermore, a global temperature rise of 1.5°C above pre-industrial levels would expose many more people to water shortages.

The drying up of the Aral Sea as the biggest lake in Central Asia, shared by Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan is often considered as the world's worst environmental catastrophe. The Aral Sea catastrophe has also contributed to the spread of drought, land degradation, desertification and sand and dust storms. With the emerging threat from climate change, along with increasing demands for food and water, exacerbated by a growing population, there are risks of other water-related disasters in inland basin systems.

While these phenomena have been studied extensively from the perspective of the sustainable management of natural resources, less work has been undertaken on the disaster-risk reduction and associated climate change adaptation perspectives of inland water basins. Consequently, the secretariat is undertaking a study on the risk drivers of water-related disasters in inland water-basins, including the impacts of climate change, through advances in Earth observation, digital elevation modelling, geospatial techniques and high-resolution climate modelling. This should support regional cooperation on the Aral Sea catastrophe from multi-sectoral risk management perspectives, and provide lessons for disaster risk reduction in other inland water basins.

The work underway is also designed to provide support to a resolution drafted by the Government of Turkmenistan, entitled 'Creating regional mechanisms to study, mitigate and minimize disasters in endorheic (inland) water basins and to prevent them, in particular considering modalities for establishment of the United Nations special programme for the Aral Sea basin'.

Pacific small island developing States

A high proportion of the population of the Pacific small island developing States are exposed to drought, heatwaves and cyclones, which, together with exposure to biological hazards, makes this subregion a risk hotspot (Box 4-7).

With funding from the Joint Sustainable Development Goals Fund, the ESCAP secretariat, together with the Government of Samoa and the United Nations system, is implementing a project on strengthening the resilience of Pacific island States through the universal social protection programme. The programme offers a strategic opportunity to consider disaster risk in the design and implementation of social protection systems. This policy brief series by the secretariat and the United Nations Joint Programme in Samoa, Cook Islands, Niue and Tokelau provides practical suggestions on how to design social protection schemes that build resilience to disasters. The first edition of the policy brief series is co-published by the secretariat with the Ministry of Natural Resources and the Environment of Samoa. The secretariat is partnering with the Secretariat of the Pacific Regional Environmental Programme and the Secretariat of the Pacific Community to scale up regional cooperation related to disaster, climate and health resilience.

Overall, the ongoing and forthcoming policy deliberations and engagements with various regional and subregional organizations as well as with ministers and government officials at the national level pave the way for strengthening and scaling up regional and subregional cooperation.

BOX 4-7 Adaptation Priorities in the Pacific small island developing States

In the Pacific small island developing States the top adaptation priorities are to make water resource management more resilient and improve dryland agriculture crop production followed by protecting mangroves, strengthening early warning systems and making new infrastructure resilient.

While most people have access to basic drinking water services, access is low in some countries like Papua New Guinea (PNG). PNG also has 58 per cent of its employed population working in agriculture, hence the importance of better water resources management and dryland agriculture.[a]

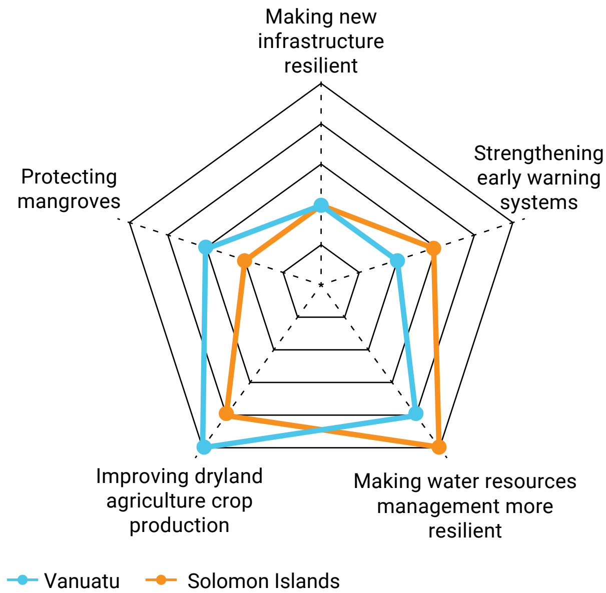
These adaptation measures also respond to the subregion's vulnerability to cyclones and related biological hazards. In some areas, protective green infrastructure is provided by mangrove forests. In 2019, total mangrove cover across 13 countries in the Pacific was 3.7 million hectares, one of the highest figures being in PNG with 728,477 hectares.[b]

Adaptation priorities at country-level: Vanuatu and Solomon Islands

Vanuatu and Solomon Islands, in the Pacific small island developing States, are also LDCs that record the highest Adaptation Costs as a percentage of GDP. For both countries, the highest adaptation priority is attributed to improving dryland agriculture crop production and resilient water resource management followed by protecting mangroves, strengthening early warning systems and making new infrastructure resilient (Figure A).

