



Pathways to Adaptation and Resilience in South and South-West Asia

SUBREGIONAL REPORT

**Asia-Pacific Disaster Report 2022
for ESCAP Subregions**

Pathways to Adaptation and Resilience in South and South-West Asia

SUBREGIONAL REPORT

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About the report

Resilience in a Riskier World: Managing Systemic Risks from Biological and Other Natural Hazards, the Asia Pacific Disaster Report 2021 captured a comprehensive picture of the complexity of disaster risk landscape ('risky landscape') from natural and biological hazards in the Asia-Pacific region. The full-length publication is available at <https://www.unescap.org/kp/2021/asia-pacific-disaster-report-2021>. Following the release of the APDR at the seventh session of the ESCAP inter-governmental Committee on Disaster Risk Reduction in August 2021, the report was customized for each of the five ESCAP subregions, namely East and North-East Asia, North and Central Asia, South-East Asia, South and South-West Asia and the Pacific. The current report highlights the key takeaways for South and South-West Asia.

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CHAPTER 1

The shifting contours of the South and South-West Asia disaster riskscape

Key Highlights

- The South and South-West Asia disaster risk landscape ('risky landscape') is being reshaped by cascading and converging hazards under the disaster-climate-health nexus, increasing the vulnerability of populations to such hazards.
- In South and South-West Asia, the total average annual loss (AAL) is estimated at US\$ 161 billion in the current climate condition. This estimate increases to \$217 billion under the moderate climate change scenario (RCP 4.5) and to \$322 billion under the worst-case climate change scenario (RCP 8.5) (2020–2059 projections).
- South and South-West Asia witnessed an increased cascading risk of climate-related and vector-borne diseases, like dengue.
- The projected economic losses from natural and biological hazards will impact the achievement of SDG 13 (all targets), SDG 14 (Target 14.2), and SDG 15 (Target 15.3) with ripple effects on SDG 1 (Target 1.5), SDG 2 (Target 2.4), SDG 3 (Target 3.d), SDG 9 (Target 9.1) and SDG 11 (Target 11.5).

The disaster riskscape of South and South-West Asia

Over the past 50 years, natural hazards in South and South-West Asia have affected over 3 billion people and killed more than 1 million. The subregion accounts for 44 per cent of all fatalities from disasters and 50 per cent of the people affected in the Asia-Pacific region (Figure 1-1). India and Nepal record the highest fatalities in the subregion with an average of 2,270 and 1036 fatalities per year, respectively, in the last decade (2011–2021), amounting to 70 per cent of all fatalities in the subregion (Figure 1-1). Shockingly, India alone accounts for 78 per cent of the affected population in the subregion, for this time period.

With numerous risk reduction measures in place, significant progress has been made in reducing the loss of lives from disasters. In the last decade alone, the average number of annual fatalities, in South and South-West Asia, has fallen from over 20,000 to under 4,500 fatalities. However, the average number of people affected from adverse disaster impacts remains high, with close to 60 million people affected on average per year, accounting for 3.2 per cent of the subregion's population.

Climate change and the disaster riskscape in South and South-West Asia

Climate change is increasing the occurrence and intensity of natural hazard-induced disasters, leading to a reshaped riskscape for South and South-West Asia. While the fatalities from specific natural disasters, such as tropical cyclones, have decreased in the past few decades, fatalities from other hazards, like earthquakes, have increased. Similar trends can be seen in the number of people affected; there has been a downward trend in the number of people affected by floods, but a simultaneous increase in the population affected by drought (Figure 1-2).

Climate change scenarios for the near and far future suggest that drought conditions are likely to become more severe in the region. The variation in rainfall pattern (anomaly) and projected higher temperatures will likely cause more frequent, extreme, dry conditions.¹ Figure 1-3 illustrates the projected maximum number of consecutive dry days for 2040–2059, under the worst-case scenario (RCP 8.5) in South and South-West Asia. It shows that multiple areas in India, Pakistan and Turkey are likely to experience a significant increase in the maximum number of consecutive dry days.

¹ *Ready for the Dry Years: Building Resilience to Drought in South-East Asia, with a focus on Cambodia, Lao Peoples Democratic Republic, Myanmar and Viet Nam: 2020 Update* (United Nations publication, 2020a). Available at: <https://www.unescap.org/sites/default/files/publications/Ready%20for%20the%20Dry%20Years.pdf>

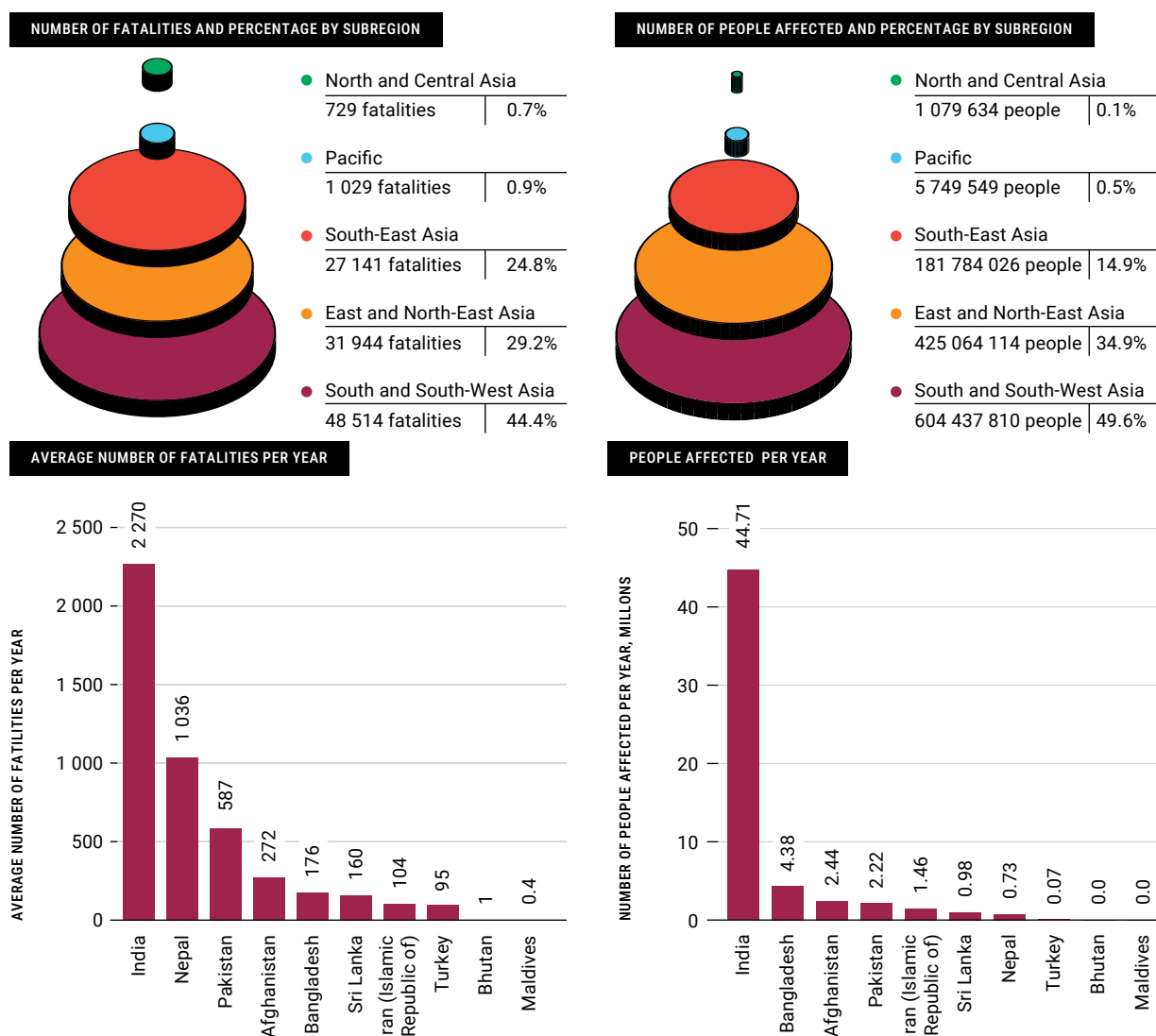
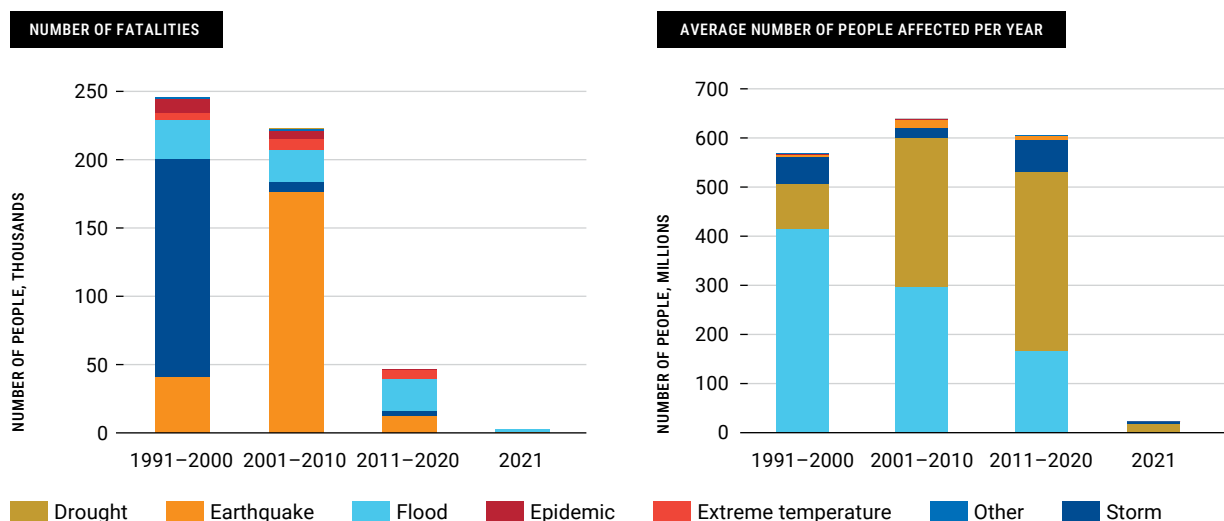
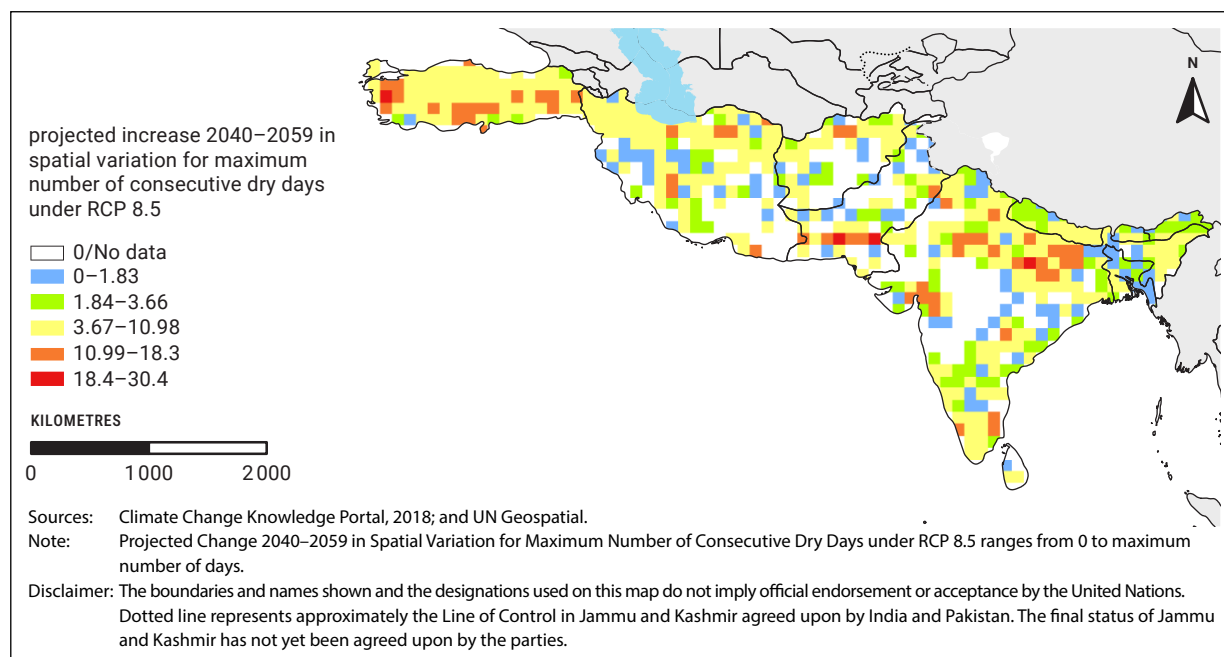
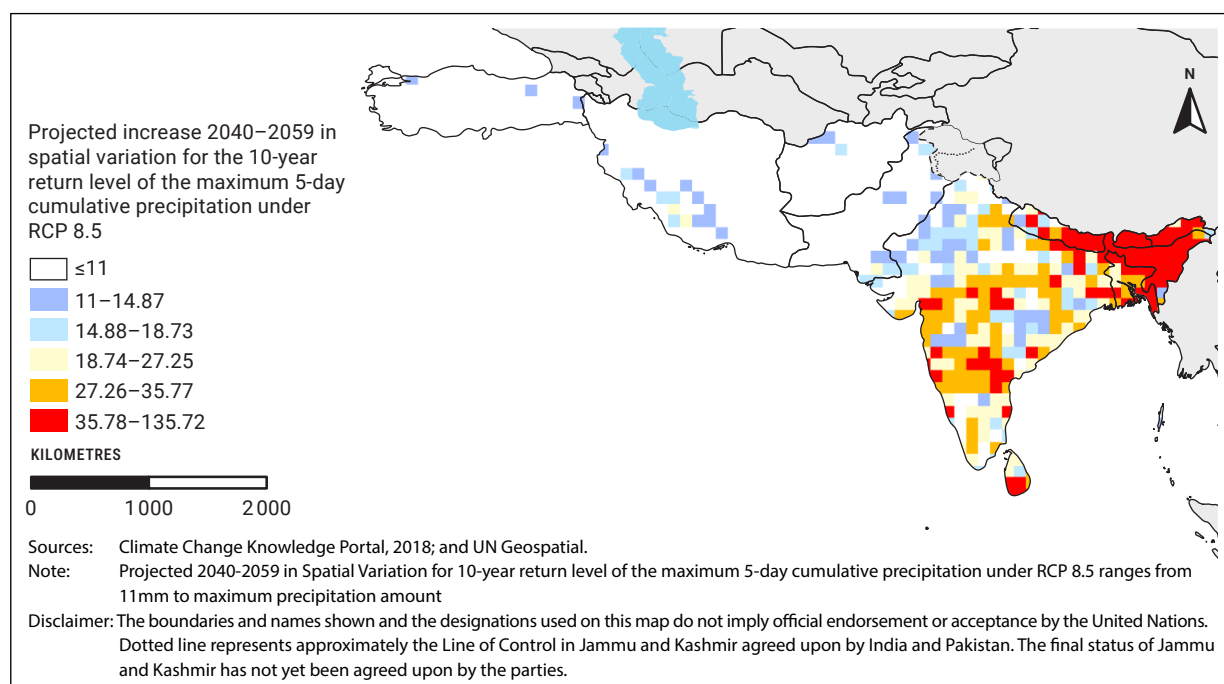
FIGURE 1-1 Number of fatalities and people affected in South and South-West Asia and across ESCAP subregions, 2011–2021Source: EM-DAT – The International Disaster Database. Available at <https://www.emdat.be/> (accessed on 31 March 2022).**FIGURE 1-2** Number of fatalities and people affected by natural hazards in South and South-West AsiaSource: EM-DAT – The International Disaster Database. Available at <https://www.emdat.be/> (accessed on 31 March 2022).

FIGURE 1-3 Number of consecutive dry days, projected increase by 2040–2059, in South and South-West Asia, under the worst-climate change scenario



As noted in the 6th IPCC Assessment Report, a warmer climate is also expected to intensify very wet weather, leading to flooding.² While the number of people affected by floods has decreased in the recent decade in South and South-West Asia, the maximum five-day cumulative precipitation is expected to increase in several parts of the subregion by 2040–2059 under the worst-case scenario, especially in the Ganga-Brahmaputra-Meghna basin and in Sri Lanka (Figure 1-4). Although more rain in a short period (5 days) does not necessarily lead to more flood events, it increases flood risks, especially in the flood-prone coastal areas. These risks are expected to rise in India, Bhutan, Bangladesh, Nepal and Sri Lanka.

FIGURE 1-4 Maximum five-day cumulative precipitation, projected increase by 2040–2059

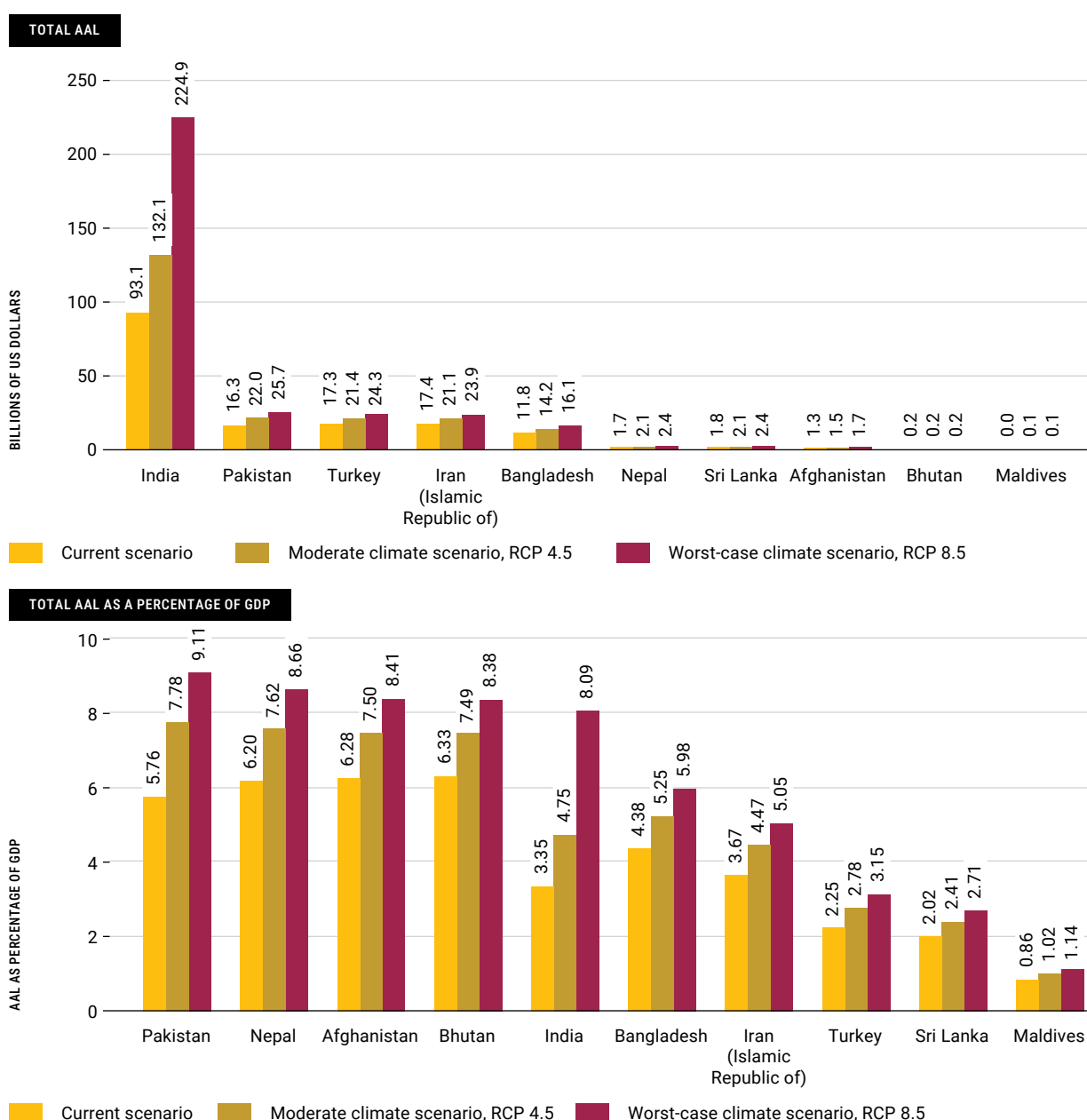


² Intergovernmental Panel on Climate Change, "Climate Change 2021: The Physical Science Basis, Summary for Policymakers," Working Group I contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, 2021. Available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

The economic cost of cascading hazards and climate change

ESCAP estimated the economic costs from the combined impacts of the disaster-climate-health nexus, considering two climate change scenarios. In South and South-West Asia, the total average annual loss (AAL) is estimated to be \$161 billion in the current climate condition.³ This estimate increases to \$217 billion under the moderate climate change scenario (RCP 4.5) and to \$322 billion under the worst-case climate change scenario (RCP 8.5) (2020–2059 projections). In absolute terms, under the worst-case scenario, India is set to record the highest AAL at \$225 billion, followed by Pakistan at \$26 billion and Turkey at \$24 billion (Figure 1-5). However, when AAL is assessed as a percentage of the country's GDP the picture changes. For example, under the worst-case climate change scenario, Pakistan will have the highest losses as percentage of GDP at 9.1 per cent, followed by Nepal at 8.7 per cent. In this scenario, India will still be the fifth highest, with estimated losses equalling 8.1 per cent of its GDP.