This can be attributed to high exposure to cyclones in both countries, and drought in Vanuatu, which contributes majorly to the total AAL ($204.6 million in Vanuatu and $100.5 million in the Solomon Islands under the RCP 8.5 climate change scenario). Further, a major share of employed population also works in the agriculture sector, 55 per cent in Vanuatu and 37 per cent[c] in Solomon Islands, reiterating the need for these adaptation measures.

FIGURE A **Adaptation priorities for Vanuatu and Solomon Islands**



Source: ESCAP calculations based on data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be; World Bank, "World Bank Open Data". Available at https://data.worldbank.org/ ; Asia-Pacific SDG Gateway. Available at https://data.unescap.org/home

a Asia-Pacific SDG Gateway. Available at https://data.unescap.org/home
b European Space Agency, "Land cover map 2019". Available at http://maps.elie.ucl.ac.be/CCI/viewer/?fbclid=IwAR19v_VeH6O3M661uhBScPHNj_z4l-1ImxHlTmHEbAPIbMPcIMc81UHocvU
c Asia-Pacific SDG Gateway. Available at https://data.unescap.org/home

Asia and the Pacific

Disaster risks know no borders, so countries across Asia and the Pacific need to work together through overarching regional initiatives. Subregional initiatives serve as the building blocks for regional approaches. The risks in the steppes of Central Asia may be very different from those of the small island States in the Pacific, but what countries across the region should have in common, however, are sound principles for managing disaster risks in a more coherent and systematic way; principles that are applied with political commitment and strengthened through regional and subregional collaboration.

In this regard, there is a need for a regional strategy on building back better with disaster, climate and health resilience. It is recommended that the strategy incorporate the analytical components and policy recommendations presented in this report, with four work streams proposed: (a) policy coherence, (b) multi-hazard and integrated early warning systems, (c) climate change adaptation, and (d) investing in resilient health infrastructure.

Building resilience in a riskier world

The Asia-Pacific region, like any other in the world, is regularly exposed to geophysical hazards, such as earthquakes, droughts, cyclones and floods. With climate change, these hazards are occurring with greater intensity and higher frequency. As the COVID-19 pandemic continues to wreak havoc, the region faces multiple challenges as biological and natural hazards are converging to reshape and redefine the contours of the Asia-Pacific disaster riskscape. Given the underlying stresses of poverty and inequality, the life prospects of millions of people across the region are at stake.

Indeed, the Asia-Pacific region has made remarkable progress in managing disaster risk. Risk communication and multi-hazard early warning systems have been effective in response and recovery programmes. But, there is still much more to be done and it is clear that countries can never relax their guard. The COVID-19 pandemic, with all its tragic consequences and huge economic losses, has exposed the frailties of human society in the face of powerful natural forces. Thus, this report encourages social protection programmes to move from being shock-responsive to being shock-prepared. Protection does not simply mean responding with relief packages, but anticipating emergencies and creating robust systems of social protection that will make the poorest communities safer and more resilient. Vulnerable groups, such as the urban poor, women, children, and people with disabilities need to be identified and health and social protection needs to be integrated into health and disaster risk management.

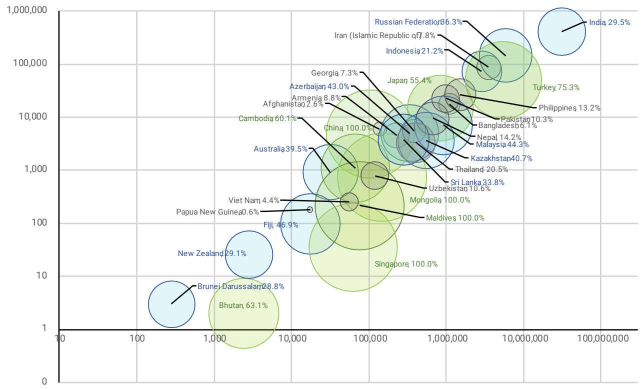
However, disaster risk management cannot function in silos. Following the Sendai Framework for Disaster Risk Reduction 2015–2030, countries in Asia and the Pacific had already come to a greater understanding of the need for a more integrated approach to disaster risk management, for treating these risks as indivisible, and for addressing them as a whole rather than one at a time. The COVID-19 pandemic has brought to the forefront, yet again, how risks interconnect; a natural hazard converging with a public health crisis can rapidly trigger an economic disaster. To address such 'systemic risks', this report suggests four priority areas for action; envisage risk scenarios; invest in health and social protection; apply emerging technologies; and target additional fiscal spending. However, given that disaster risks know no borders, subregional and regional cooperation to build disaster, climate and health resilience that incorporate the analytical findings and policy recommendations of this report can serve to truly help the region to *build forward better*.

BOX 4-8 COVID-19 vaccination in Asia and the Pacific

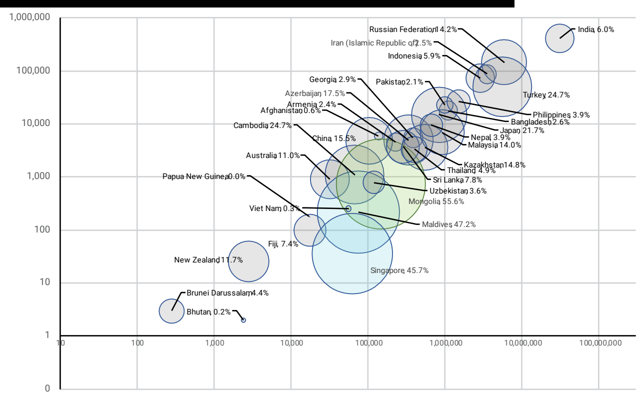
Countries in Asia and the Pacific have been efficiently managing the Covid-19 vaccination programme. As of 19 July 2021, the percentage of population fully vaccinated in Mongolia was more than 50 per cent, and more than 40 per cent in Maldives and Singapore, followed by around 25 per cent in Cambodia and Turkey. China, Maldives, Mongolia and Singapore also distributed at least first doses of vaccines to 100 per cent of their population, followed by Turkey, at around 75 per cent of population, Bhutan and Cambodia at around 60 per cent, and Japan at around 55 per cent.[a]

FIGURE Administered doses of the COVID-19 vaccine as a proportion of the total population, number of confirmed cases, and number of deaths[b]

PERCENTAGE OF ADMINISTERED DOSES OVER TOTAL POPULATION



PERCENTAGE OF FULLY VACCINATED PEOPLE OVER TOTAL POPULATION



Source: Johns Hopkins University. Coronavirus Resource Center – COVID-19 Overview and Vaccine tracker. Available at https://coronavirus.jhu.edu/region (accessed on 19 July 2021).
Notes: Some countries are not presented in the diagram due to data unavailability.

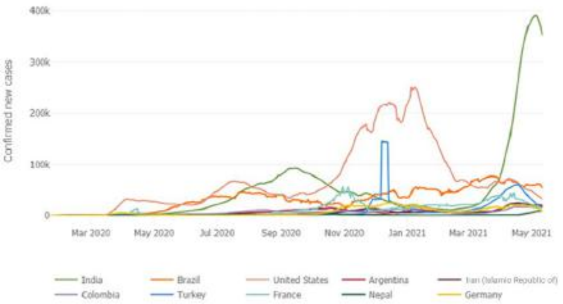
This chart indicates that India accounts more than 31 million confirmed COVID-19 cases and more than 400,000 deaths, and has vaccinated 30 per cent of its population, where 6 per cent have been fully vaccinated. The Russian Federation, recording the second highest confirmed cases at more than 5.8 million and more than 140,000 COVID-19 deaths, is currently preparing vaccine doses for more than 35 per cent of its population, where 14 per cent have been fully vaccinated. Third, Turkey, with 5.5 million cases, has administered vaccine doses for 75 per cent of its total population. It is followed by Islamic Republic of Iran with more than 3.5 million cases and 87,000 deaths, with vaccine doses at 8 per cent of its population, and Indonesia with more than 2.8 million cases and vaccine doses to cover 21 per cent of its population.

a Johns Hopkins University, Coronavirus Resource Center – COVID-19 Overview and Vaccine tracker. Available at: https://coronavirus.jhu.edu/region (accessed on 19 July 2021).
b Ibid.