FIGURE 1-5 Total AAL and AAL as percentage of GDP from cascading risks

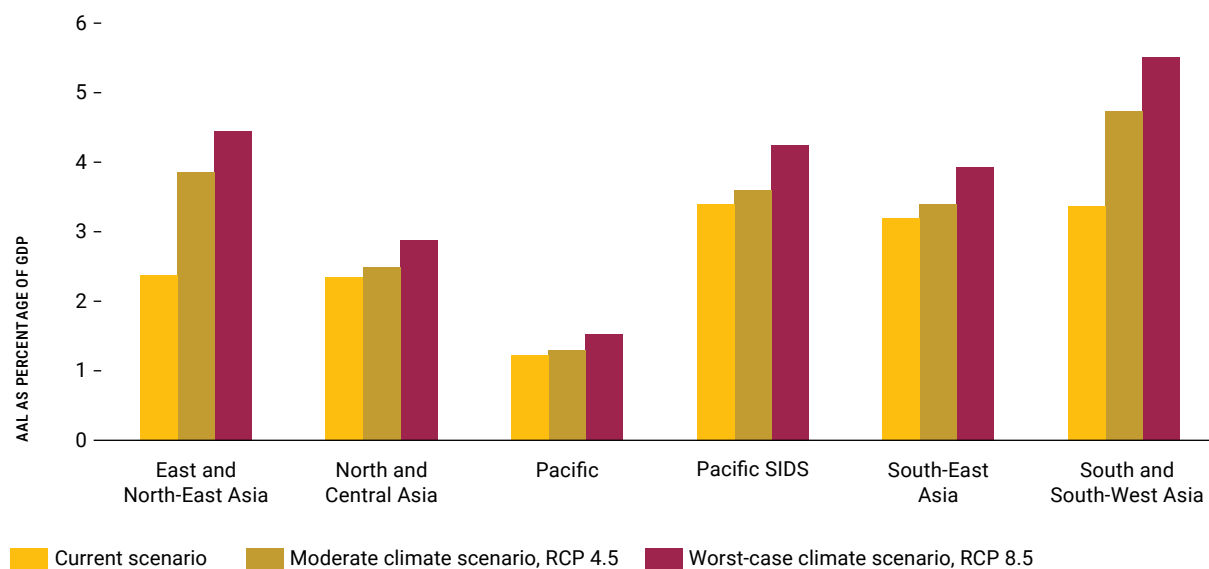


Source: ESCAP (2021) estimation based on "Disaster Risk and Resilience Portal". Available at <https://rrp.unescap.org/>

3 ESCAP, "Risk and Resilience Portal". Available at: rrp.unescap.org

When looking at these figures as a percentage of subregional GDP, South and South-West Asia is expected to suffer the greatest losses under the moderate and worst-case climate change scenario across all subregions in Asia and the Pacific (Figure 1-6).

FIGURE 1-6 Average Annual Losses (AAL) from cascading hazards as percentage of subregional GDP



Source: ESCAP (2021) estimation based on "Disaster Risk and Resilience Portal". Available at <https://rrp.unescap.org/>
 Note: Pacific SIDS = Pacific small island developing States

A riskscape of cascading hazards



































The convergence of biological and natural hazards together with climate change has added significantly to the already prevailing stresses of poverty and inequality in South and South-West Asia. For instance, 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 their breaking point.⁴ Figure 1-7 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 in South and South-West Asia.

Such challenges 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.'⁵ Climate change is thus not only a hazard itself, but also exacerbates interactions between biological and other hazards, which in turn affects the underlying risk drivers of poverty and inequality, in a vicious circle.

4 International Federation of Red Cross and Red Crescent Societies, "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/>

5 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>

FIGURE 1-7 Climate change exacerbates the impacts of converging natural and biological hazards

	CLIMATE CHANGE RISK	RELATED BIOLOGICAL AND HEALTH RISKS
Afghanistan	 Increased precipitation and drought	 Increase in cholera, typhoid, diarrhea and ascariasis  Increase in malaria and leishmaniasis
Bangladesh	 Increased precipitation and drought  Increased sea level risk and flooding  Increase in cyclones	 Increase in diarrheal incidence rates by 5.6%  Increase in dengue  Increase in leishmaniasis
Bhutan	 Increase in glacial lake outburst floods, landslides and flash floods	 Increase in malaria, dengue, Japanese encephalitis and chikungunya
India	 Increased drought  Increased heatwaves  Increased sea level risk and flooding	 Undernutrition due to food insecurity  Increase in heatwaves related health risks (heatstroke etc.)  Increase of more than 50 million population exposed to sea level rise  Increased 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	 Decreased precipitation  Increased drought	 Increase in dengue, chikungunya, scrub typhus ; Emerge of Zika virus  Undernutrition due to food insecurity
Nepal	 Increased drought  Increase in precipitation	 Increased incidence of diarrheal  Increase in malaria, chikungunya, and dengue, lymphatic filariasis and Japanese encephalitis; Emerge of Zika Virus
Pakistan	 Increase in heatwaves  Increase in glacial lake outburst floods, severity of monsoons and cyclones and saline intrusion	 Increase in geographical range and incidence of vector-borne diseases  Increase in water-borne diseases and malnutrition
Sri Lanka	 Increased drought and flooding	 Increase in malaria, dengue, and heat related diseases

Source: *Asia-Pacific Disaster Report 2021* (United Nations publication, 2021a).

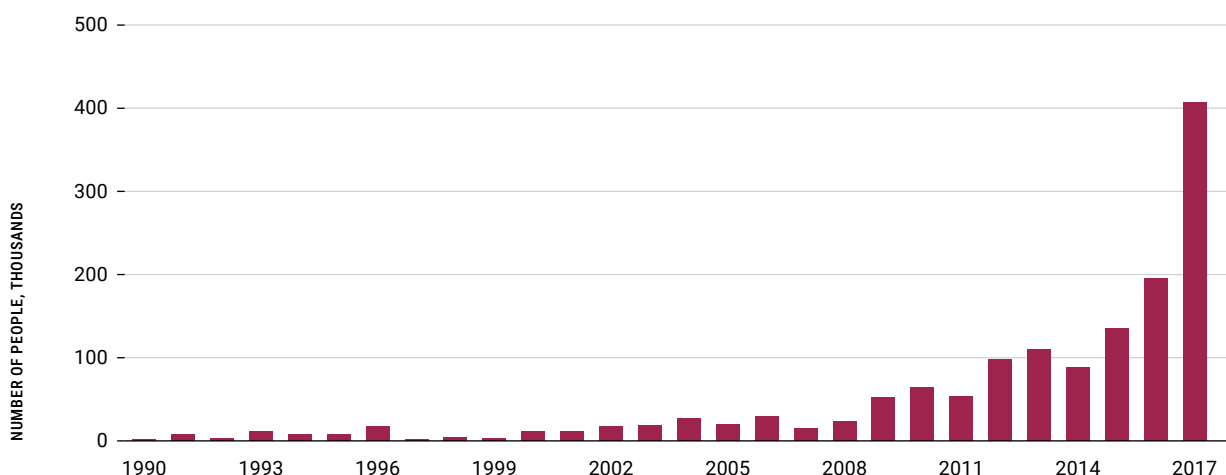
Recent decades have seen an increase in the risk of climate-related diseases leading to illness and death.⁶

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.⁷ South and South-West Asia has witnessed a sharp rise in dengue cases. The records have risen from less than 100,000 cases in 1990, to nearly 400,000 by 2018 (Figure 1-8). In some countries, 2019 brought along some of the highest rises in dengue cases since 1990; there were 99,120 cases in Sri Lanka (double the number since 2018), 92,000 cases in Bangladesh, and 91,457 cases in India (until October 2019).⁸

6 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>

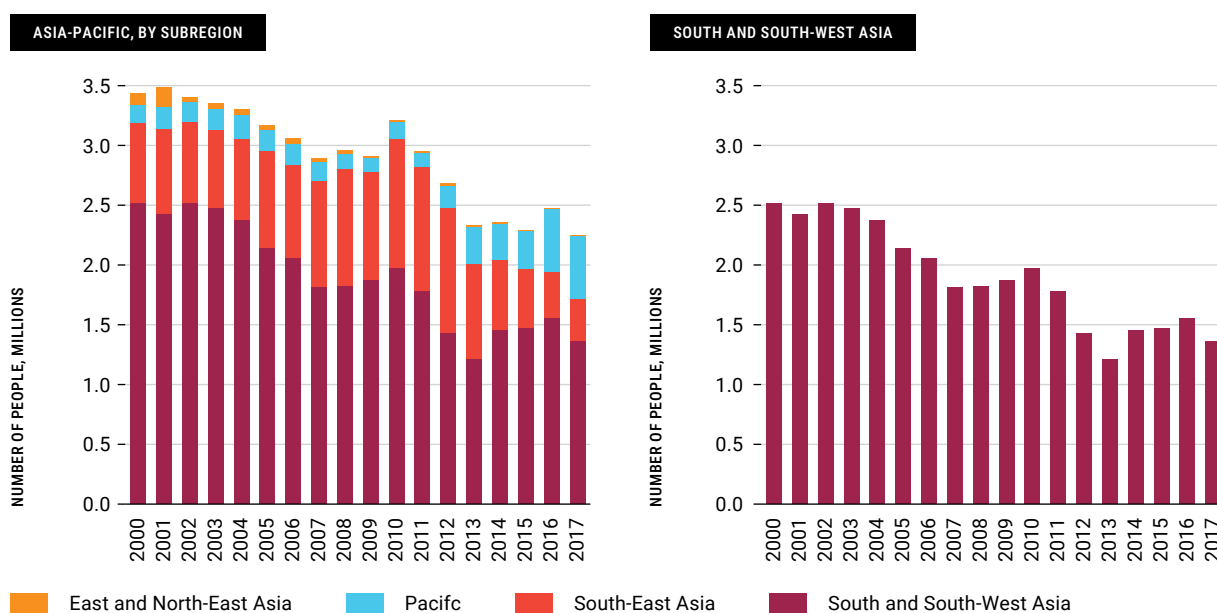
7 World Health Organization, "Climate change and human health - risks and responses", technical report, 4 December 2003. Available at <https://www.who.int/publications/i/item/climate-change-and-human-health—risks-and-responses>

8 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>; 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>

FIGURE 1-8 Confirmed dengue cases in South and South-West Asia, 1990–2018

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).

On the other hand, for malaria, the total number of confirmed cases in South and South-West Asia has gradually decreased from nearly 2.5 million cases, in 2000, to nearly 1.3 million cases, in 2017 (Figure 1-9). However, this subregion continues to record the highest numbers of malaria cases across Asia and the Pacific.

FIGURE 1-9 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).

Note: ENEA = East and North-East Asia; SEA = South-East Asia; SSWA = South and South-West Asia

In South and South-West Asia, the convergence of natural hazards, like floods, cyclones and droughts, with biological hazards brings forth a cascading risk scenario. The COVID-19 pandemic demonstrated this convergence of natural and biological hazards. It has revealed the gaps between the interdependent economic and social systems.



CHAPTER 2

Managing disasters during a global pandemic

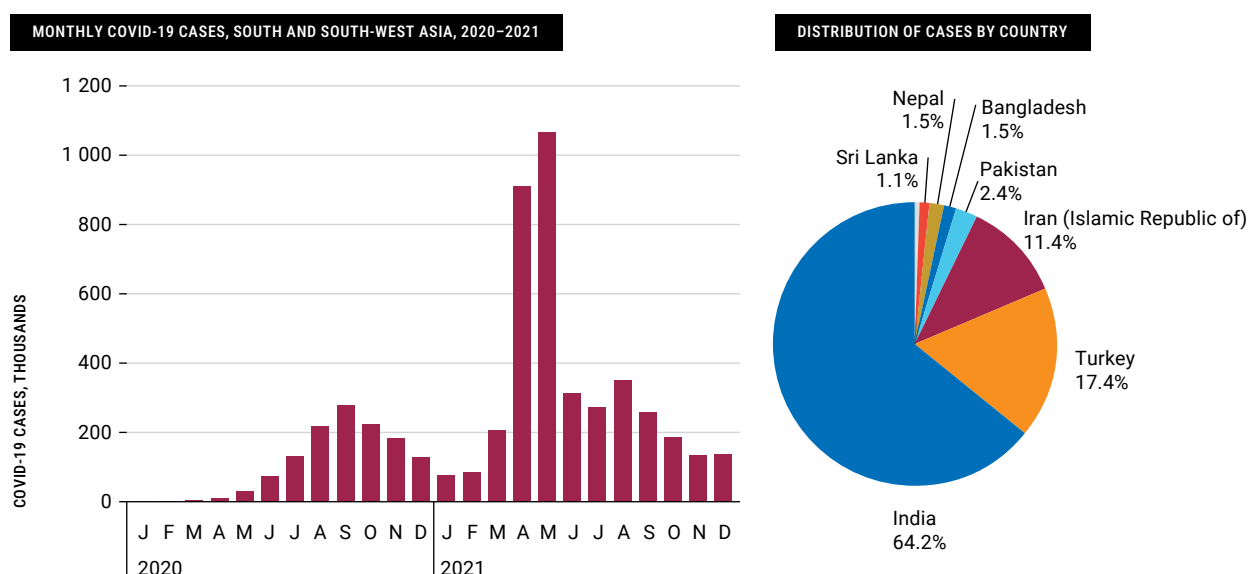
Key highlights

- The deluge of weather events, including cyclones and floods, occurring simultaneously with the COVID-19 pandemic has compounded impacts on livelihoods, economies and populations in South and South-West Asia.
- South-West Asia is likely to face a more complex set of hazards arising from the nexus of climate change and related biological hazards

COVID-19-compounded disasters

In South and South-West Asia, like other subregions in Asia and the Pacific, countries faced the dual challenge of addressing the COVID-19 pandemic and managing natural hazards. Impacts of biological hazards were compounded by other hazards like typhoons and floods, making it more difficult to respond effectively. As of December 31st 2021, the pandemic had the greatest impact in South and South-West Asia across all subregions in Asia and the Pacific, with 52.8 million confirmed cases (Figure 2-1).⁹ India alone accounts for 64 per cent of the COVID-19 cases in the subregion, this is followed by Turkey at 17 per cent of all cases.

FIGURE 2-1 Monthly COVID-19 cases in Asia and the Pacific, 1 January 2020–31 December 2021



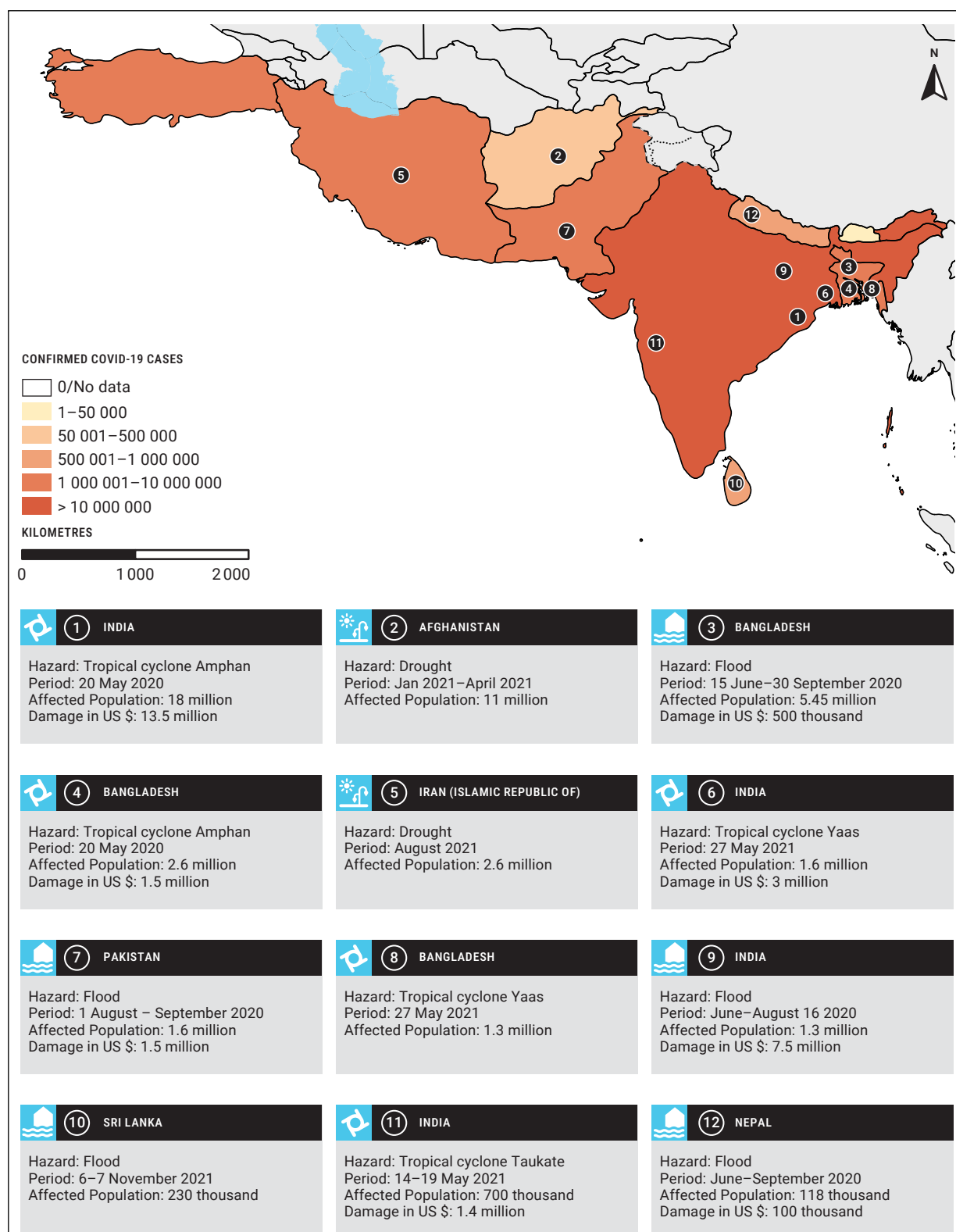
Source: Data from World Health Organization, "WHO Coronavirus (COVID-19) Dashboard". Available at <https://covid19.who.int> (accessed on 5 March 2022).

While the COVID-19 pandemic raged on, the region continued to experience other natural hazards, a fair share of which were hydro-meteorological hazards. (Figure 2-2). The lockdowns, travel restrictions and other containment measures imposed as a response to COVID-19 interrupted many established measures for prevention, response, and recovery from natural hazards. For instance, in May 2020, the COVID-19 pandemic was rapidly spreading in India and Bangladesh when cyclone Amphan made landfall (Figure 2-3). 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.¹⁰

⁹ World Health Organization, "WHO Coronavirus (COVID-19) Dashboard". Available at <https://covid19.who.int>

¹⁰ International Federation of Red Cross and Red Crescent Societies, "India: Cyclone Amphan Operation Update Report", Situation Report, (India, 23 July 2020d). Available at <https://reliefweb.int/report/india/india-cyclone-amphan-operation-update-report-dref-n-mdrin025> (accessed on 12 February 2021).

FIGURE 2-2 Convergence of COVID-19 with natural hazards in South and South-West Asia in 2020 and 2021

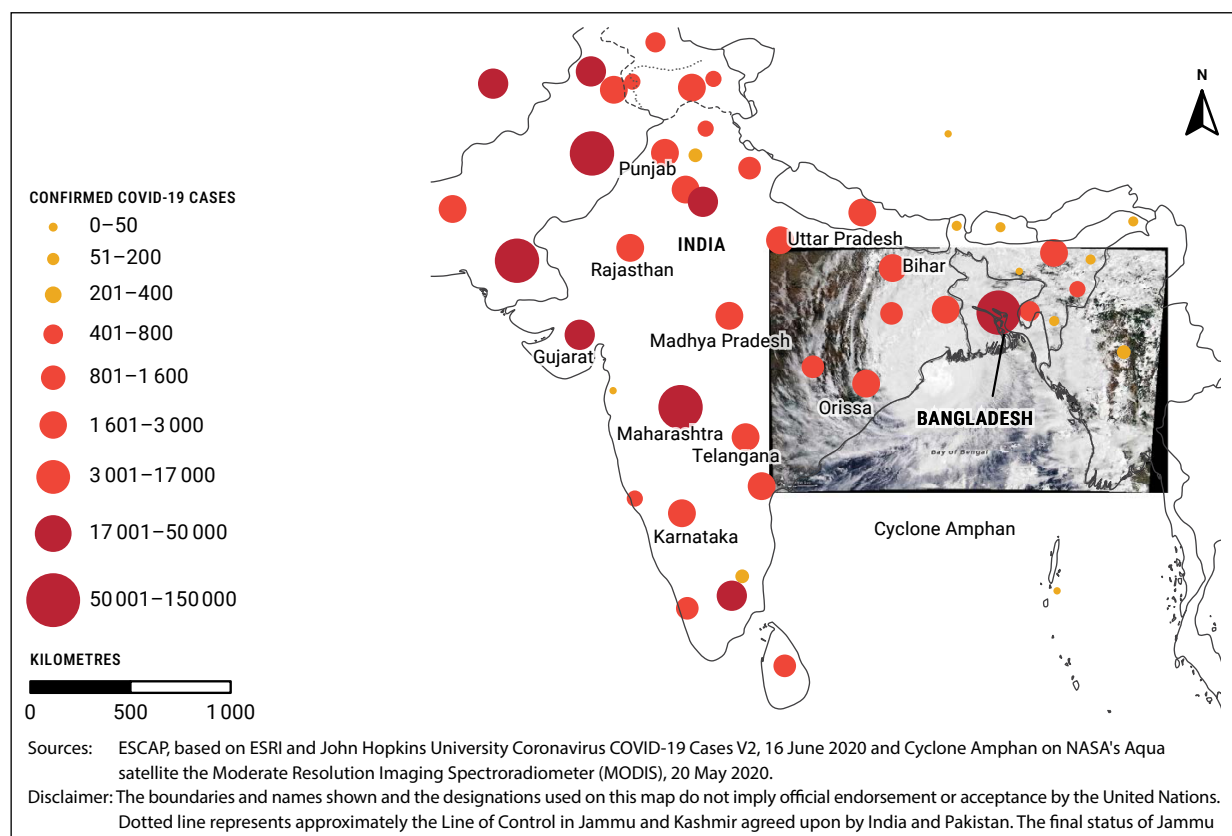


Sources: ESCAP, based on World Health Organization, "WHO Coronavirus (COVID-19) Dashboard". Available at <https://covid19.who.int> (accessed 5 March 2022); EM-DAT - The International Disaster Database. Available at: <http://www.emdat.be> (accessed 31 December 2021); and Reliefweb (accessed February 2021); and UN Geospatial.

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



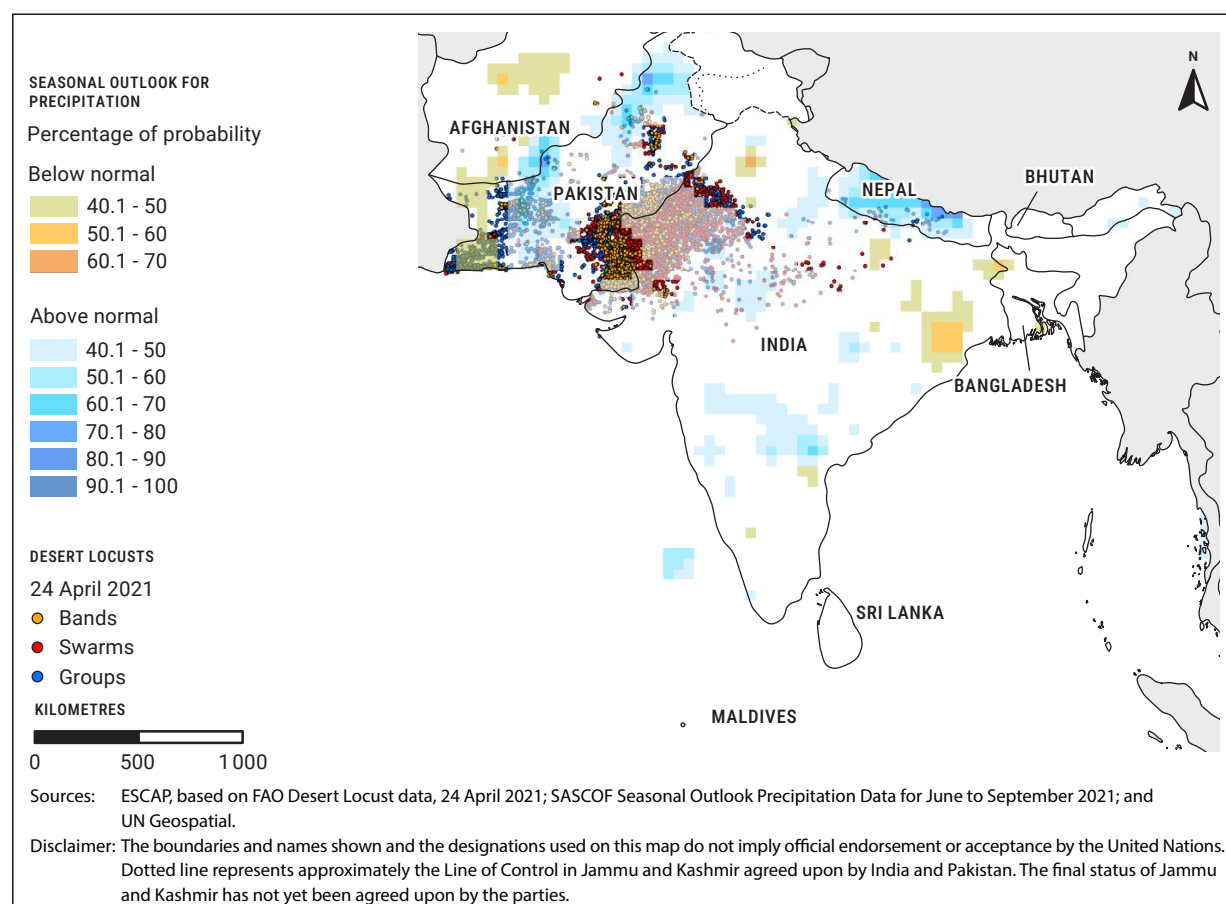
FIGURE 2-3 Convergence of cyclone Amphan with the COVID-19 pandemic



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>

Furthermore, in India, Pakistan and Nepal, 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 2-4). 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 containment measures.

FIGURE 2-4 Locust swarms forming in spring 2021



Responses to disasters during the COVID-19 pandemic

While responding to the pandemic, South and South-West Asian countries also faced natural hazards ranging from one of the strongest recorded cyclones¹¹ in the region to flash floods caused by glacial lake outbursts, heatwaves, and locust storms. While these events have different risk pathways from biological hazards, multiple emergencies intersect and converge in complex and destructive ways.

Cyclones and floods

In May 2020, during the COVID-19 pandemic, cyclone Amphan hit the densely populated, low-lying coastal areas of the Indian states of Odisha, West Bengal, and the adjoining areas of Bangladesh. Cyclone Amphan affected 10 million people and killed more than 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.¹² Local authorities, however, had to strike a balance between tackling the impacts of the cyclone and COVID-19, which was a unique challenge

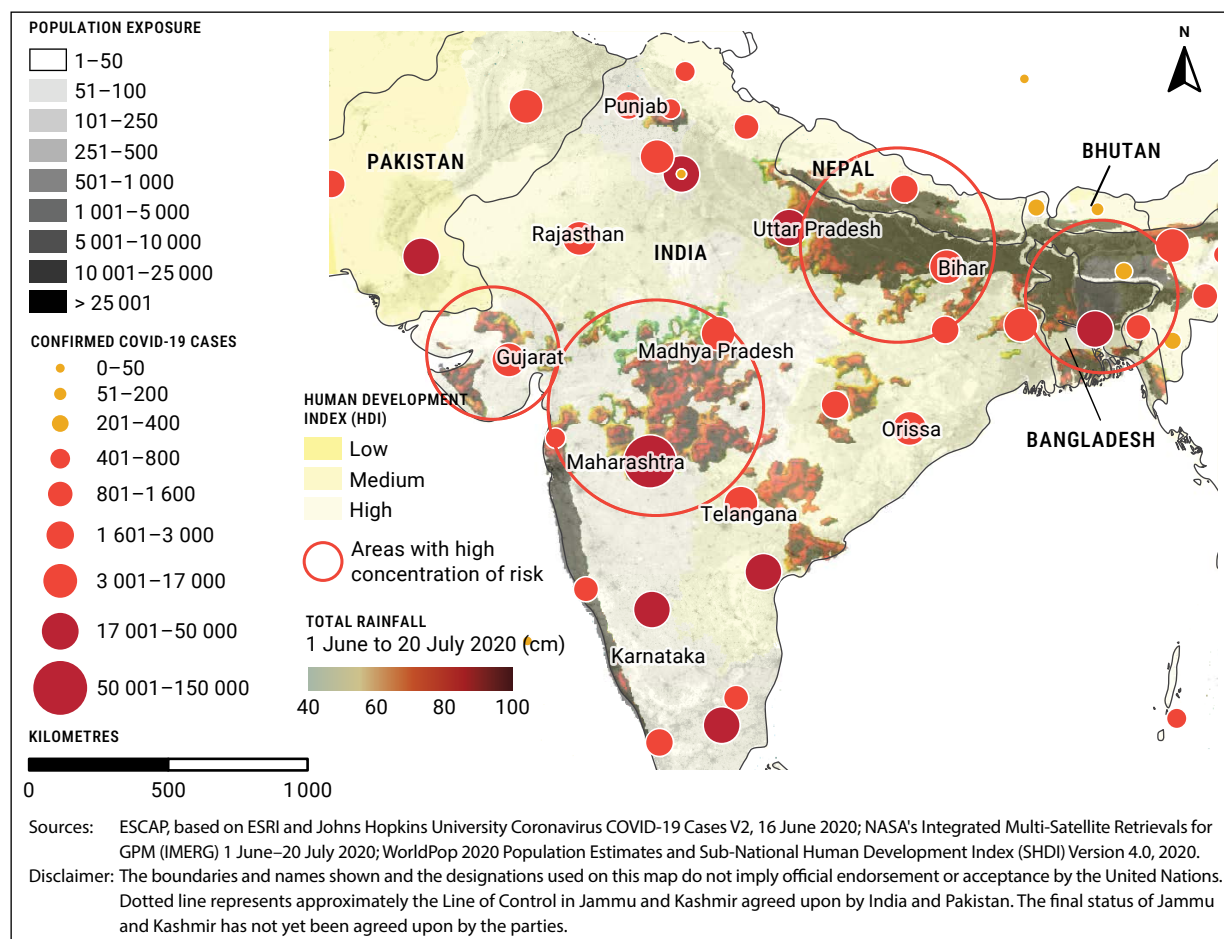
11 International Federation of Red Cross and Red Crescent Societies, "India: Cyclone Amphan", Final Report, (India, 30 November 2020c). Available at <https://reliefweb.int/sites/reliefweb.int/files/resources/India%20-%20Cyclone%20Amphan%20Final%20Report%20%28DREF%20n%C2%B0%20MDRIN025%29.pdf>

12 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](https://www.unescap.org/sites/default/files/Policy%20brief_when%20crises%20converge_v1%20(4).pdf)

for them. 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 the need for social distancing. In areas with the highest exposure to the cyclone, shelters operated at full capacity, with all possible preventative measures in place. 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.

The heavy monsoon flooding in South Asia, in 2020, is also a prime example of this convergence of disasters. In the Assam state of 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 lockdowns.¹³ South and South-West Asia was most impacted by the simultaneous occurrence of floods and COVID-19 (Figure 2-5).

FIGURE 2-5 Population affected simultaneously by floods and COVID-19, in South Asia (June to July 2020)



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).

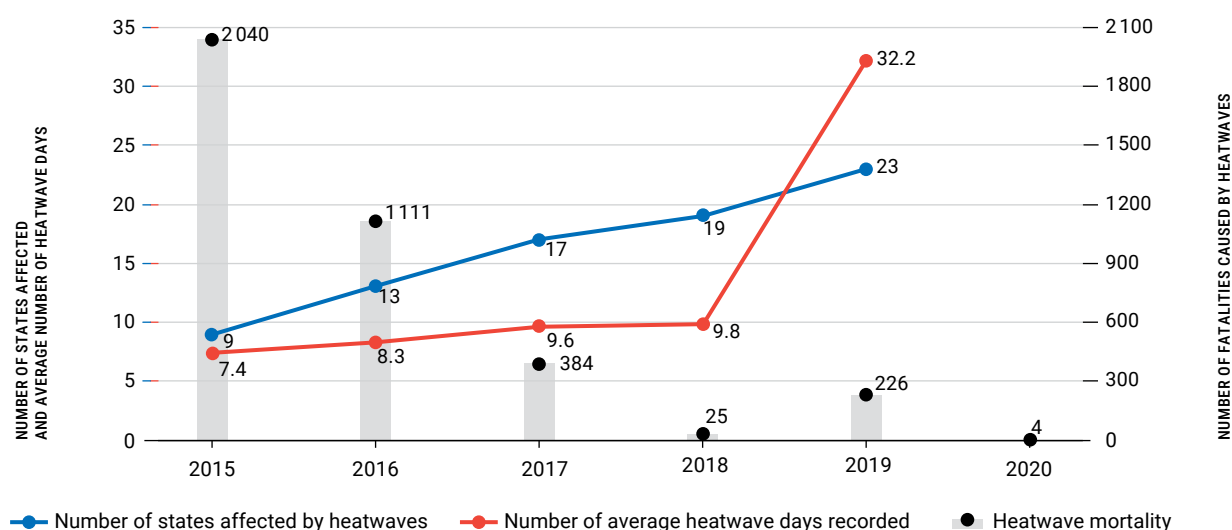
Heatwaves

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 successfully been able to mobilize stakeholders and know how to reduce the number of fatalities, which were down to

13 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>

four in 2020, as reflected in the 'Guidelines for Preparation of Action Plan — Prevention and Management of Heat-Wave,' (Figure 2-6).¹⁴ Part of this accomplishment can be attributed to precise warnings. The Indian Meteorological Department (IMD) provides not only a seasonal outlook over the country, at a sub-divisional scale, but also guidance on temperatures over a two-week scale.¹⁵

FIGURE 2-6 More heatwaves but fewer deaths in Indian states, 2015–2020



Source: Adapted from 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>

Amid the rising COVID-19 infections in India, in May 2020, the Indian Meteorological Department (IMD) issued the imminent heatwave alert. Under the influence of the dry north-westerly winds, heatwaves (4.5°C to 6.4°C departure from normal) to severe heatwaves (greater than 6.4°C departure from normal) were predicted across north-western and central India.¹⁶ In response, the National Disaster Management Authority (NDMA) issued a set of guidelines to cope with the dual challenge of heatwaves during the pandemic titled, 'Heatwave: Do's and Don'ts during COVID-19'. These included advisories related to going out during lockdowns, for example, to avoid going out during peak heat hours (12:00 noon–3 pm), instead schedule essential outdoor work during the cool hours, and follow news, TV, radio etc., for updates on local weather and the COVID-19 situation.¹⁷

More complex hazards ahead

As climate change intensifies and further biological threats surely lie in wait, South and South-West Asia will face an increasingly complex set of hazards. To combat these, countries will need to take comprehensive action to protect their populations, especially the most vulnerable, by integrating health and disaster risk management into stronger systems for health and social protection.

14 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>

15 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>

16 Government of India, Earth System Science Organization, Ministry of Earth Sciences, Indian Meteorological Department, "Heat wave to severe heat wave conditions over Northwest, Central and adjoining Peninsular India during next 5 days b) Intense rainfall activity over Northeast India during 25th – 27th May, 2020", press release, 23 May 2020. Available at: https://mausam.imd.gov.in/backend/assets/press_release_pdf/Press_Release3.pdf

17 "Heat Wave: Do's and Don'ts during COVID-19", National Disaster Management Authority, Government of India, Available at: <https://ndma.gov.in/sites/default/files/PDF/covid/Heat%20Wave-Dos-and-Donts.pdf>



CHAPTER 3

Hotspots of exposure and vulnerability to climate-induced cascading risks



Key Highlights

- In South and South-West Asia there is intensifying risk from floods and related disease hotspots as well as those emanating from increasing aridity; additionally there are emerging risk from cyclones originating from the Arabian Sea.
- Identifying vulnerable groups and at-risk infrastructure to cascading hazards is critical for building resilience to climate change and achieving the targets of SDG 13.

Climate change and expanding hotspots of cascading hazards

South and South-West Asia has several risk hotspots, mainly from floods and cyclones. Climate-related disasters are increasing in many parts of the subregion with changing climate variables. The areas already vulnerable to natural hazards face a more complex riskscape from changing climate conditions and associated risks from biological hazards.

Multi-hazard risks (from climate-related and biological hazards)

Hotspots of multi-hazard risks and related diseases will intensify from the moderate to worst-case climate change scenarios in South and South-West Asia. For instance, from 2040 to 2059, cascading multi-hazard risks will likely intensify in the worst-case scenario, and they are to be highest in parts of India, Nepal, Bangladesh, Pakistan and Sri Lanka (Figure 3-1).

Flood and related diseases

In South and South-West Asia, the Ganga-Brahmaputra-Meghna (GBM) basin, which is home to the largest concentration of poor people in the world (Figure 3-2), is also an expanding hotspot for flood and related diseases. In the current scenario, around 290 million people in the GBM basin are 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, 2040–2059). In the worst-case climate change scenario, the population exposed to floods and related diseases is set to be the highest in parts of India, Bangladesh and Nepal, while new risk hotspots will form in the north-western parts of India and in some provinces in Pakistan (Figure 3-3).

FIGURE 3-1 Multi-hazard risk hotspots from climate-related hazards and climate change under moderate (RCP 4.5) and worst-case (RCP 8.5) scenarios in South-East Asia, 2040–2059

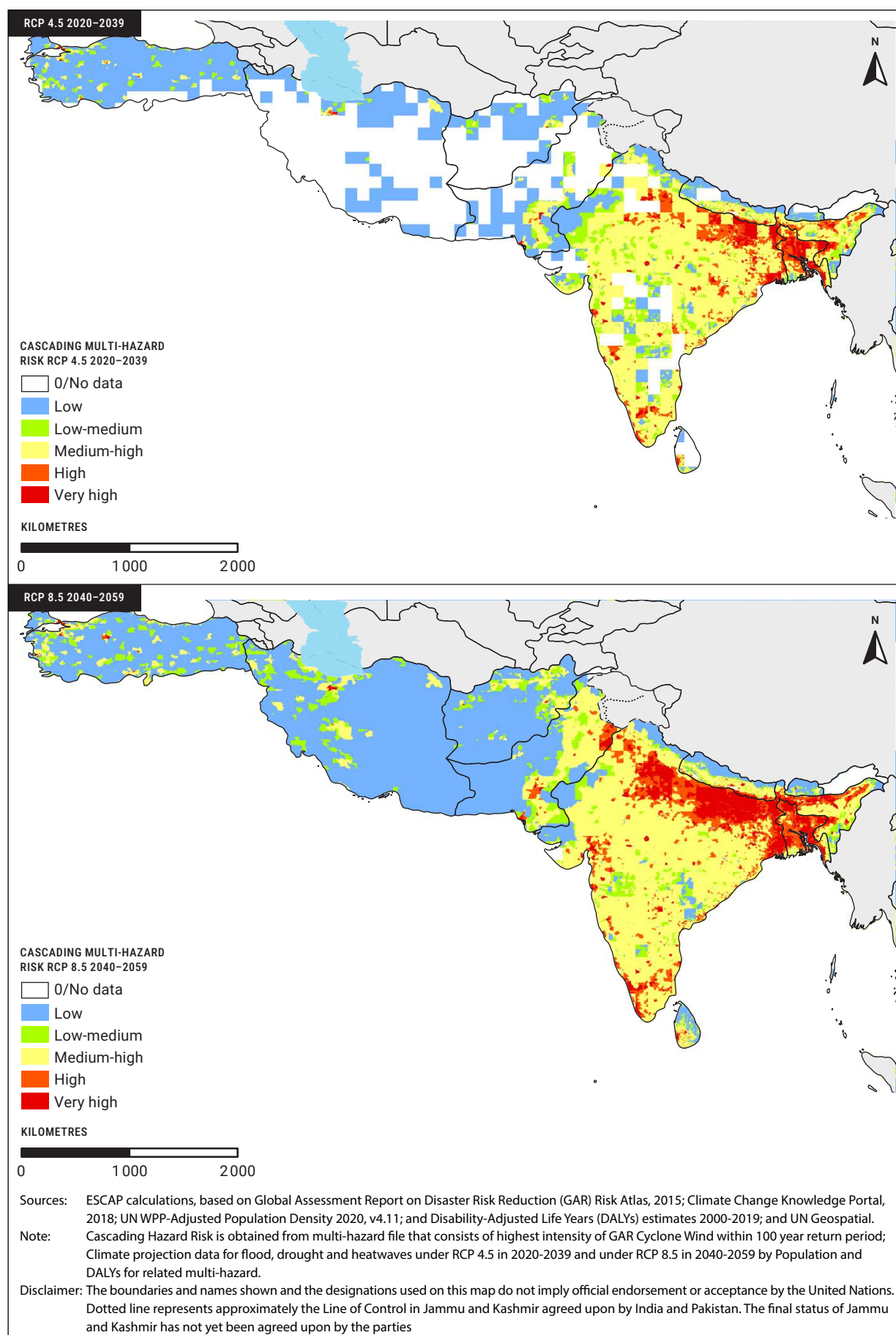


FIGURE 3-2 Population exposure to floods and related diseases under current and worst-case (RCP 8.5) scenarios in South and South-West Asia