BOX 4-9 Critical infrastructure services: key policy innovations for future pandemic

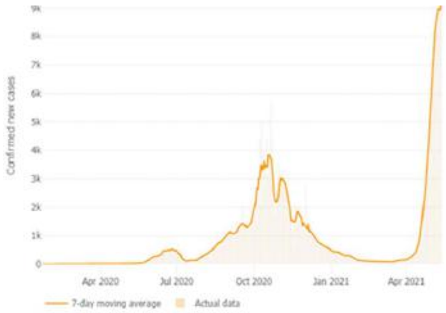
India's second COVID-19 wave was devastating, reaching world records for the total numbers of cases and deaths, and overwhelming the health-care system. The most striking aspect of the second wave was the speed with which it grew, with daily caseloads rising from about 12,000 in mid-March to 412,000 by the first week of May. The rapid speed with which the virus spread during the second wave is unique, with over 3,200 per cent growth in cases (Figure A), a similar speed is being seen in neighbouring Nepal.

FIGURE A Daily confirmed new cases (7-day moving average): outbreak evolution for the current most affected countries



Source: Johns Hopkins University. Coronavirus Resource Center – COVID-19 Overview and Vaccine tracker. Available at https://coronavirus.jhu.edu/region (accessed on 14 May 2021).

FIGURE B Daily confirmed new cases (7-day moving average) in Nepal



Source: Johns Hopkins University. Coronavirus Resource Center – COVID-19 Overview and Vaccine tracker. Available at https://coronavirus.jhu.edu/region (accessed on 14 May 2021).

Oxygen is vital for patients of COVID-19, which is a respiratory disease that attacks the lungs and leads to dangerously low levels of oxygen in the body. It is listed in the WHO's model list of essential medicines. Before the second wave, 700–800 tons per day of medical oxygen were required. This increased to 3,500–4,000 tons per day by the second week of April; a jump of over 400 per cent that put immense pressure on oxygen manufacturing units in the country. A large proportion of the 238,000 deaths in the second wave (by the first week of May only), are attributed to overstretched basic health-care facilities, particularly the supply of medicinal oxygen. The crisis reveals three key lessons for preparing for future pandemics:

Anticipatory actions – While the evidence indicates that a more contagious COVID-19 variant is spreading in India, the spread of the second wave is also driven by gaps in policy responses that emanate from a lack of anticipatory actions. So far mathematical models have been used to inform public policies and many of the social distancing measures implemented worldwide. All models, however, face challenges due to availability of data, the rapid evolution of the pandemic and unprecedented control measures put in place. It is therefore essential to strengthen mathematical modelling research capacity for pandemic planning forecast response and early warning systems to support risk-informed anticipatory actions.

Health infrastructure services – Basic, and scalable services for essential emergency and critical care (EECC), including oxygen, must be prioritized. The key lesson from this pandemic is that the capacities of public health systems must be scaled up and re-purposed, using systemic approaches for strengthening disaster resilience across all sectors. Otherwise, disruptions to the supply chain systems on which various facilities and undisrupted services depend will have fatal consequences.

Regional cooperation – As the world responds to the pandemic and many countries begin to roll out vaccination programmes, there is a unique opening to develop a resilient, accessible, inclusive, and affordable health and supply chain system for all by building regional cooperation.

BOX 4-10 Scenario planning in the coastal city of Visakhapatnam, India

The city of Visakhapatnam lies on the eastern coast of India. It is vulnerable to sea-level rise as well as climate change-induced extreme events like cyclones and storm surges. To assess the vulnerability of infrastructure services and support climate resilience planning, scenario planning was conducted by the Energy and Resources Institute (TERI) and submitted to the city government, municipal corporation, and the urban development authority. Following is an example of the scenario planning conducted for the city of Visakhapatnam.

Scenario planning steps	Details
1. Preparing an urban infrastructure inventory	Inventory of information on infrastructure assets
2. Preparing spatial inventory of urban infrastructure services	Sector-wise assets and services networks mapped using GIS platform (see Figure A)
3. Developing climate knowledge	Climate exposure assessments on precipitation, cyclones and sea-level rise. Four climate change scenarios considered for vulnerability assessment of the city based on sea-level rise model projections of 0.2 mm/year, 1.09 mm/year, 1-metre sea-level rise in 100 years and the case of cyclonic events with surge height of 4 metres.
4. Vulnerability assessment	The four scenarios overlayed on a digital elevation model (DEM) to identify hotspots, areas and assets likely to face climate hazard impacts
5. Sensitivity Analysis	Sea-level rise scenarios, sector-wise assets superimposed on the DEM to identify the most sensitive assets and areas. For example, in Visakhapatnam Airport area, airport infrastructure, storm-water drainage systems are exposed to potential sea-level rise, storm surges and floods
6. Understanding adaptive capacity	Assessment of entire systems to cope with climate-induced hazards, continuous assessment based on review of city plans, state-level policies, stakeholders, and expert group consultations.