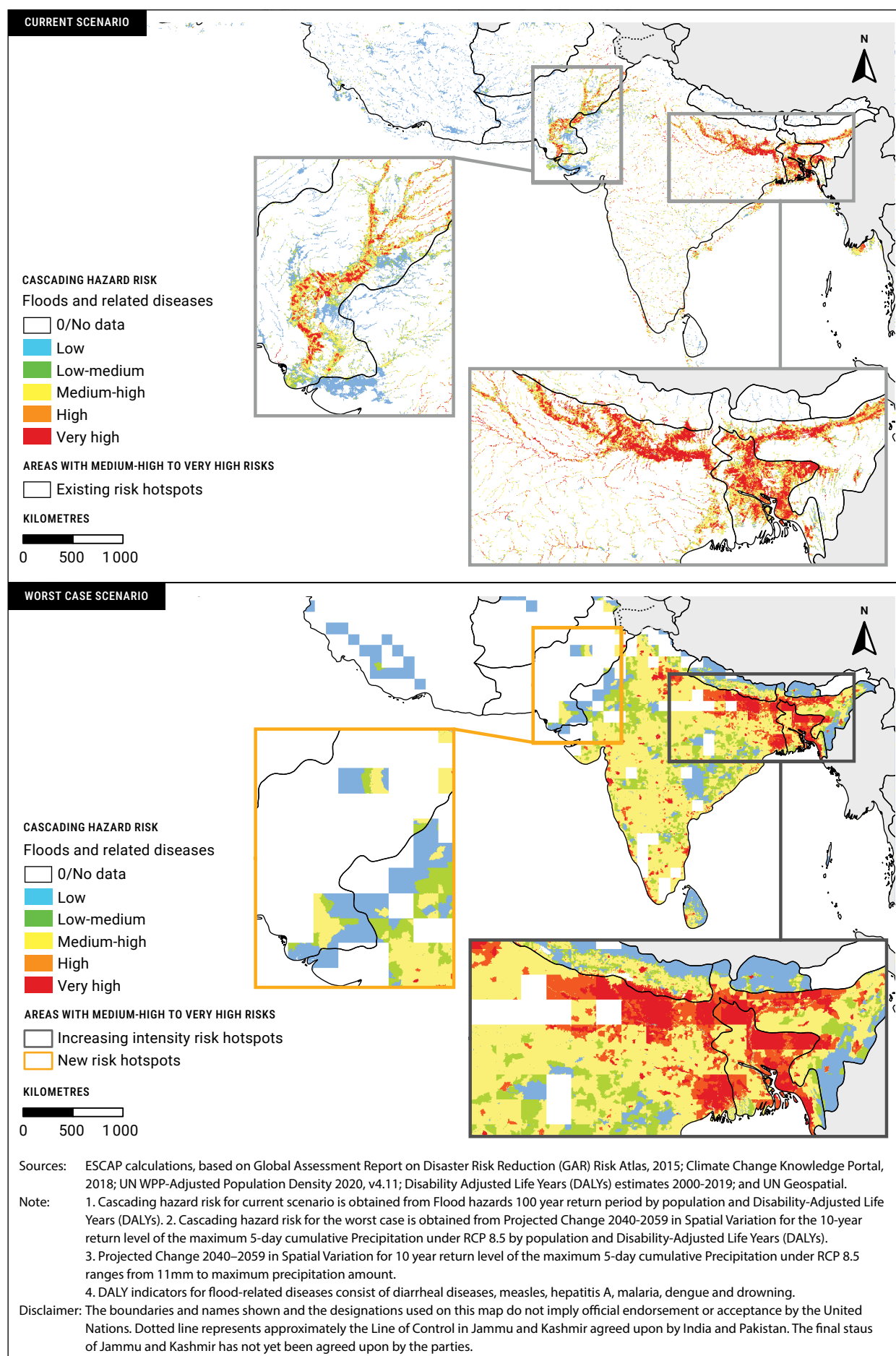
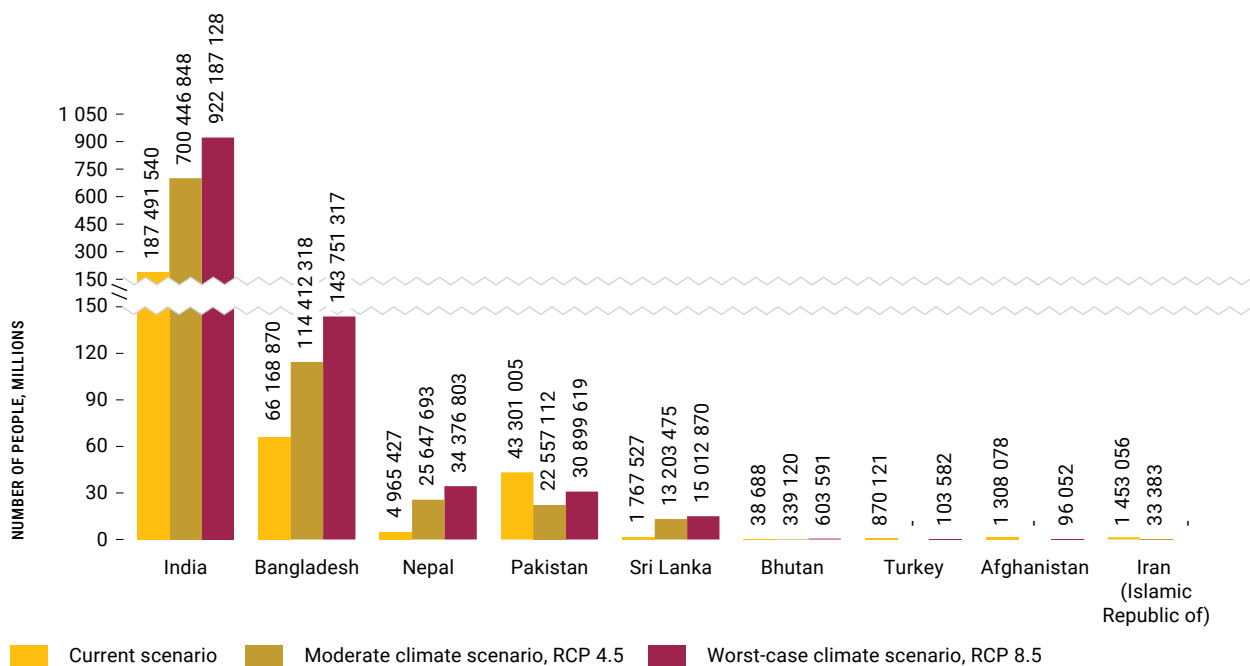




FIGURE 3-3 Average population exposure to floods and related diseases, millions, 2020–2059

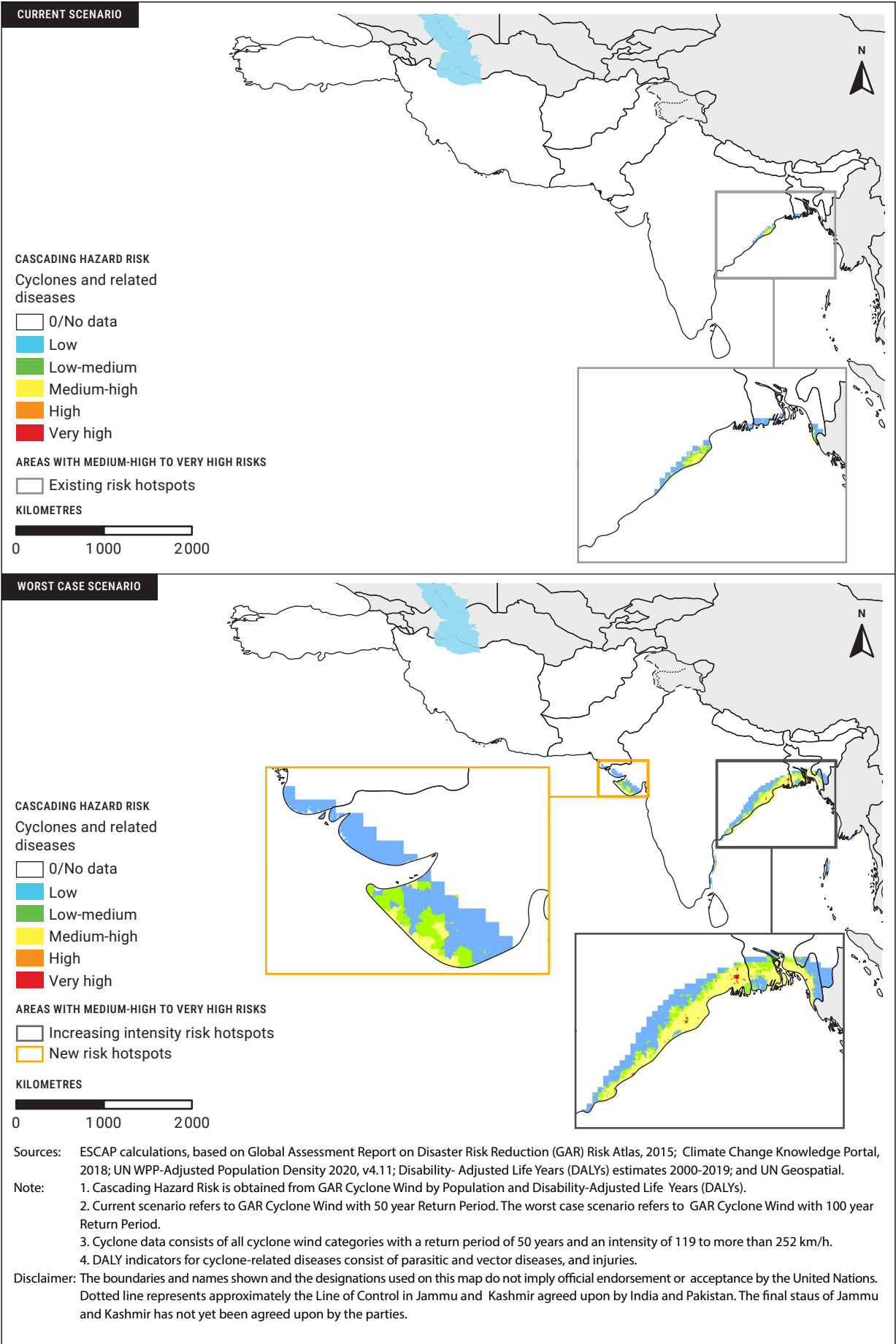


Cyclones and related diseases

The GBM basin is set to experience an increasing intensity in the risk of cyclones and related diseases, while new emerging risk hotspots are projected to occur in the north-western (including coastal) parts of India and south-eastern parts of Pakistan. Overall, the region is facing an increasing frequency of cyclones, both in the Bay of Bengal and in the Arabian Sea due to climate change (Figure 3-4).¹⁸

18 "Arabian sea- hotbed of cyclones", *Journals of India*, 19 May 2021. Available at <https://journalsofindia.com/arabian-sea-hotbed-of-cyclones/>

FIGURE 3-4 Population exposure to cyclones and related diseases under current and worst-case scenarios in South and South-West Asia



Identifying vulnerable groups to cascading hazards

Often, the most vulnerable populations face cascading multi-hazard risks, and climate change is expected to worsen this situation. Thus, one of the critical principles of disaster risk management is identifying the most vulnerable and protecting them.

People living in low human development countries

The capabilities of people to manage disaster risks can be broadly understood, among others, by the Human Development Index (HDI), a summary measure of average achievement in key dimensions of human development. ESCAP analysis shows that in South and South-West Asia, nearly 1 billion people who are in the low/medium HDI category will also be exposed to high multi-hazard cascading risks under RCP 4.5 (2020–2039). This figure will rise to 1.3 billion people across the subregion in the worst-case climate change scenario (RCP 8.5, 2040–2059). The highest percentage of population exposed to these converging risks is in Bangladesh, India, Nepal and Pakistan (Figure 3-5).¹⁹

Poverty and disasters are always closely connected; the poorest people typically live in the most exposed places. They also lose a higher proportion of their assets during disasters, and are thus driven deeper into poverty.²⁰ South and South-West Asia is characterised by high population exposure consisting of mostly poor people and high economic stock exposure.²¹ For instance, Bangladesh and India, both vulnerable to cascading hazard risks record nearly 14.3 per cent and 22.5 per cent of the population living below the national poverty line, respectively.²²

Table 3-1 indicates countries where poor people are at increasing risk of disasters under the moderate (RCP 4.5) and severe (RCP 8.5) climate change scenarios. In South and South-West Asia, the poor populations at the greatest risk, under RCP 8.5, live in Bangladesh, India and Nepal.

TABLE 3-1 Countries with highest proportion of their poorest population exposed to multi-hazard cascading risk (current and two climate scenarios)

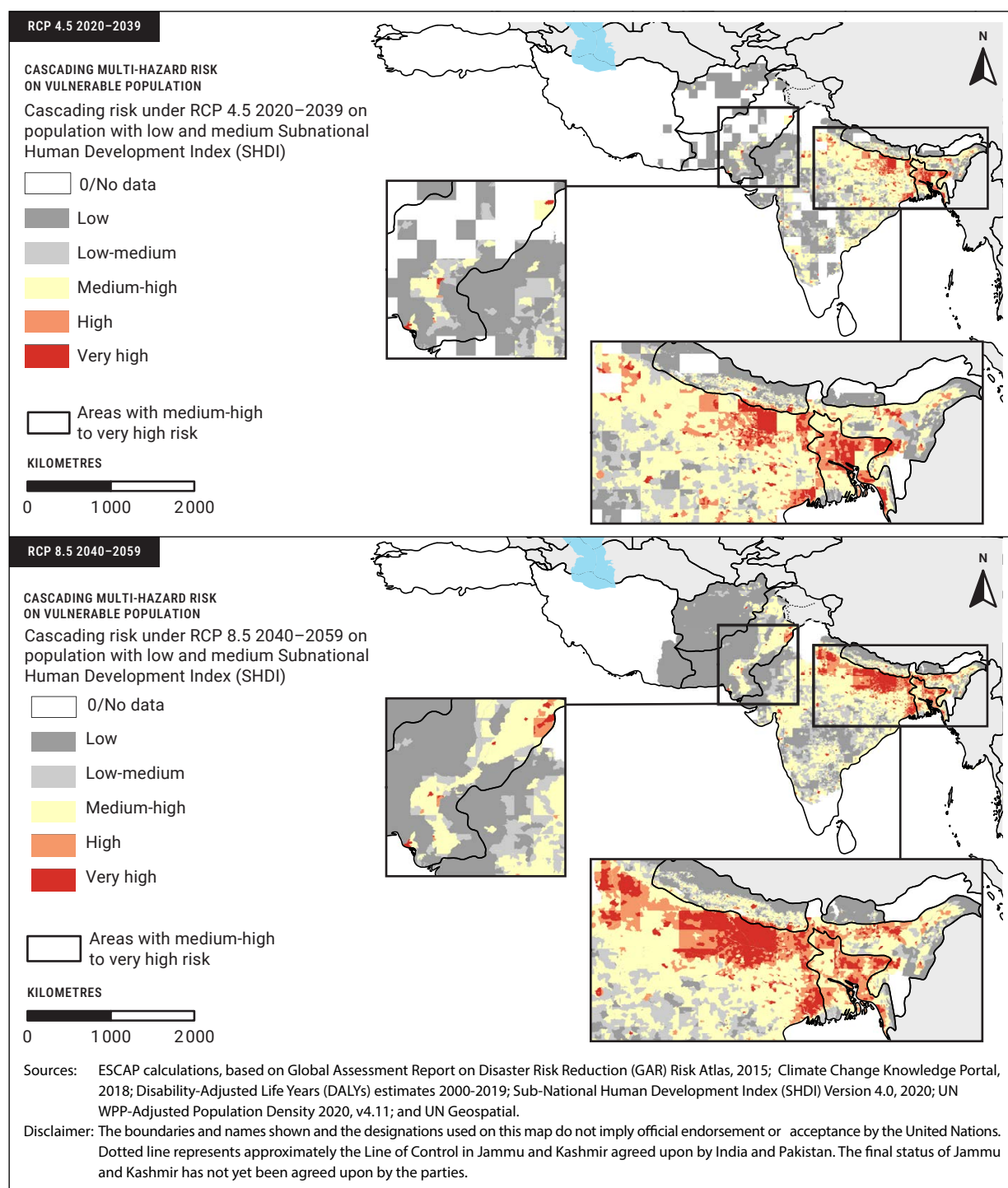
Subregion	Country	Timescale under climate change scenarios →			
		Percentage of population with low/medium HDI under RCP 4.5 (2020–2039)	Percentage of population with low/medium HDI under RCP 4.5 (2040–2059)	Percentage of population with low/medium HDI under RCP 8.5 (2020–2039)	Percentage of population 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

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

20 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>

21 *Asia-Pacific Disaster Report 2019: The Disaster Riskscape across Asia-Pacific* (United Nations publication, 2019a). Available at <https://www.unescap.org/publications/asia-pacific-disaster-report-2019>.

22 World Bank Open Data. Available at <https://data.worldbank.org/indicator/SI.POV.DDAY?view=chart&locations=AF-BD-BT-IN-IR-MV-NP-PK-LK-TR>

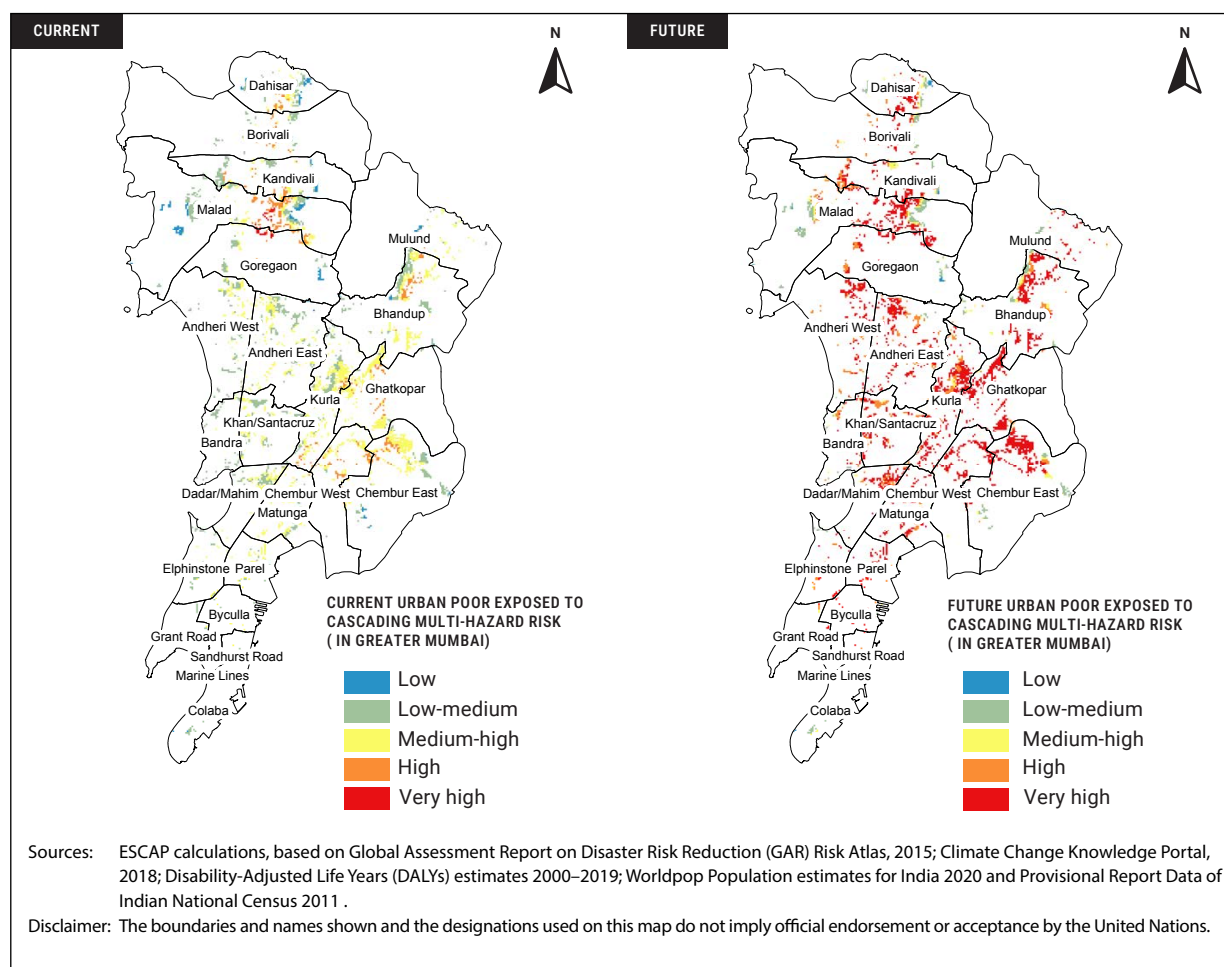
FIGURE 3-5 Populations with lower levels of human development at risk from cascading risks

The urban poor

Climate change is already affecting people in the rapidly growing cities in South and South-West Asia. People in cities are particularly vulnerable to heatwaves which are prevalent in this subregion. 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. This is a concern for some countries in the subregion where substantial urban population lives in slums. The highest estimates of people living in slums as a percentage of urban population are 71 per cent in Afghanistan, 49 per cent in Nepal, 47 per cent in Bangladesh, 40 per cent in Pakistan and 35 per cent in India.²³

As mentioned before, for instance, Asia's largest slum Dharavi, in Mumbai, is located around the Dadar/Mahim, Matunga and Kurla neighbourhoods. As demonstrated in Figure 3-6, under the moderate climate change scenario (RCP 4.5) 2020–2039, the hotspots of urban poor exposed to multi-hazard climate risks can be seen around Bhandup, Borivali, Chembur East, Chembur West, Dadar/Mahim, Dahisar, Ghatkopar, Goregaon, Kandivali, Kurla, Malad Wards. Under the worst-case climate scenario (RCP 8.5) 2040–2059, the former hotspots will intensify, and new hotspots will appear in Andheri East, Andheri West, Bandra, Khan, Matunga, Mulund and Parel Wards areas.

FIGURE 3-6 Urban poor exposed to cascading climate risk in Mumbai



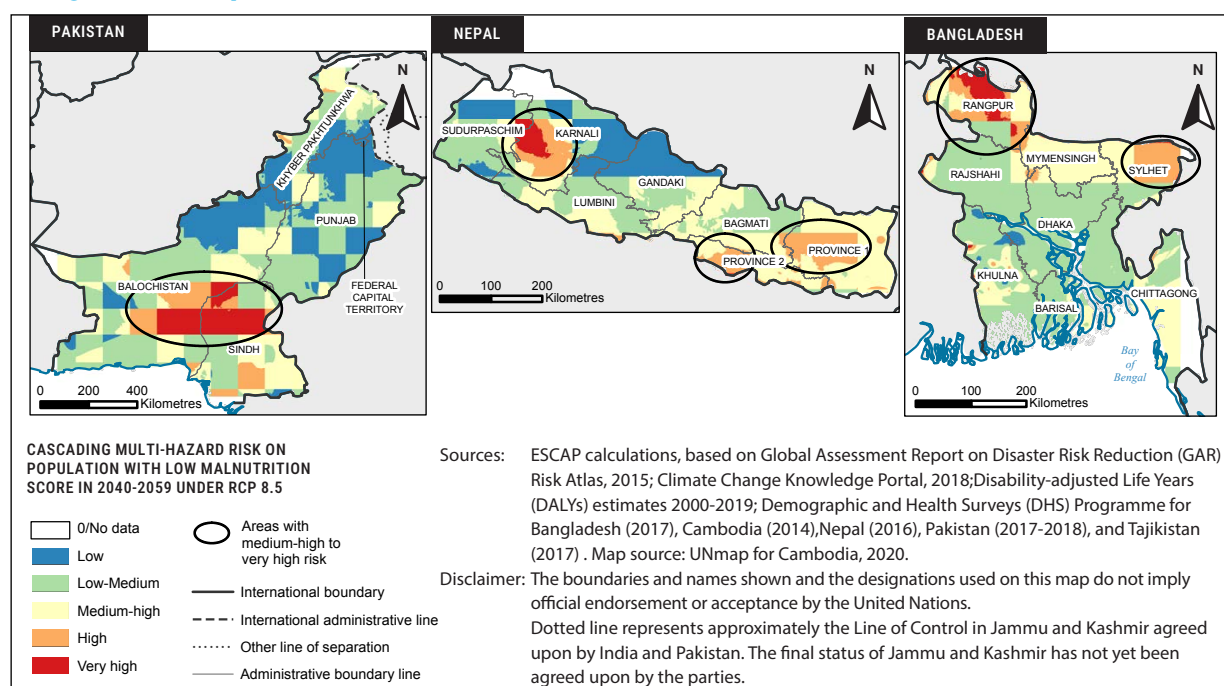
Children and young people

Children

When disasters strike, children, more than adults, are at a higher risk of encountering violence, abuse, neglect and exploitation.²⁴ Children exposed to meteorological hazards, caused by climate change, 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.²⁵

The convergence of climate change, and natural and biological hazards will also increase child malnutrition. This is illustrated in Figure 3-7 for Bangladesh, Nepal and Pakistan for which data was available from the Demographic and Health Surveys. For instance, 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 and means of service delivery like hospitals, schools, and electricity grids, are resilient to the impacts of cascading hazards.

FIGURE 3-7 Projected child malnutrition under the worst-case climate change scenario, Bangladesh-Nepal-Pakistan



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.²⁶ In many countries, women and girls already face multiple barriers in access to healthcare services.²⁷ Moreover, the combination of cascading hazards under climate change is likely to exacerbate the problem (Figure 3-8). For example, in Pakistan, the risk will be greatest in Balochistan and Punjab provinces.

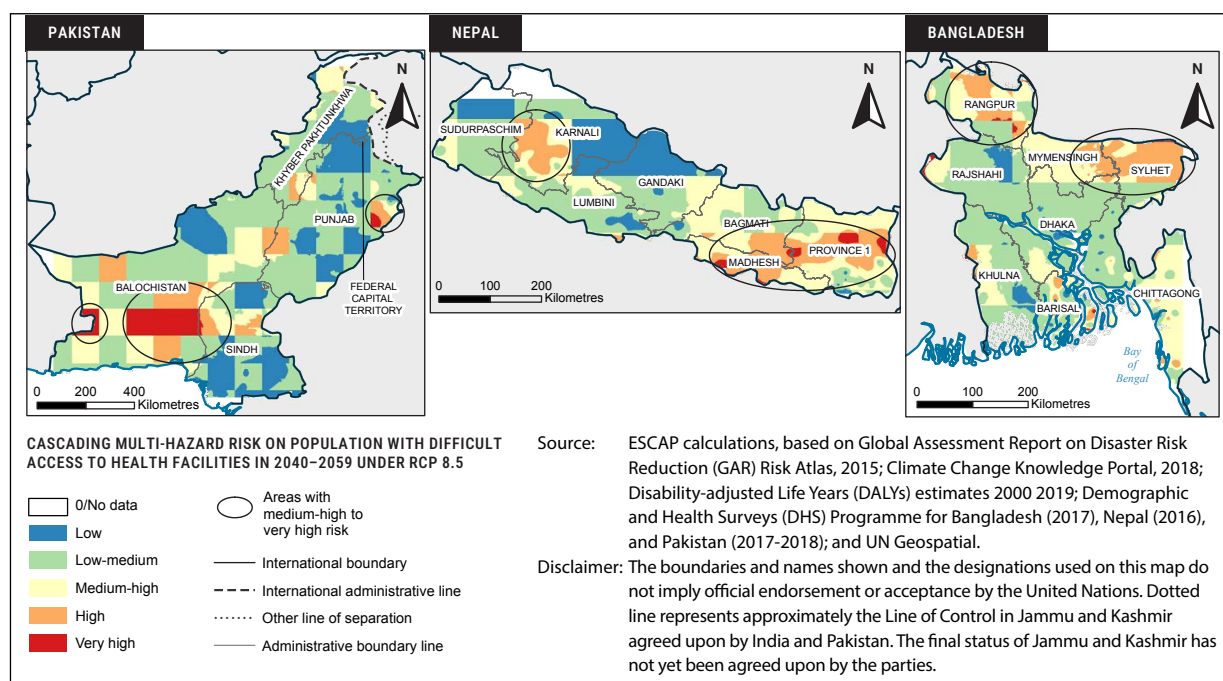
24 International Federation of Red Cross and Red Crescent Societies, "Come heat or high water: Tackling the humanitarian impacts of the climate crises together", World Disasters Report 2020 (Geneva, 2020b). Available at https://media.ifrc.org/ifrc/wp-content/uploads/2020/11/20201116_WorldDisasters_Full.pdf

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

26 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>

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

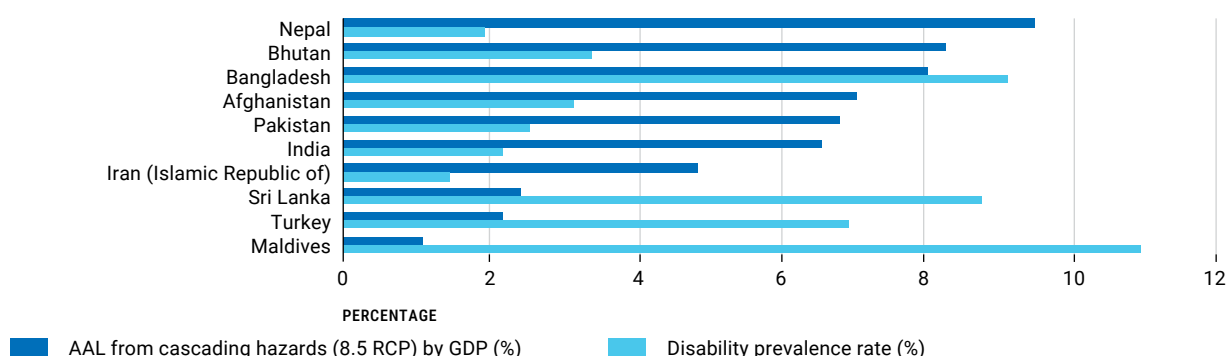
FIGURE 3-8 Proportion of women with limited access to health care under the worst-case climate change scenario, Bangladesh-Nepal-Pakistan



People with disabilities

In South and South-West Asia, disability prevalence stands out for some countries, such as Maldives at 10.9 per cent, Bangladesh at 9.1 per cent, Sri Lanka at 8.7 per cent, and Turkey at 6.9 per cent of their population.²⁸ In Bhutan, Bangladesh, and Afghanistan, there is evidently an overlap between a high disability prevalence and high Average Annual Losses in the worst-case climate change scenario (Figure 3-9). Persons with disabilities are often excluded from disaster risk reduction policies, plans and programmes and therefore cannot contribute to decision-making on measures that would support them.^{29, 30} 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 3-9 Disability prevalence and losses from multi-hazard cascading risks in South and South-West Asia



Source: Data from *Disability at a Glance: Investing in Accessibility in Asia and the Pacific – Strategic Approaches to Achieving Disability-inclusive Sustainable Development* (United Nations publication, 2019b). Available at: <https://www.unescap.org/sites/default/d8files/knowledge-products/SDD-DAG-2019.pdf>

²⁸ *Disability at a Glance: Investing in Accessibility in Asia and the Pacific – Strategic Approaches to Achieving Disability-inclusive Sustainable Development* (United Nations publication, 2019b). Available at: <https://www.unescap.org/sites/default/d8files/knowledge-products/SDD-DAG-2019.pdf>

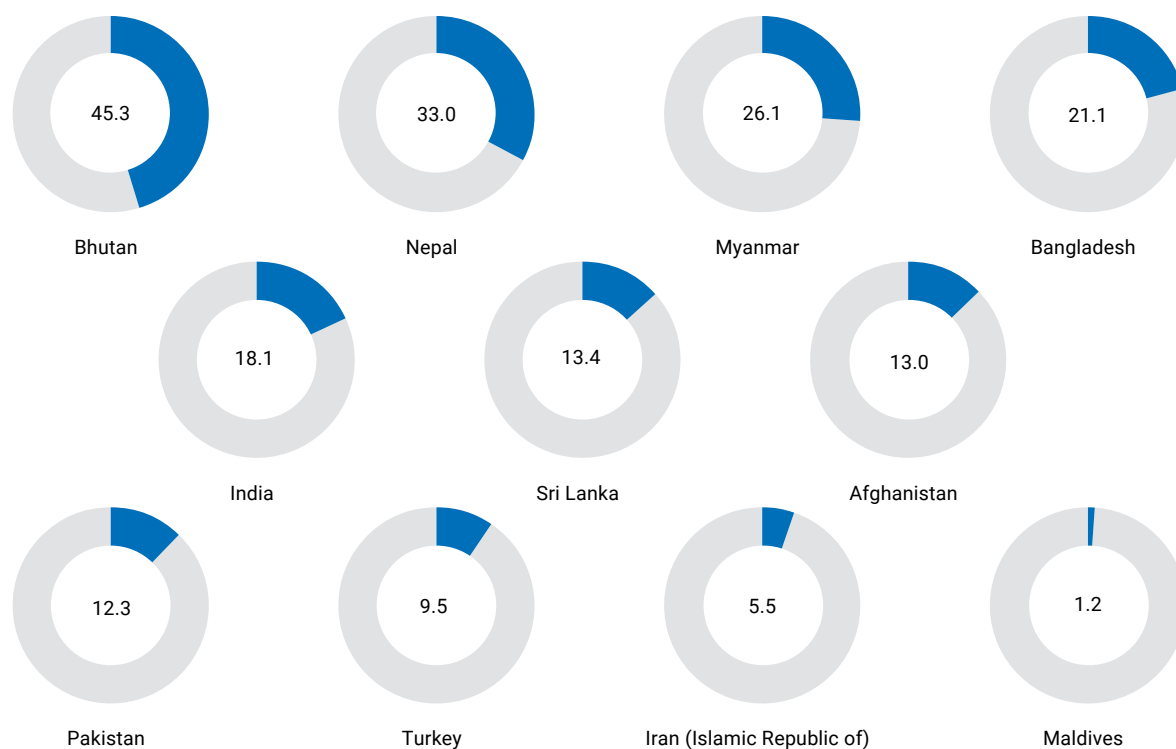
²⁹ Takashi Izutsu, "Disability-inclusive disaster risk reduction and humanitarian action: An urgent global imperative", United Nations World Conference on Disaster Risk Reduction, 29 November 2019. Available at <https://www.un.org/development/desa/disabilities/wp-content/uploads/sites/15/2020/03/Final-Disability-inclusive-disaster.pdf>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

³⁰ 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

Older people

Across South and South-West Asia, more than 200 million people aged above 70 are estimated to be at risk of cascading multi-hazards in the worst-case climate change scenario, the highest proportion of population are recorded in Bhutan, Nepal, Myanmar and Bangladesh (Figure 3-10).

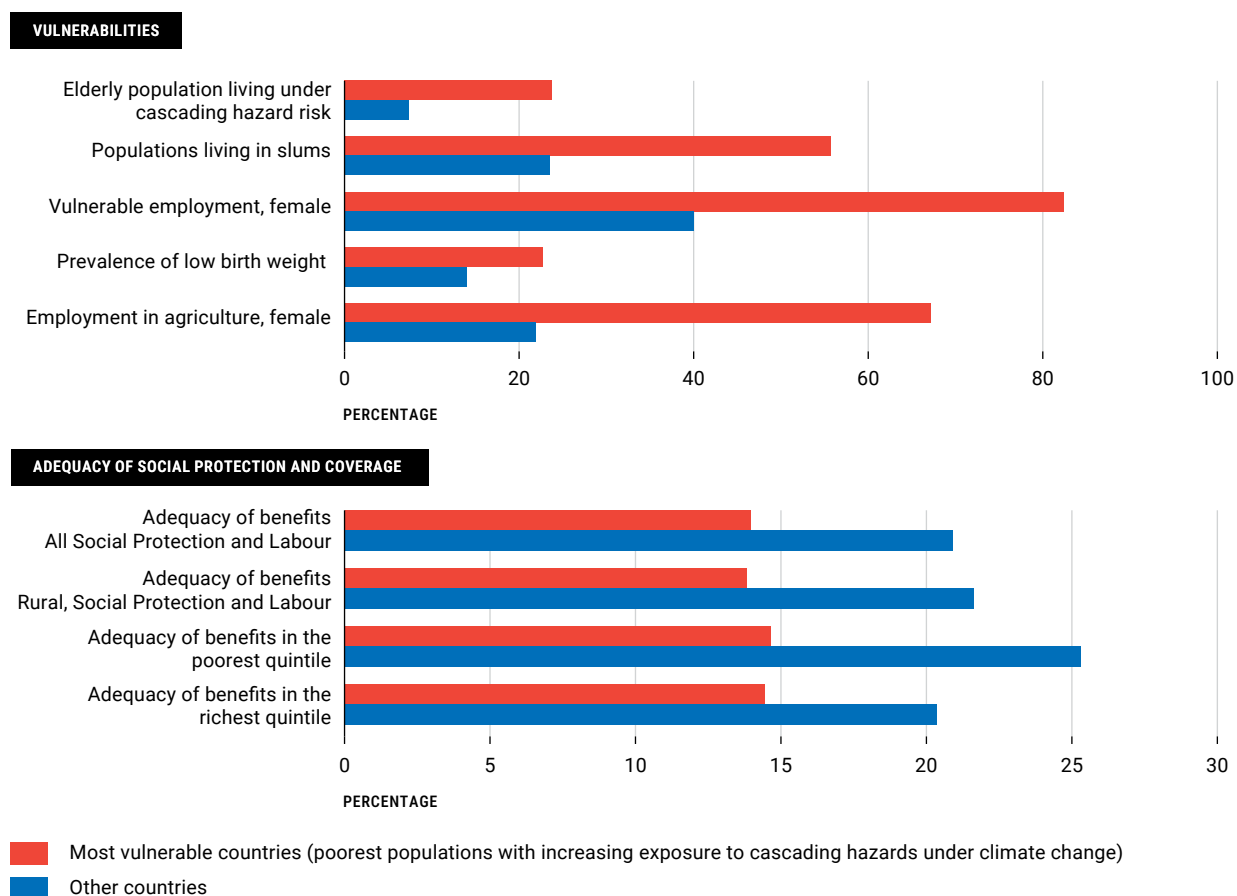
FIGURE 3-10 Percentage of elderly population (people aged over 70) at risk from natural hazards under worst-case scenario



Source: ESCAP estimations based on 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>

Disaster responsive social protection is critical to build resilience

Within South and South-West Asia, those most vulnerable to disasters are the poorest of people, living in countries that offer the least social protection (Figure 3-11). These countries also typically have higher incidences of low birthweight and have more people living in slums. It also stands out that in more vulnerable countries, a larger part of the population, and particularly more women, work in vulnerable employment sectors, such as agriculture, where they are exposed to extreme weather conditions, occupational diseases and poor general health.

FIGURE 3-11 South and South-West Asia countries vulnerable to climate hazards and social protection

Source: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015;

Note: Adequacy of Benefits 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", as defined in the World Bank, "The Atlas of Social Protection Indicators of Resilience and Equity".

Overall, these communities would be less vulnerable to the impacts of disasters if they could rely on social protection that includes disaster preparedness. The scale of the impacts of the COVID-19 pandemic has also shown that it would be better for social protection programmes to be not only shock-responsive, but also shock-prepared.

Identifying critical infrastructure at risk

Natural disasters have a more devastating impact on countries with low-quality infrastructure, including a lack of good roads and telecommunications, which can delay disaster relief and prolong economic disruptions.³¹ 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.

Healthcare Infrastructure

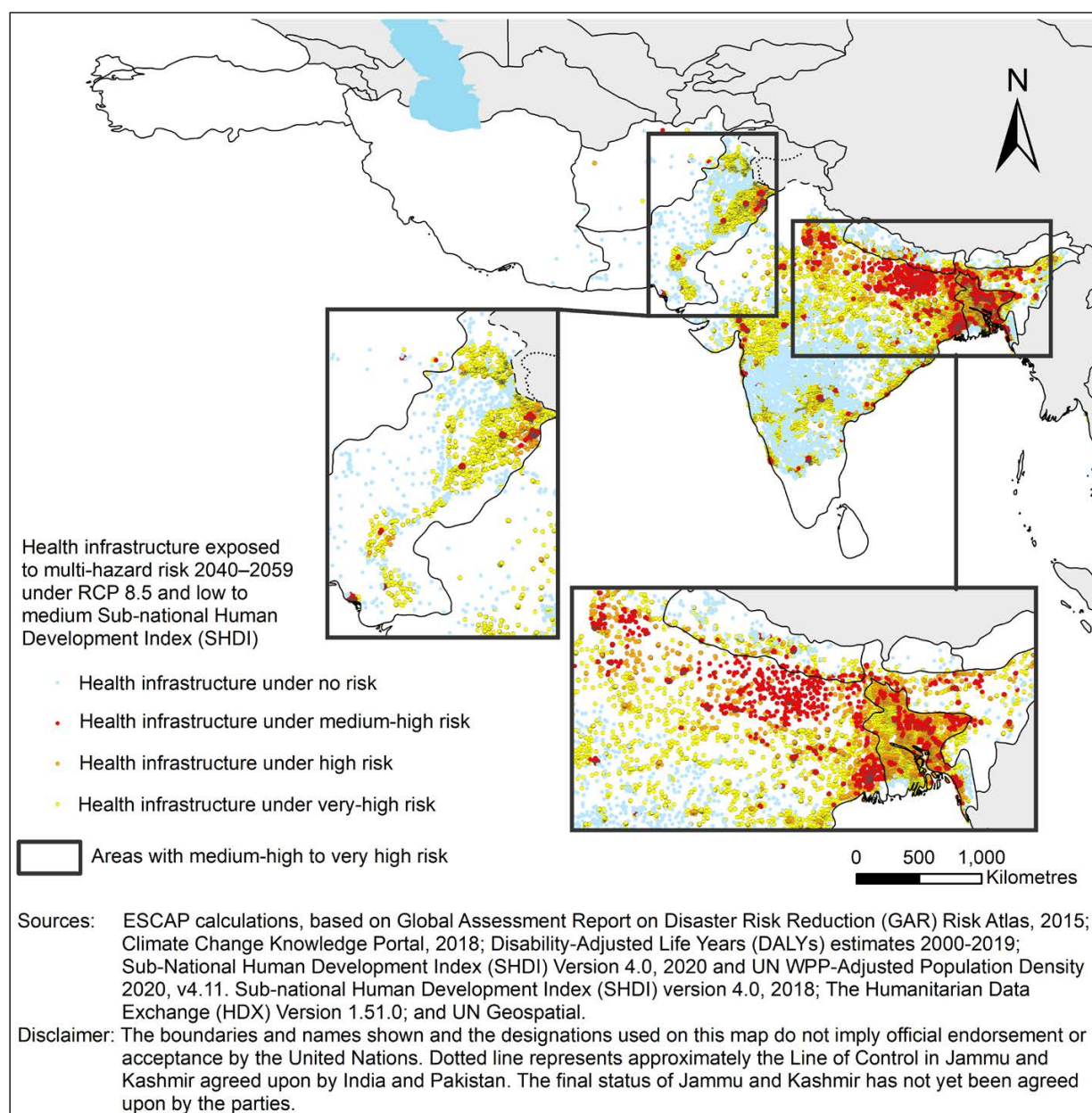
Disasters impose multiple pressures on health systems and disrupt health services exposing people to greater risks in facilities with poor health conditions.³² Figure 3-12 indicates the healthcare facilities for people living in the marginal areas of the low or medium HDI countries and who are at risk from multiple hazards under RCP 8.5. The proportion is the highest in Bangladesh, Nepal, India and Sri Lanka

31 *The Economic and Social Survey of Asia and the Pacific 2021* (United Nations publication, 2021d).

32 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://bmcpublihealth.biomedcentral.com/articles/10.1186/s12889-021-10806-9>

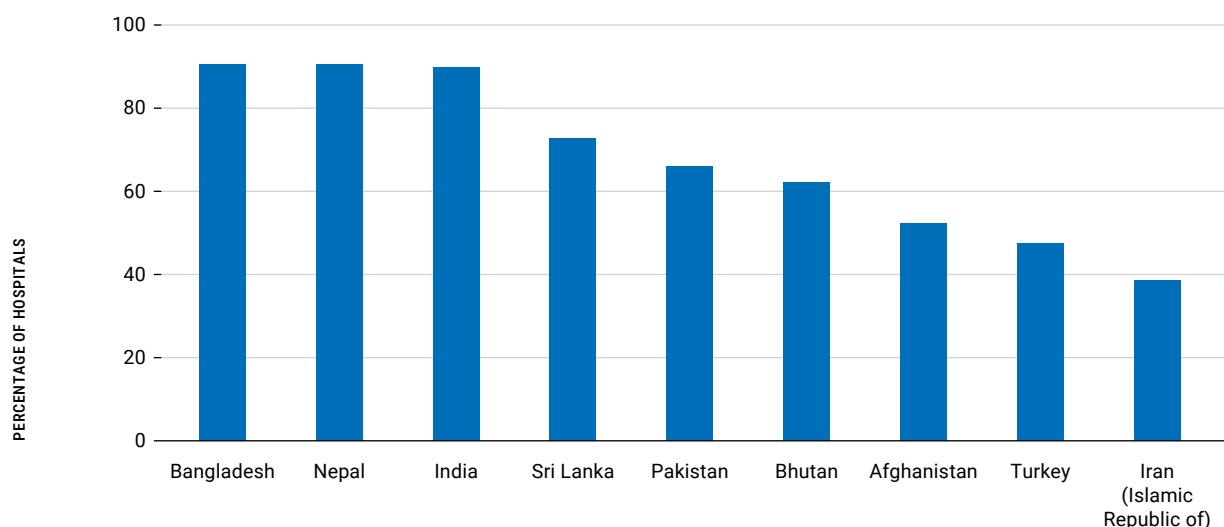
(Figure 3-13). To cope with cascading risks from natural and health hazards, healthcare infrastructure should be risk-informed, and the resilience of health systems to changing climate conditions should be enhanced.³³

FIGURE 3-12 Hospitals serving vulnerable people at risk from natural, biological and other health hazards under the worst-case (RCP 8.5) climate change scenario



33 "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 3-13 Percentage of hospitals serving vulnerable people at risk from natural, biological and other health hazards under the worst-case (RCP 8.5) climate change scenario



Source: ESCAP calculations, based on data from Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; Disability-Adjusted Life Years (DALYs) estimates 2000–2019.