Overall, based on the six levels of assessment, the project derived sector-wise recommendations for building resilient infrastructure. For the energy and telecommunications sector, for example, these were:

- Building design solutions to reduce flood damage
- On-site drainage in production and refuelling stations
- New infrastructure planning: avoiding vulnerable hotspots for siting
- Data collection on details of transmission lines: tower locations, networks, underground cabling details for flood prone and low-lying areas

FIGURE A Telecommunications sector, Visakhapatnam, cell phone towers mapped across the city

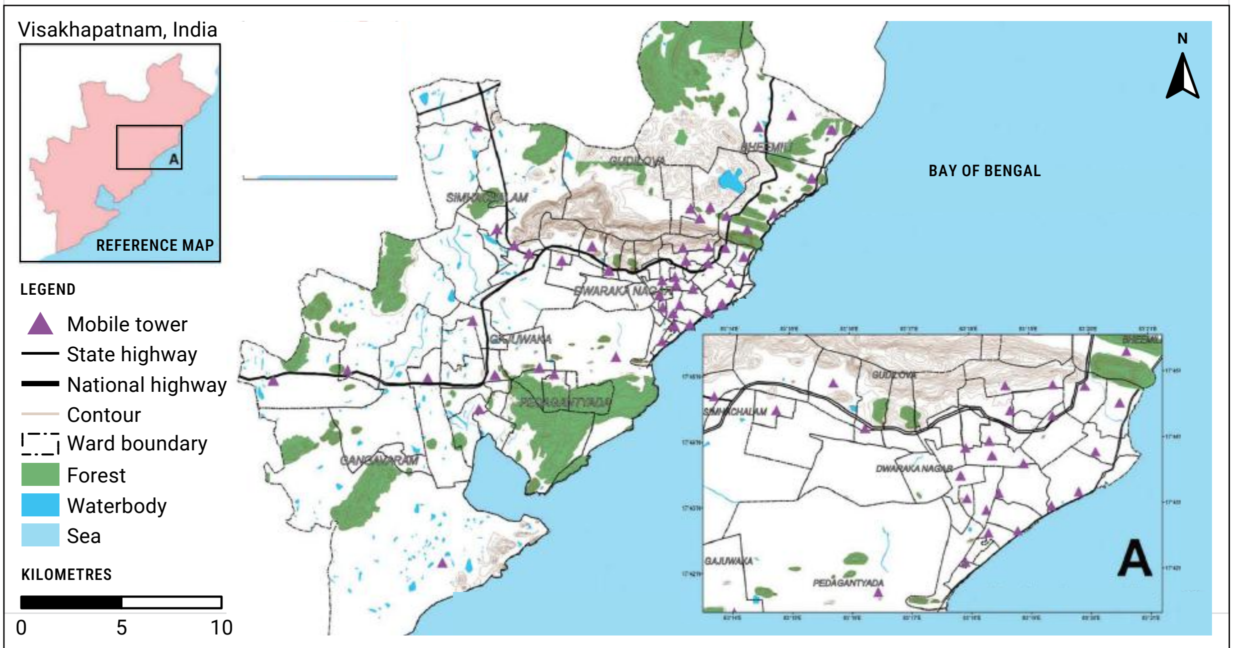
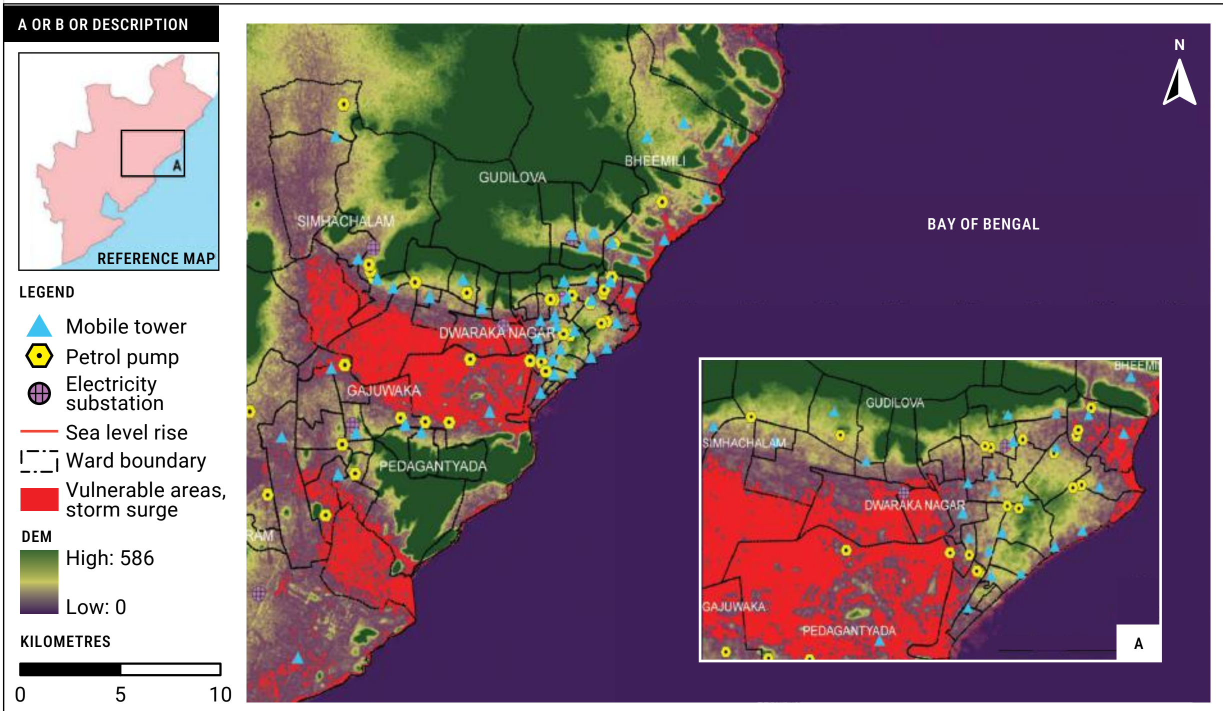