Electricity Infrastructure

Natural hazards can damage energy infrastructure and disrupt power supply. Extreme temperature and changes in precipitation can reduce the capacity of transmission lines, transformers and substations, as well as water volumes for hydropower.³⁴ The links between energy consumption and socioeconomic disadvantage, are generally underappreciated,³⁵ but shutoffs and power outages clearly have a number of direct health impacts, and in the most severe cases, can lead to either hypothermia or heat stress.

ESCAP has analysed the risk to electricity infrastructure 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. In South and South-West Asia, the Ganga-Brahmaputra-Meghna basin, Pakistan, the Islamic Republic of Iran and Turkey are expected to have high exposure of electricity transmission and distribution lines to multi-hazard risk (Figure 3-14). In Nepal, for example, almost 92 per cent of the electricity grid and 96 per cent of hydropower capacity are exposed to multiple risks, which threaten to have dire implications for healthcare facilities and the communities that rely on them (Figure 3-15).

Out of the silos

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

The Sendai Framework of Disaster Risk Reduction 2015–2030 envisages, instead, a paradigm shift from managing disasters to managing risk. It calls for broadening the scope to take into account both natural and man-made hazards along with the related environmental, technological and biological hazards and risks. In this regard, the following chapter discusses how South and South-West Asia can best respond to the growing disaster-climate-health nexus.

34 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).

35 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>

FIGURE 3-14 Electricity infrastructure exposed to multi-hazards under the worst-case (RCP 8.5) climate change scenario

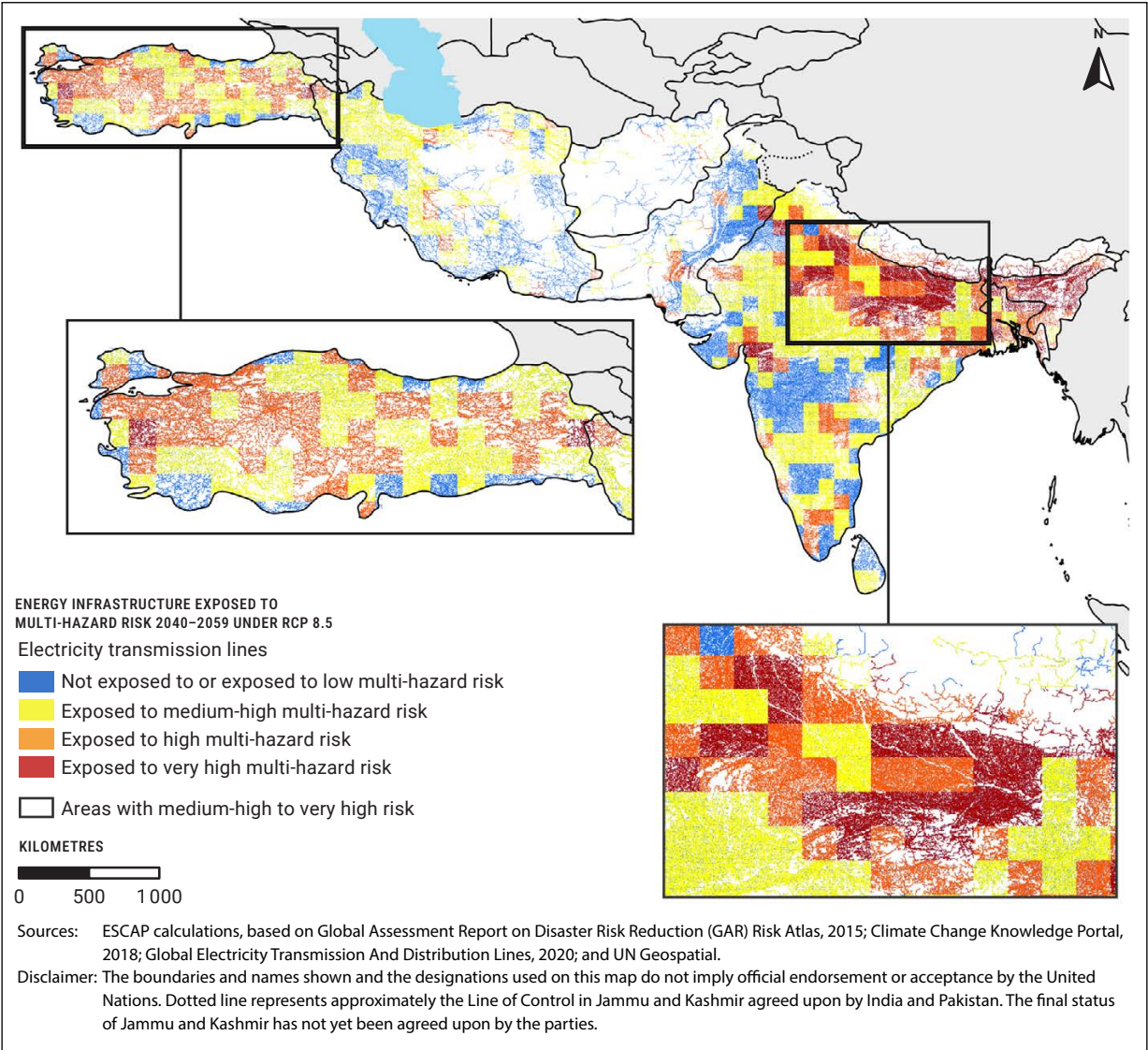
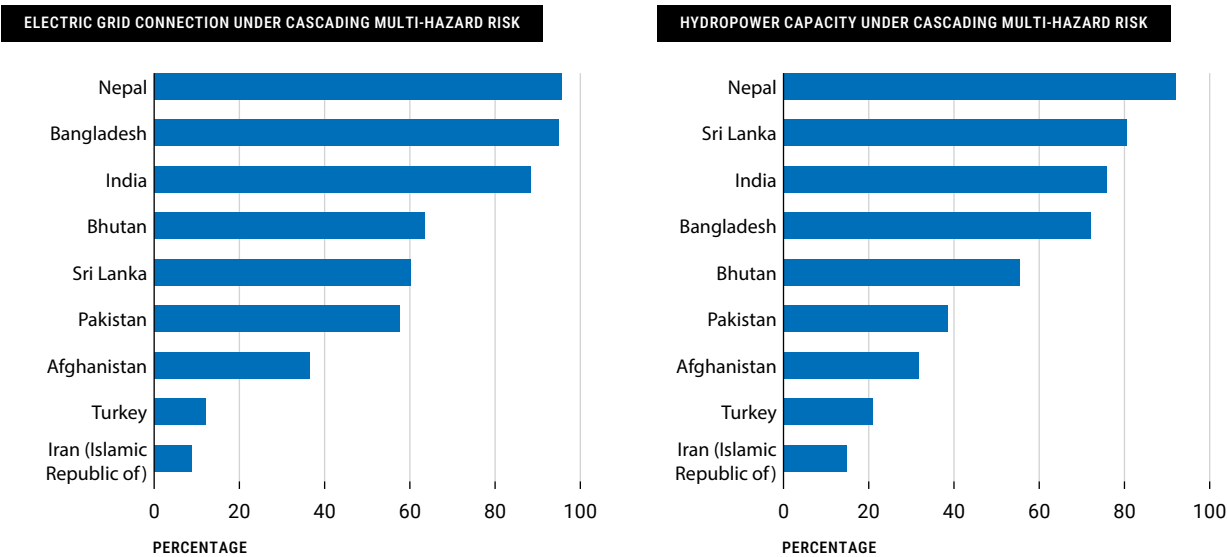


FIGURE 3-15 Proportion of electrical grid and hydropower capacity at risk from multi-hazards under the worst-case (RCP 8.5) climate change scenario



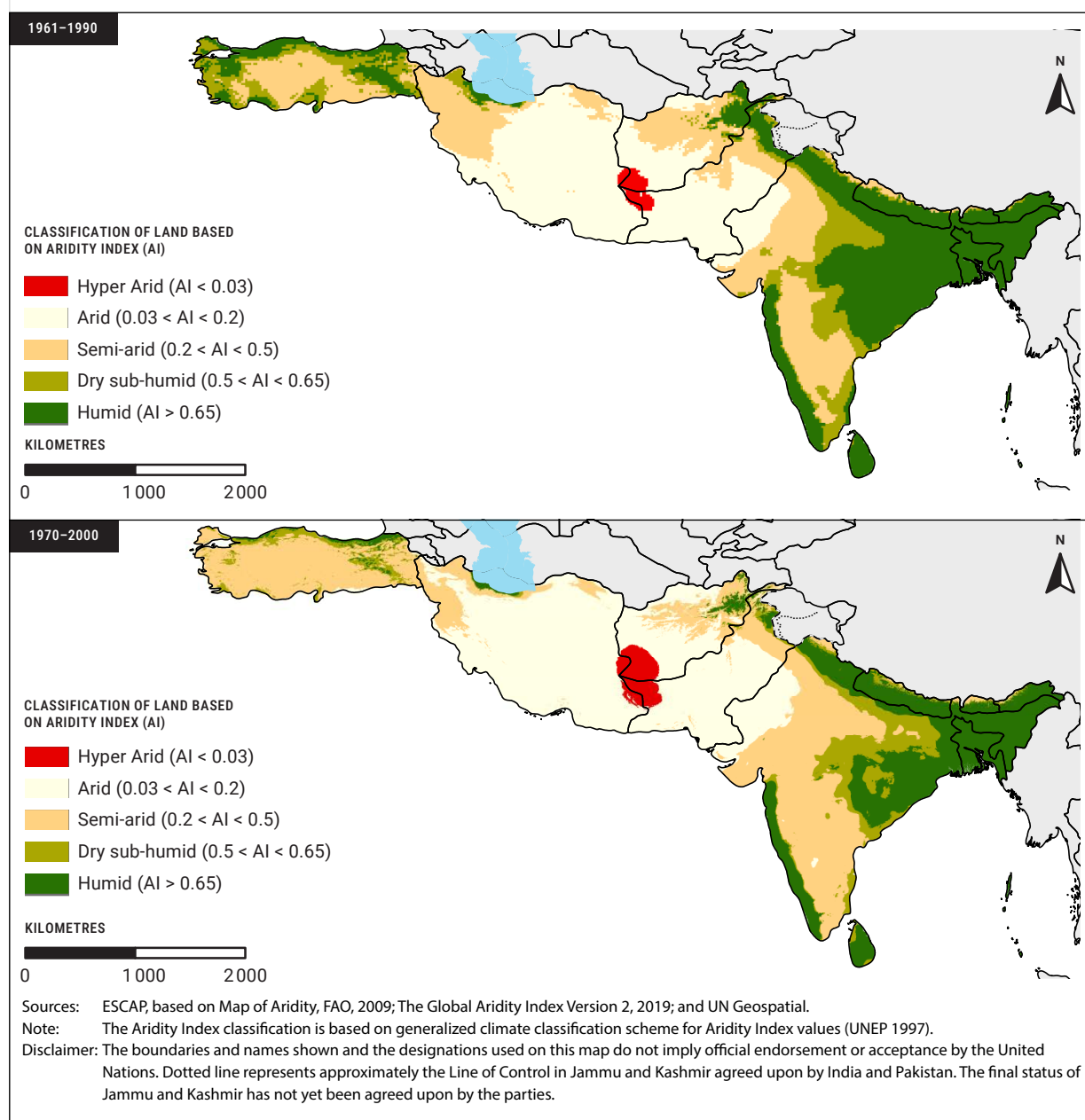
BOX 3-1 Increasing aridity in South and South-West Asia under the new Shared Socioeconomic Pathway models using Coupled Model Intercomparison Project Data

ESCAP analysis shows that arid and semi-arid land has been expanding and the aridity has been intensifying in South and South-West Asia, particularly in Afghanistan, the Islamic Republic of Iran, Pakistan, and India with potential impacts on drought and sand and dust storms.

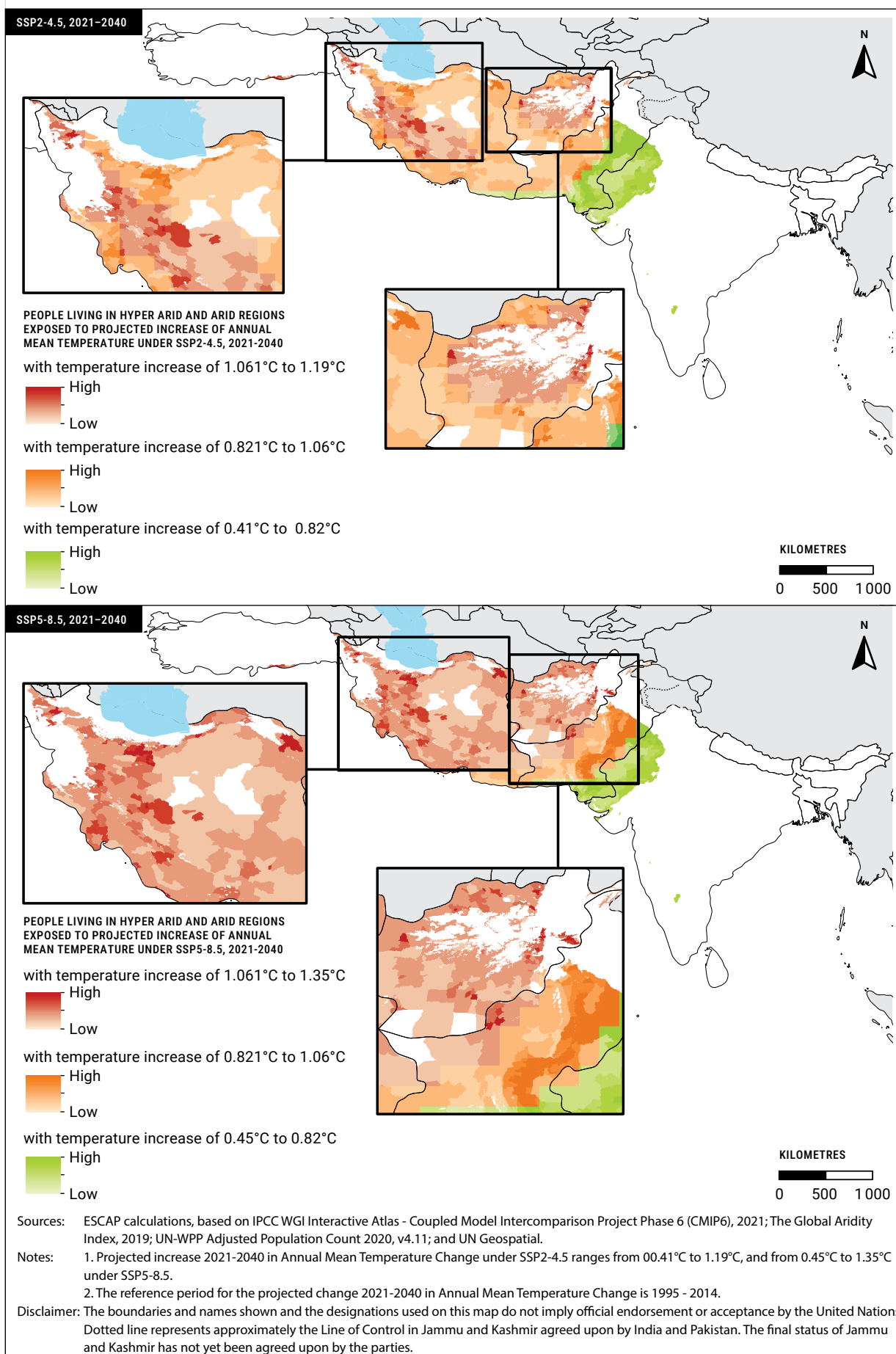
In the bordering areas of Afghanistan, the Islamic Republic of Iran, and Pakistan, hyper arid land is increasing (Figure 3-1A).

Using the latest projections by IPCC from the Shared Socioeconomic Pathways (SSP), ESCAP estimates that, in the subregion, the intersection of aridity with projected increases in temperature under SSP 2 (compared to RCP 4.5) and SSP 5 (compared to RCP 8.5) will result in growing areas of concern for Afghanistan, the Islamic Republic of Iran, Pakistan, and the north-western parts of India (Figure 3-1B).

FIGURE 3-1A Changes in aridity in South and South-West Asia (20 year period)



BOX 3-1

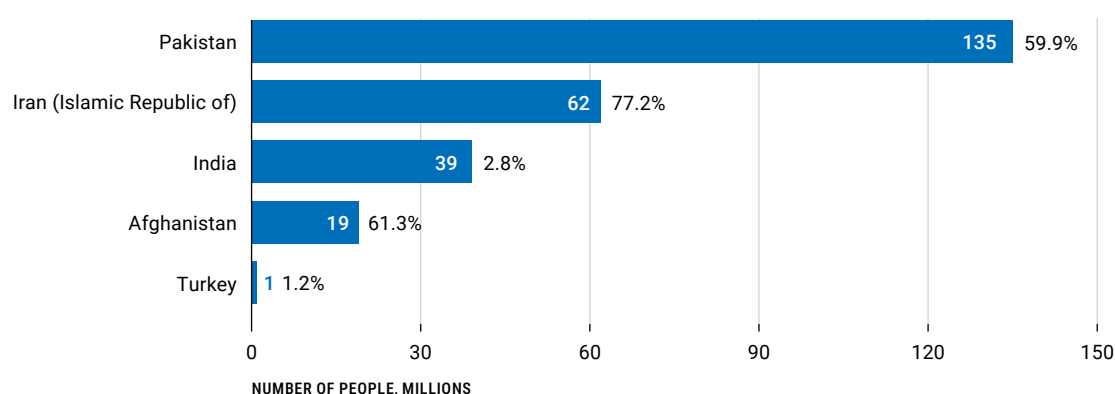
FIGURE 3-1B People living in hyper arid and arid regions with additional exposure to projected increase of annual mean temperature under SSP 2 and SSP 5

BOX 3-1

Currently, about 14.1 per cent of the total population of South and South-West Asia lives in hyper arid and arid regions. Under SSP 2, these populations will face the projected increase in temperature from 0.41°C to 1.19°C, and from 0.45°C to 1.35°C under SSP 5. This could have potentially devastating impacts, leading to an increase in droughts and sand and dust storms in the next 20 years.

Countries with the highest percentage of population living in hyper arid and arid areas exposed to increase in temperature under SSP 2 (compared to RCP 4.5) are the Islamic Republic of Iran (77.2 per cent of the total population), followed by Afghanistan (61.3 per cent), Pakistan (59.9 per cent), India (2 per cent) and Turkey (1.2 per cent) (Annex A).

FIGURE 3-1C People in hyper arid and arid areas exposed to increase in annual mean temperature (SSP 5)



BOX 3-2 Climate change will impact the lives and livelihoods of population dependent on dryland agriculture in South and South-West Asia

In the entire subregion, around 13.2 per cent of agricultural yield is produced in hyper arid and arid regions. 13.1 per cent of total agriculture production will be exposed to projected temperature increases under SSP 2-4.5 and 5-8.5, as noted in the Sixth Assessment report of the IPCC, leading to additional drought and potential increases in climate-related land degradation.

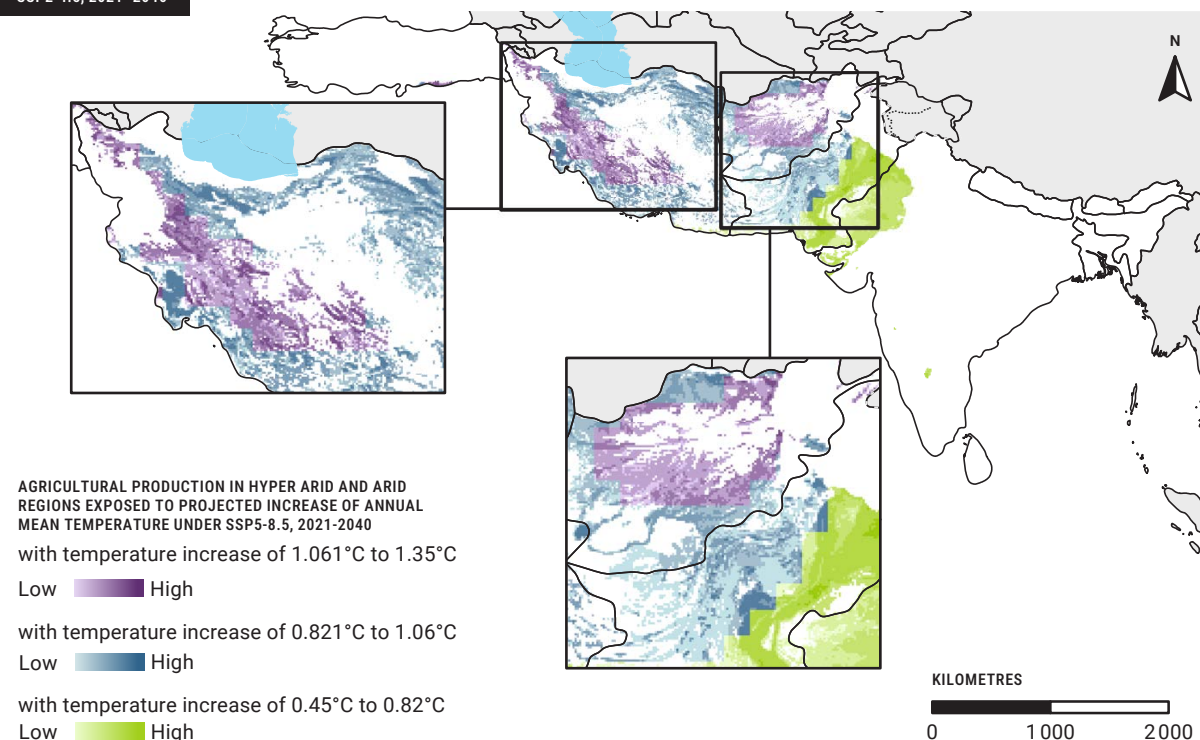
The increase in mean temperatures in hyper arid and arid areas will have a significant impact on dryland agriculture in Afghanistan, India, the Islamic Republic of Iran, Pakistan, and Turkey. Dryland agriculture in India, for example, occupies 68 per cent of India's cultivated areas, supports 40 per cent of human and 60 per cent of livestock population and produces 44 per cent of food requirements and will continue to play a critical role in food security.^a In Afghanistan and the Islamic Republic of Iran, dry land farmers are generally poor and the degradation of water resources has contributed to the relative poverty of rural communities.^{b, c}

In Pakistan, almost 77 per cent of the agricultural production in arid regions will be exposed (Figure 3-2B). This could pose a threat to related livelihoods and food security in the country.

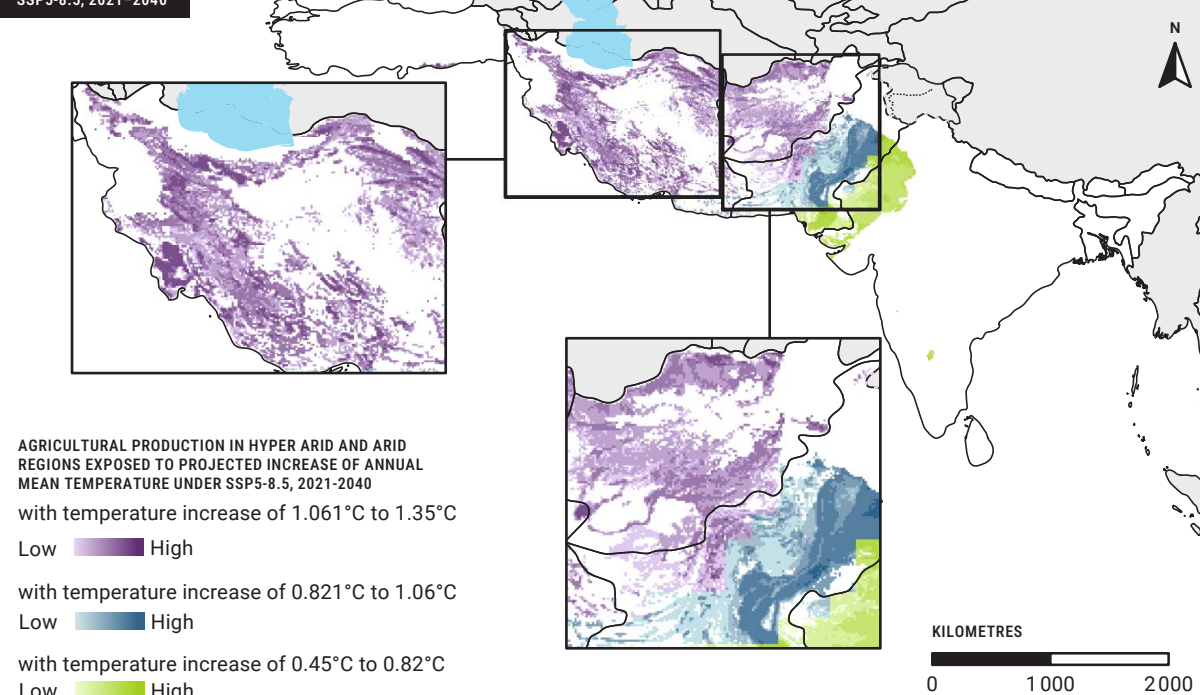
BOX 3-2

FIGURE 3-2A Agricultural production quantity in hyper arid and arid regions exposed to projected increase of annual mean temperatures under SSP2 and SSP5

SSP2-4.5, 2021–2040



SSP5-8.5, 2021–2040



Sources: ESCAP calculations, based on IPCC WGI Interactive Atlas - Coupled Model Intercomparison Project Phase 6 (CMIP6), 2021; The Global Aridity Index, 2019; Global Spatially-Disaggregated Crop Production Statistics Data of 2010 (MapSPAM) V2r0 2020; and UN Geospatial.

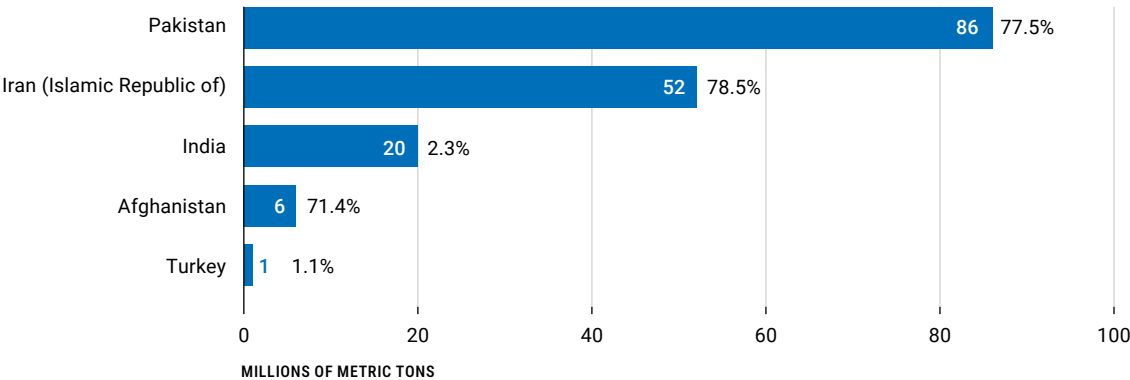
Notes: 1. Projected increase 2021–2040 in Annual Mean Temperature Change under SSP2-4.5 ranges from 0.39°C to 1.19°C, and from 0.45°C to 1.35°C under SSP5-8.5.

2. The reference period for the projected change 2021–2040 in Annual Mean Temperature Change is 1995–2014.

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

BOX 3-2

FIGURE 3-2B **Agricultural production exposed to aridity and projected temperature increases under SSP**



- a Harish P. Singh and others, "Dryland agriculture in India", in *Challenges and Strategies of Dryland Agriculture, Volume 32*, (Winconsin, Crop Science Society of America, American Society of Agronomy, 2004). Available at <https://access.onlinelibrary.wiley.com/doi/abs/10.2135/cssaspecpub32.c6#~:text=Dry%20land%20agriculture%20occupies%2068,role%20in%20India's%20food%20security>
- b A. Ghaffari, "The role of Dryland Agricultural Research Institute in drought mitigation in Iran", *Options Méditerranéennes: Série A.Mediterranean Seminars*, vol. 95 (2010), pp. 273–278.
- c Michael Jacobs, Catherine A. Schloeder, and Philip D. Tanimoto, "Dryland agriculture and rangeland restoration priorities in Afghanistan", *Journal of Arid Land*, vol. 7 (2015), pp. 391–402. Available at <https://doi.org/10.1007/s40333-015-0002-7>



CHAPTER 4

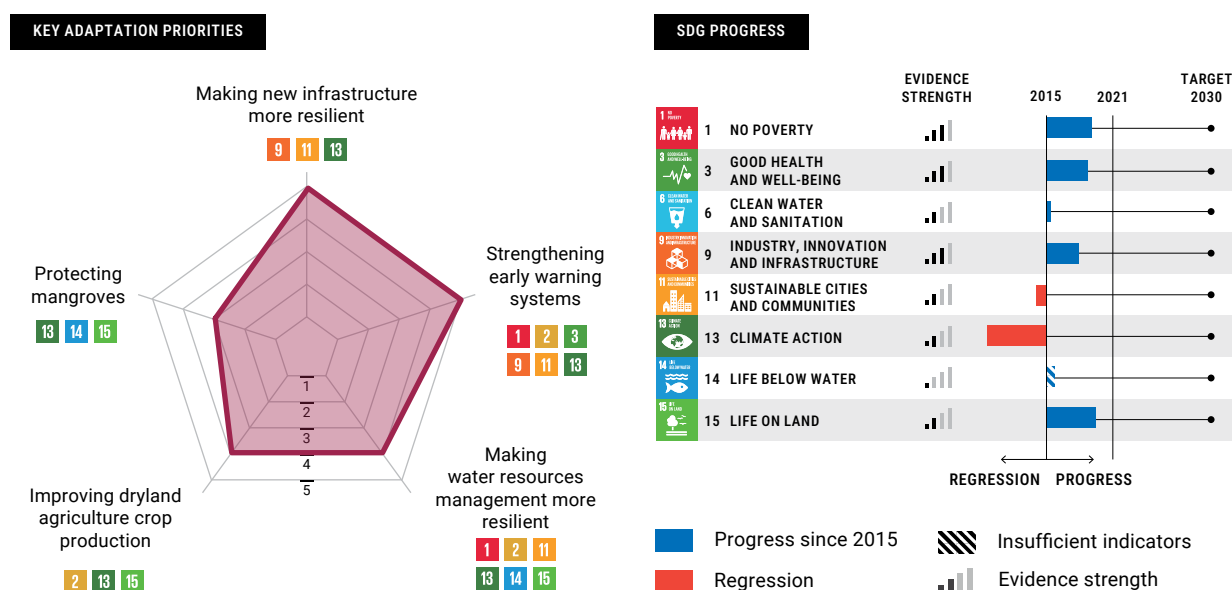
Building resilience to cascading risks to accelerate implementation of the Sustainable Development Goals

Key highlights

- ESCAP estimated a total annual adaptation cost of \$61.5 billion for South and South-West Asia under the worst-case climate change scenario, from which \$57.1 billion is the adaptation cost for climate-related hazards and \$4.4 billion is the adaptation cost for biological hazards.
- Economic recovery from the COVID-19 pandemic must include investing in climate adaptation to build resilient economies and populations to future crises and to meet the targets of Sustainable Development Goals, such as SDG 13, SDG 14 and SDG 15.
- ESCAP Risk and Resilience Portal shows that the top adaptation solutions for South and South-West Asia to support SDG Goals 13, 14 and 15 in order are:
 - Strengthening early warning systems (Supports SDG 13: All targets)
 - Making new infrastructure resilient (Supports SDG 13: All targets)
 - Making water management systems more resilient (Supports SDG 13: Target 13.1; SDG 15: Target 15.3)
 - Improving dryland agriculture (Supports SDG 15: Target 15.3)
 - Protecting mangroves (Supports SDG 14: Target 14.2)

SDG progress and resilience of South-West Asia

FIGURE 4-1 Snapshot of SDG progress in South and South-West Asia, 2021



Source: *Asia and the Pacific SDG Progress Report 2022* (United Nations publication, 2022).

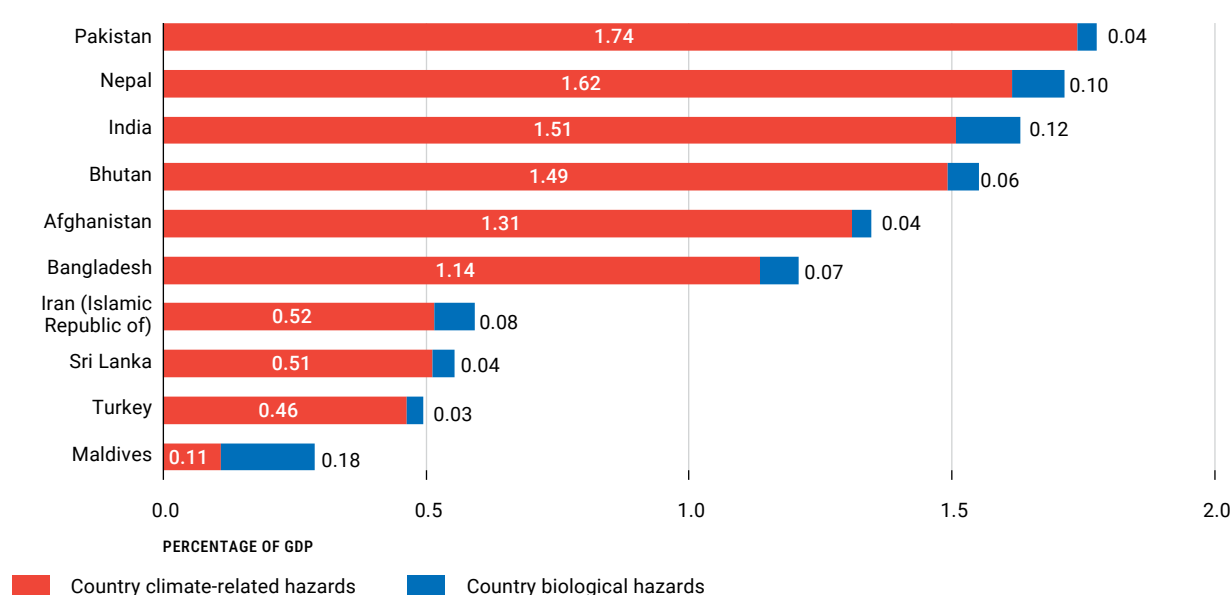
Significant progress has been made towards achieving several SDGs in South and South-West Asia (Figure 4-1). Nevertheless, **gaps remain, especially as regression is recorded for several goals, such as Goal 11 (Sustainable cities and communities), Goal 12 (Responsible consumption and production) and Goal 13 (Climate action)**. Particularly, among others, there is a need to accelerate progress on targets 11.5, 11.b and 13.1 on building resilience to disasters, developing disaster risk management policies, resilience and adaptive capacity respectively as well as a reverse trend on targets 12.2 and 13.2 on sustainable use of natural resources and climate change policies respectively.³⁶ These signal the need for enhanced adaptation measures to be put in place to build resilience and achieve the SDGs.

36 *Asia and the Pacific SDG Progress Report 2022* (United Nations publication, 2022). Available at: https://www.unescap.org/sites/default/d8files/knowledge-products/ESCAP-2022-FG_SDG-Progress-Report.pdf

ESCAP estimated a total annual adaptation cost of \$61.5 billion for South and South-West Asia under the worst-case climate change scenario, from which \$57.1 billion is the adaptation cost for climate-related hazards and \$4.4 billion is the adaptation cost for biological hazards. At the country level, the highest total adaptation cost is recorded for India at \$45.3 billion, followed by Pakistan with \$5 billion and Bangladesh with \$3.3 billion. However, when considering the size of the economy, the picture alters. The costs of adapting to climate change, as a percentage of GDP, varies from 1.8 per cent and 1.7 per cent in Pakistan and Nepal, respectively, to 0.3 per cent in Maldives. The highest adaptation cost for biological hazards, as a percentage of the country's GDP, is estimated at 0.18 per cent for Maldives, and at 0.12 per cent for India.

Figure 4-2 also shows that the least developed countries (LDCs) in the region; Afghanistan, Bangladesh, Bhutan, and Nepal also record very high requirements for adaptation investment as economic assets are highly exposed to natural hazards in these countries.³⁷

FIGURE 4-2 South and South-West Asia adaptation costs for climate-related hazards and biological hazards as percentage of GDP, by country



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). For instance, while the adaptation cost per year in the INDC submitted by Bangladesh records \$2.67 billion,³⁸ ESCAP estimates suggest that this amount should be raised to \$3.86 billion given the risk landscape of Bangladesh.

Building comprehensive recovery through key adaptation measures

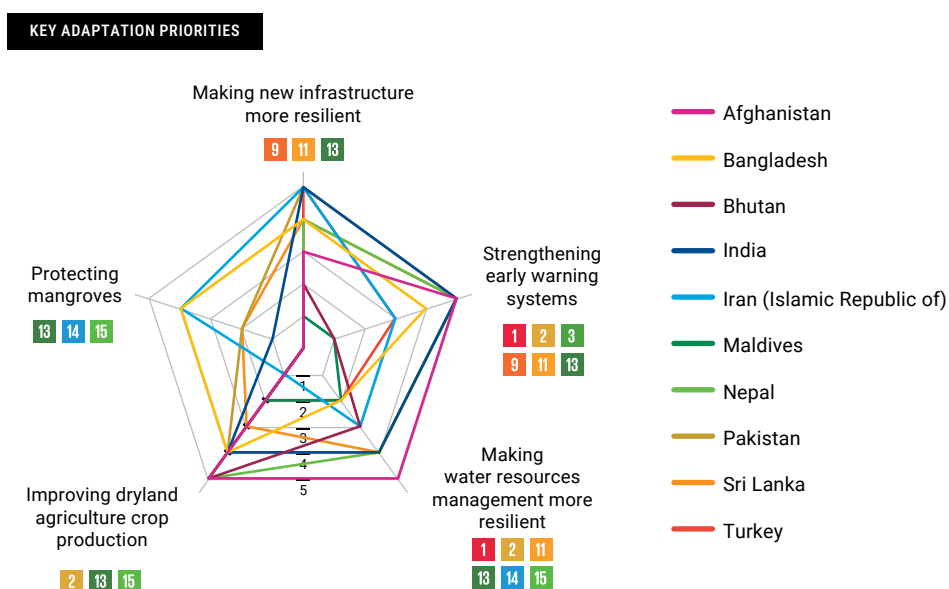
Countries need to invest in key adaptation priorities specific to their respective disaster riskscape. The Global Commission on Adaptation has established five key priorities that yield a high cost-benefit ratio, for adapting to the new riskscape of natural and biological hazards: strengthening early-warning systems; making new infrastructure resilient, making water resource management more resilient, improving dryland agriculture crop production and protecting mangroves.³⁹ Building on these five priorities, the following adaptation investment priorities are recommended for South-West Asian countries, along with their linkages to SDGs (Figure 4-3).

³⁷ *Economic and Social Survey of Asia and the Pacific 2019: Ambitions beyond Growth* (United Nations publication, 2019c).

³⁸ World Bank INDC portal. Available at <http://spappssecext.worldbank.org/sites/indc/Pages/INDCHome.aspx>

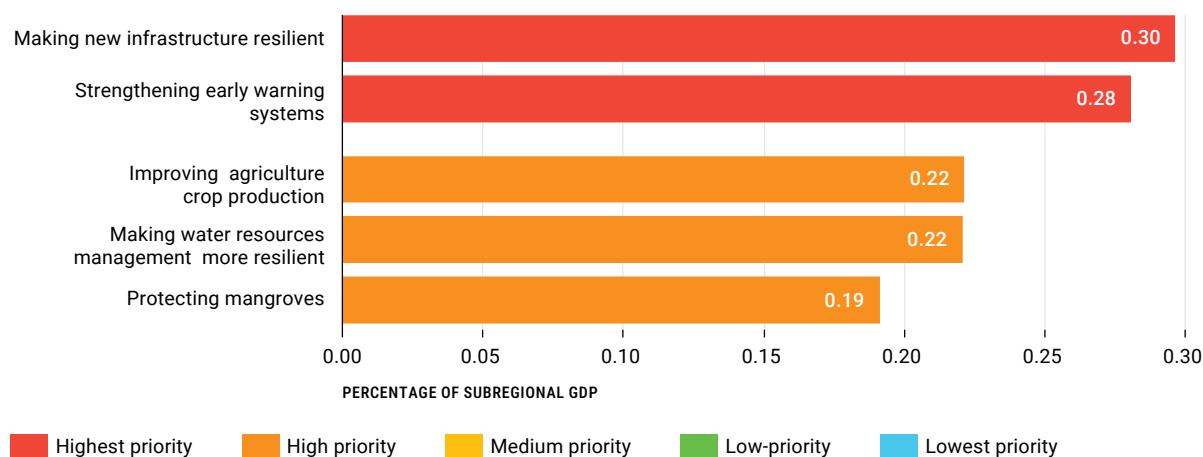
³⁹ Global Center on Adaptation, "Adapt now: A global call for leadership on climate resilience", 13 September 2019. Available at <https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/> (accessed on 26 March 2021).

FIGURE 4-3 How the five priority adaptation measures support achieving SDGs in South and South-West Asia



For South and South-West Asia, the top adaptation priorities are strengthening early warning systems, and making new infrastructure resilient followed by making water resources management more resilient, improving dryland agriculture crop production, and protecting mangroves.

FIGURE 4-4 Estimated adaptation cost and priorities for South and South-West Asia



Source: ESCAP (2021) "Risk and Resilience Portal". Available at: rrp.unescap.org

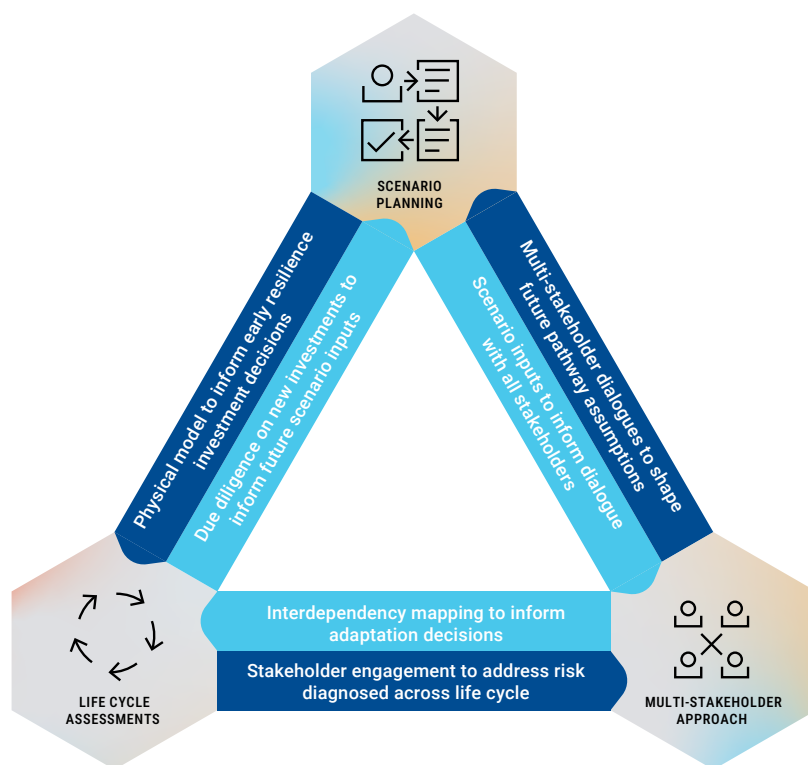
1. Strengthening Multi hazard early warning systems

Disaster risk reduction and climate change adaptation will rely on effective early warning systems. Early warning systems are identified as a top priority in the NDCs on climate change for a number of LDCs, yet countries often lack the capacity or financial resources to implement them. LDCs should be able to take advantage of the Global Framework for Climate Services (GFCS) to incorporate science-based climate information and prediction into planning and policymaking and utilize the key initiatives under development by the World Meteorological Organization (WMO). ESCAP partnerships with the UK Met Office and the Regional Integrated Multi-hazard Early Warning Systems (RIMES), through the South Asia Climate Outlook Forum, and the Asia Regional Resilience to a Changing Climate programme, can improve early warning systems in multi-hazard risk hotspots in South Asia.