FIGURE B **Energy and telecommunication assets at risk of flooding during sea-level rise and storms**



Source: Chapter 3 – Preparing For The Future, The Energy and Resources Institute (TERI), 2021
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Source: The Energy and Resources Institute (TERI), "Climate Resilient infrastructure services, Case study brief: Visakhapatnam". Available at https://www.teriin.org/eventdocs/files/Case-Study-Vishakhapatnam.pdf

BOX 4-11 **Melbourne Water's Industry Climate Change Committee**

Melbourne is Australia's second-largest city with a population of over 4.5 million. The city is often exposed to climate change impacts like droughts, intense rainfall, high-speed winds, and heatwaves as well as sea-level rise.

Melbourne Water is a primary state-owned authority with responsibility for providing drinking water, recycled water, and waste treatment and for managing floods. To address shared risks, Melbourne Water established the Melbourne Water Industry Climate Change Committee (MWICCC) with three local water retailers for sharing information and lessons on climate risks and adaptation. Some overlapping risks and concerns include management of water during droughts, and tackling overflows from sewer networks during high-rainfall events.

The committee shares climate science inputs and risks to improve understanding of implications for businesses, identifies areas of joint research and work on developing consistent datasets as well as risk assessments. MWICCC has, for example, developed an industry risk register that records common risks facing these organizations.[a]

a C40 Cities, "C40 Infrastructure Interdependencies and Cascading Climate Impacts Study", Spring 2017. Available at https://assets.locomotive.works/sites/5ab410c8a2f42204838f797e/content_entry5ab410fb74c4833febe6c81a/5ad4fd8574c4837def5d3f8a/files/C40_Interdependencies_TOOL.pdf?1528290641

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Since the incursion of COVID-19 pandemic, the region has been hit by multiple natural and biological disasters, while climate change has continued to warm the world, exacerbating the impacts. This has reshaped and expanded the Asia-Pacific riskscape.

The *Asia-Pacific Disaster Report 2021* addresses the complexity of these converging and cascading risks by analysing natural and biological hazards simultaneously. It presents the impacts of these risks on populations and infrastructure under current, moderate and worst-case climate change scenarios. The *Report* estimates that annual economic losses arising from such cascading risks could almost double under the worst-case climate change scenario.

The *Report* emphasises that in an increasingly risky world all these hazards need to be considered not just as individual threats, but also in relation to the larger systems that they are likely to disrupt. Hence, with the help of advanced technologies, policymakers must consider more complex and varied future scenarios.

Finally, the *Report* makes the case for more purposeful and systemic national action plans. It also highlights areas where subregional cooperation can be strengthened and serve as building blocks of a regional strategy for disaster, climate and health resilience.

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