2. Making new infrastructure resilient

All infrastructure investment must be risk-informed. Infrastructure covers not only discrete assets, such as roads and buildings, but also collective sets of systems and services that can be synchronized to provide essential services. In this regard, the report recommends a three-pillar approach: dynamic scenario planning, lifecycle assessments and multi-stakeholder engagement, with multiple interdependencies among the three pillars (Figure 4-5).⁴⁰

FIGURE 4-5 The three-pillar approach to risk-informed infrastructure



Source: Adapted from Marsh & McLennan Advantage, "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

Dynamic scenario planning should combine all technical innovations, analytics and expertise to understand the sensitivity and exposure of infrastructure and related services in the face of climate hazards. For example, in coastal cities all new infrastructure should take into account sea-level rise and potential increased frequency of storms. Effective climate risk integration should engage all stakeholders in short-medium- and long-term scenario planning, and in lifecycle infrastructure assessments (Box 4-1 and 4-2).

In addition to these three pillars, all new infrastructure, as well as retrofits to existing infrastructure, must take into account changing natural ecosystems. The best way to do this is by **combining traditional grey infrastructure with green infrastructure**. For example, for water resource management, grey infrastructure components would include building reservoirs, pipe networks and treatment plants, while complementary green infrastructure would include watersheds that improve source water quality and wetlands to filter wastewater effluents. This is not only a cost-effective approach, it also empowers communities by engaging local stakeholders and incorporates longer-term flexibility for responding to changing climate conditions.⁴¹ Building infrastructure resilience would support the achievement of SDG 9 (Industry, innovation and infrastructure), SDG 11 (Sustainable cities and communities), and SDG 13 (Climate action).

40 Marsh & McLennan Advantage, "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

41 Greg Browder and others, *Integrating Green and Gray Creating Next Generation Infrastructure* (Washington, D.C., World Bank Group and World Resources Institute, 2019). Available at <https://openknowledge.worldbank.org/handle/10986/31430>

3. Protecting mangroves

One of the most important nature-based climate adaptation measures is the conservation and restoration of mangroves which face the threat of being converted for aquaculture and coastal development. Mangroves reduce the impact of tropical cyclones, storm surges, coastal flooding and erosion (SDG 14: Life below water), and thus support climate adaptation (SDG 13: Climate action).

A recent study coupling hydrodynamic and economic models has assessed the amount of property damage that is avoided each year as a result of mangrove cover.⁴² By combining these avoided economic losses with the average annual loss (AAL) due to tropical cyclones presented in chapter 1, it is evident that in South and South-West Asia, losses would increase substantially in the absence of the mangrove cover, especially in India, Bangladesh, Pakistan and Sri Lanka (Table 4-1).

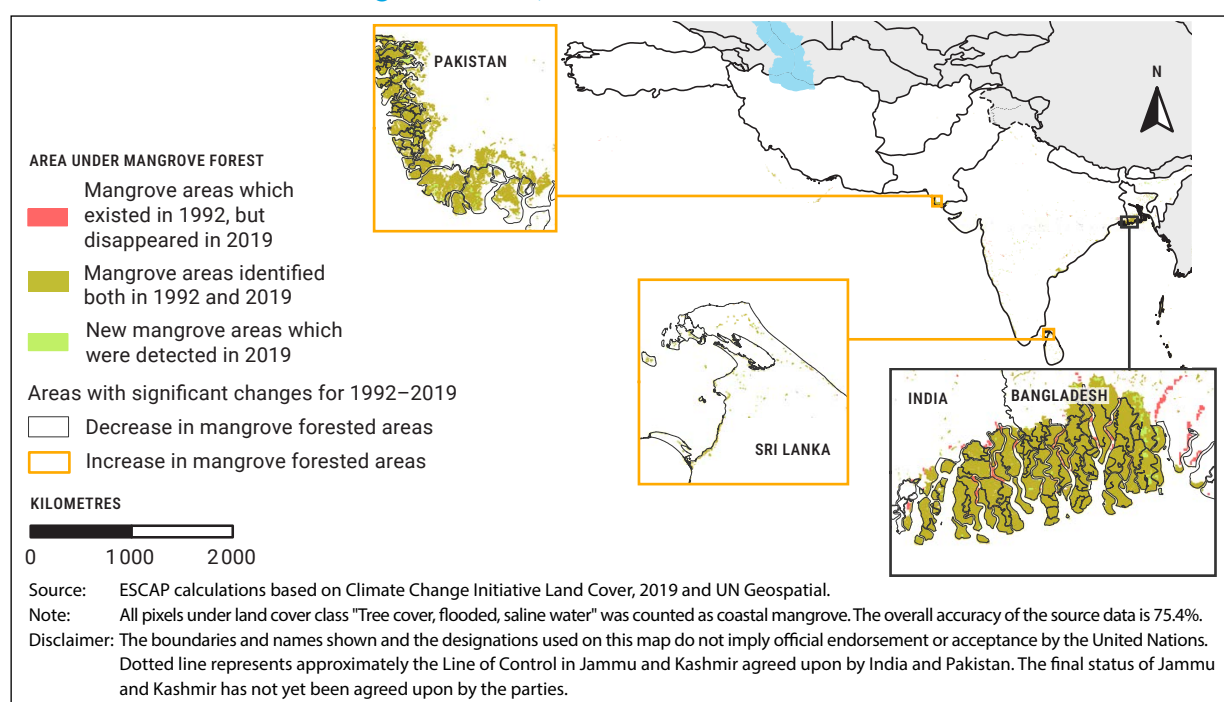
TABLE 4-1 **Flood AAL and losses prevented by mangrove cover**

Country	Avoided property losses due to mangrove cover, \$ billions	Tropical cyclone AAL – current scenario, \$ billions	Total losses if mangrove cover was lost, \$ billions
Iran (Islamic Republic of)	0.0160	0.0002	0.0162
Sri Lanka	0.0040	0.0369	0.0409
Pakistan	0.1310	0.0466	0.1776
Bangladesh	1.5590	0.8903	2.4493
India	7.8360	3.4350	11.2710

Source: ESCAP calculations, based on Pelayo Menéndez and others, "The Global Flood Protection Benefits of Mangroves", *Scientific Reports*, vol. 10, No. 4404 (10 March 2020). Available at <https://www.nature.com/articles/s41598-020-61136-6>

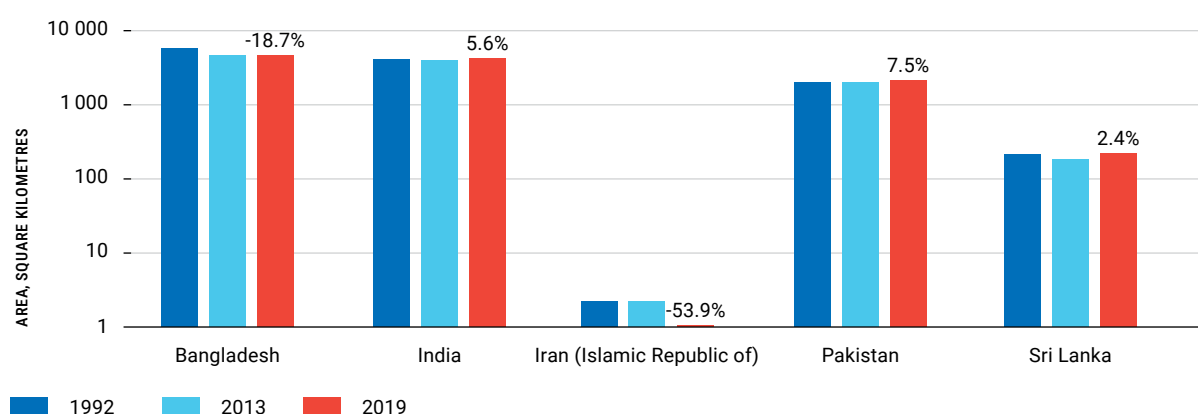
Between 1992 and 2019 South and South-West Asia lost 6 per cent of its mangrove cover with Bangladesh and the Islamic Republic of Iran among the countries that saw significant decreases in their mangrove cover. In these cases, mangrove losses were attributed to tropical cyclones, coastal erosion and sea level rise.⁴³

FIGURE 4-5 **Area under mangrove cover, 1992 and 2019**



42 Pelayo Menéndez and others, "The Global Flood Protection Benefits of Mangroves", *Scientific Reports*, vol. 10, No. 4404 (10 March 2020). Available at <https://www.nature.com/articles/s41598-020-61136-6>

43 C. Giri and others, "Status and distribution of mangrove forests of the world using earth observation satellite data", *Global Ecology and Biogeography*, vol. 20, No. 1 (17 August 2010) pp. 154–159.

FIGURE 4-6 Area of mangrove forest and percentage change, by country, 1992–2019

Source: ESCAP calculations based on Climate Change Initiative Land Cover, 2019

Note: The Y-axis scale is logarithmic.

4. Making water resources management more resilient

Sustainable year-round solutions for water resource management include rainwater harvesting, and reuse of wastewater. For resilient water infrastructure, the grey measures include reservoirs, tanks, ponds, canals, check dams and levees. A green alternative to grey infrastructure is storing water in the groundwater aquifer. It will also be important to strengthen traditional water management systems. In agrarian societies these have generally been developed either for water harvesting in the arid or semi-arid areas or water management for irrigation purposes.

5. Dryland agricultural systems

Drylands are susceptible to degradation, with a decline in the soil's water-holding capacity and fertility, reducing agricultural output and increasing the land's vulnerability to drought. This can be addressed by integrated spatial land-use planning and a multidisciplinary approach to land management. This can include practices like integrated soil fertility management and watershed management to reduce soil erosion and run off, vegetation management and sustainable forest management.

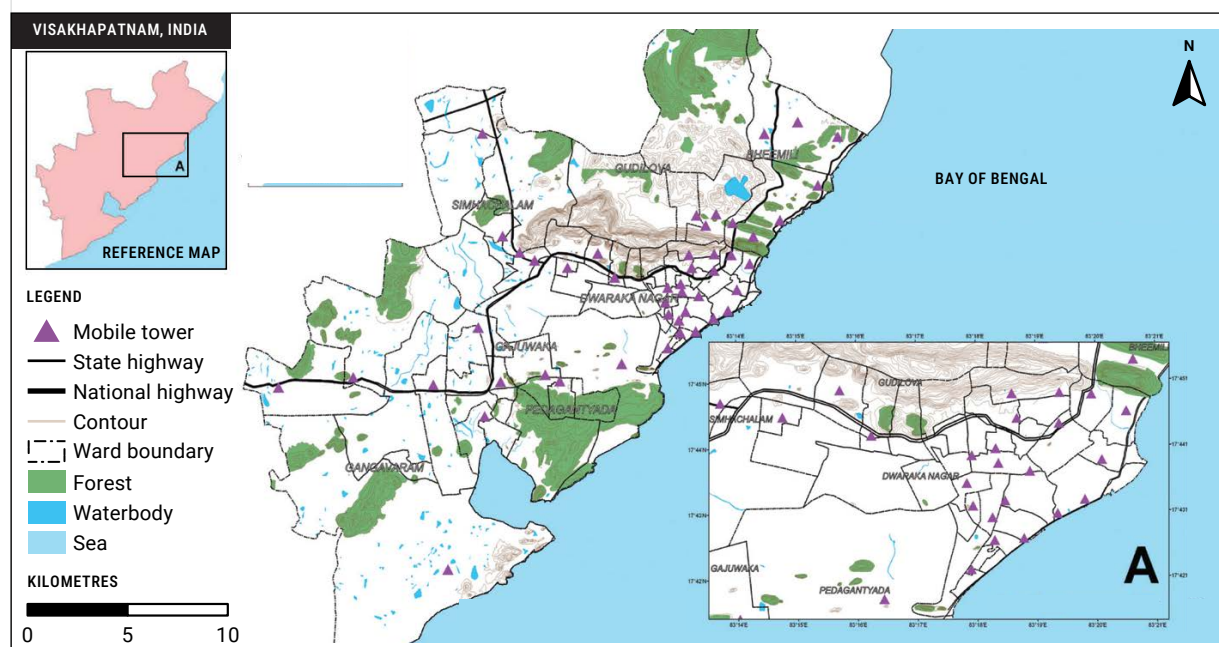
BOX 4-1

Scenario planning in the coastal city of Visakhapatnam, India

An example of scenario planning at the city level is the assessment carried out by the Energy and Resources Institute (TERI) which was submitted to the city government, municipal corporation, and the urban development authority.^a

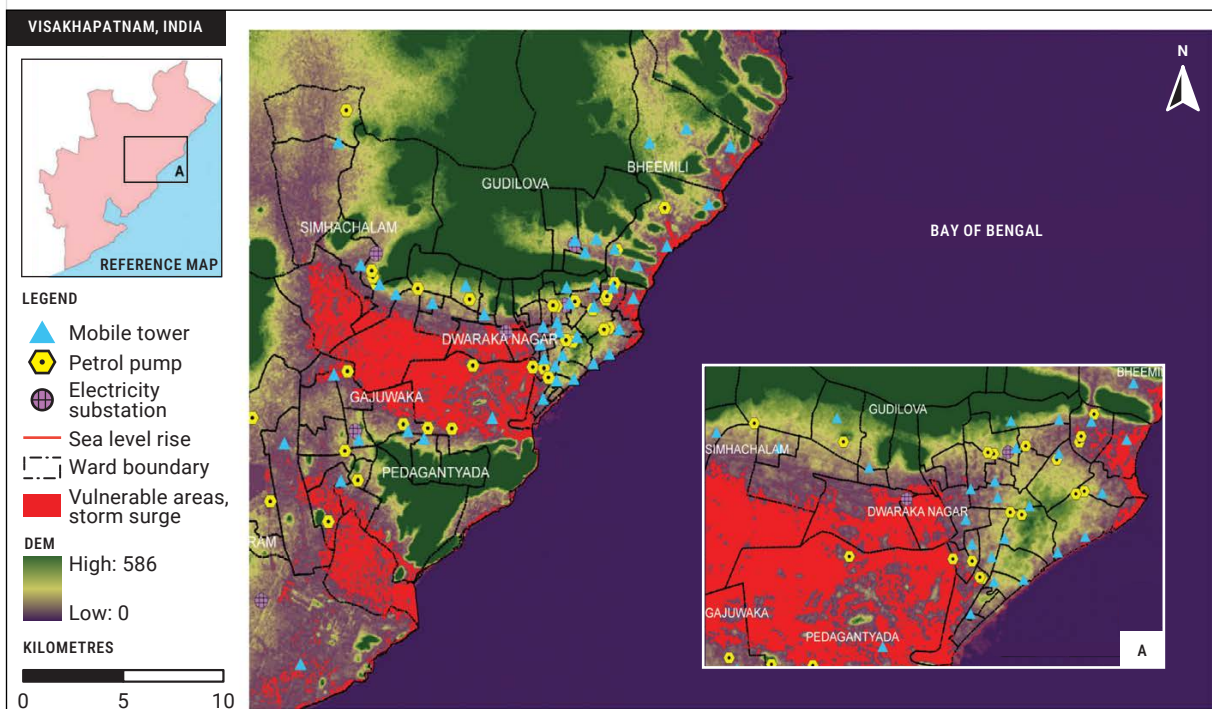
Scenario planning steps	Details
1. Preparing an urban infrastructure inventory	Inventory of information on infrastructure assets.
2. Preparing spatial inventory of urban infrastructure services	Sector-wise assets and services networks mapped using GIS platform. (Figure 4-1A)
3. Developing climate knowledge	Climate exposure assessments on precipitation, cyclones and sea-level rise. Four climate change scenarios were considered for vulnerability assessments 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.

FIGURE 4-1A Telecommunications sector, Visakhapatnam, cell phone towers mapped across the city



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-Visakhapatnam.pdf>

BOX 4-1

FIGURE 4-1B 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>

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

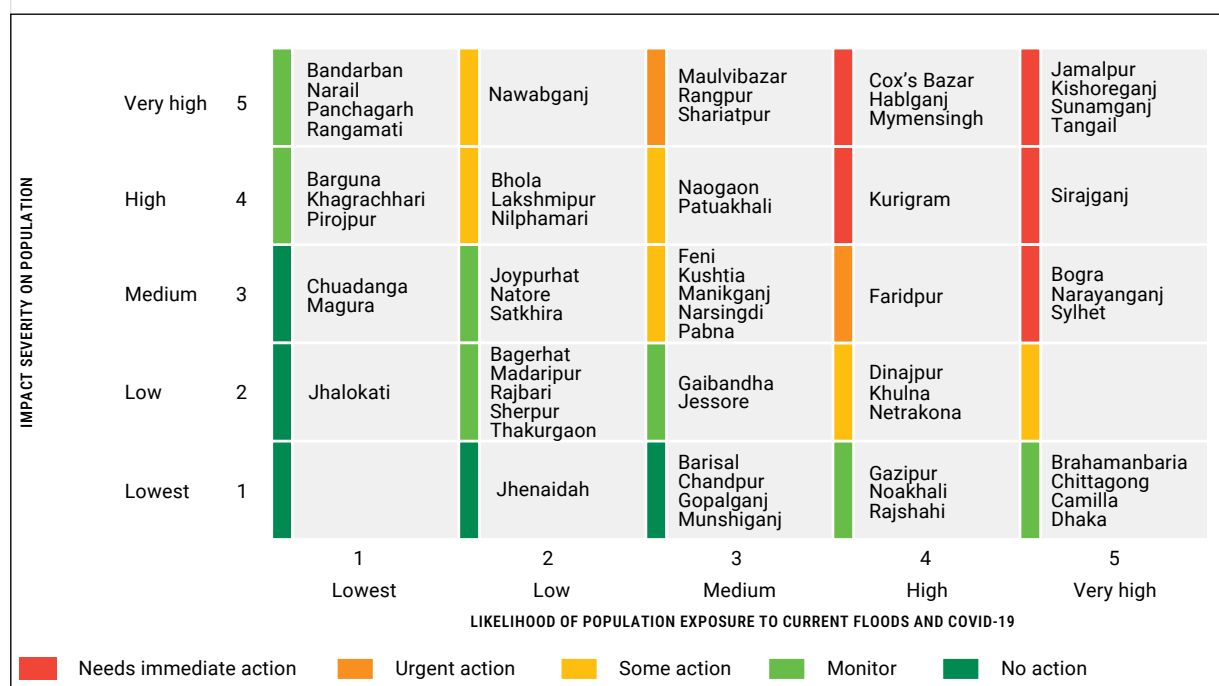
- Building design solutions to reduce flood damage;
- On-site drainage in production and refuelling stations;
- New infrastructure planning: avoiding vulnerable hotspots for siting;
- Data collection on details of transmission lines: tower locations, networks, underground cabling details for flood prone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

a 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 4-2 ESCAP's prototype for downscaled dynamic scenarios

ESCAP has developed a prototype that can place districts or areas into appropriate risk zones under multiple scenarios, using a composite matrix incorporating endemic, biological, and other natural hazards.^a Figure 4-2A illustrates this methodology with a risk matrix for Bangladesh which integrates data from diverse sources and shows the states that were most exposed to other natural disasters during COVID-19. The integrated matrix shows that, in 2020, 15 districts in the red zones with almost 12 million people were at the highest risk from disasters, and in need of immediate action to mitigate the impacts.

FIGURE 4-2A Composite matrix for targeted policymaking in Bangladesh: provinces ranked by likelihood and impact of disasters in the short term



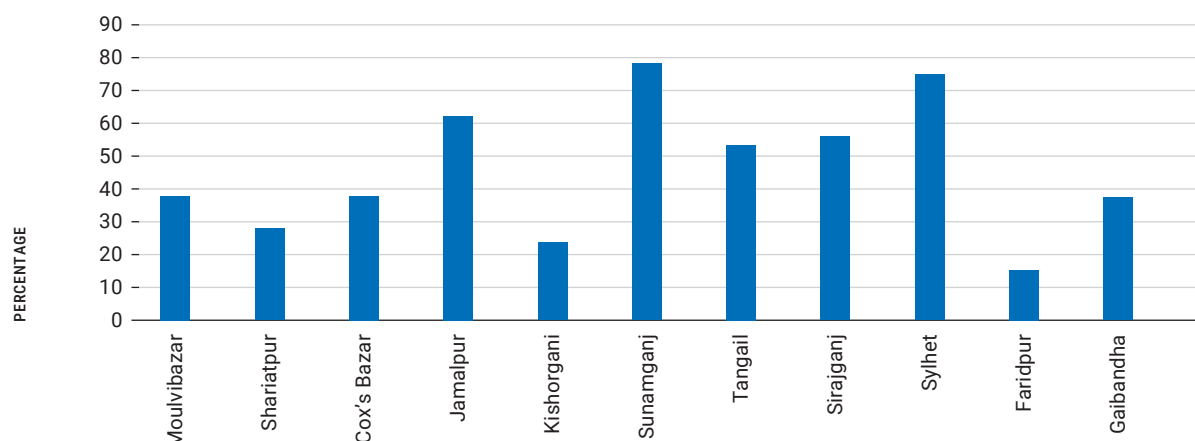
Source: United Nations Economic and Social Commission for Asia and the Pacific, "Scenario based risk analytics for managing cascading disasters: A pathway to manage risks and protect people in South Asia", Asia Pacific Disaster Report 2021, Working Paper 01. November 2020b. Available at <https://www.unescap.org/sites/default/d8files/knowledge-products/Working%20paper%20on%20Scenario%20based%20risk%20analytics%20to%20manage%20cascading%20risks%2C%20APDR%202021%2C%20WP01.pdf>

Figure 4-2B shows the proportion of health facilities that are in zones of high flood risk and simultaneously affected by COVID-19 in the high priority provinces shown in Figure 4-2A. The 12 million people who face the highest risk are served by around 610 hospitals, almost 40 per cent of which were exposed to heavy floods in 2020.^b

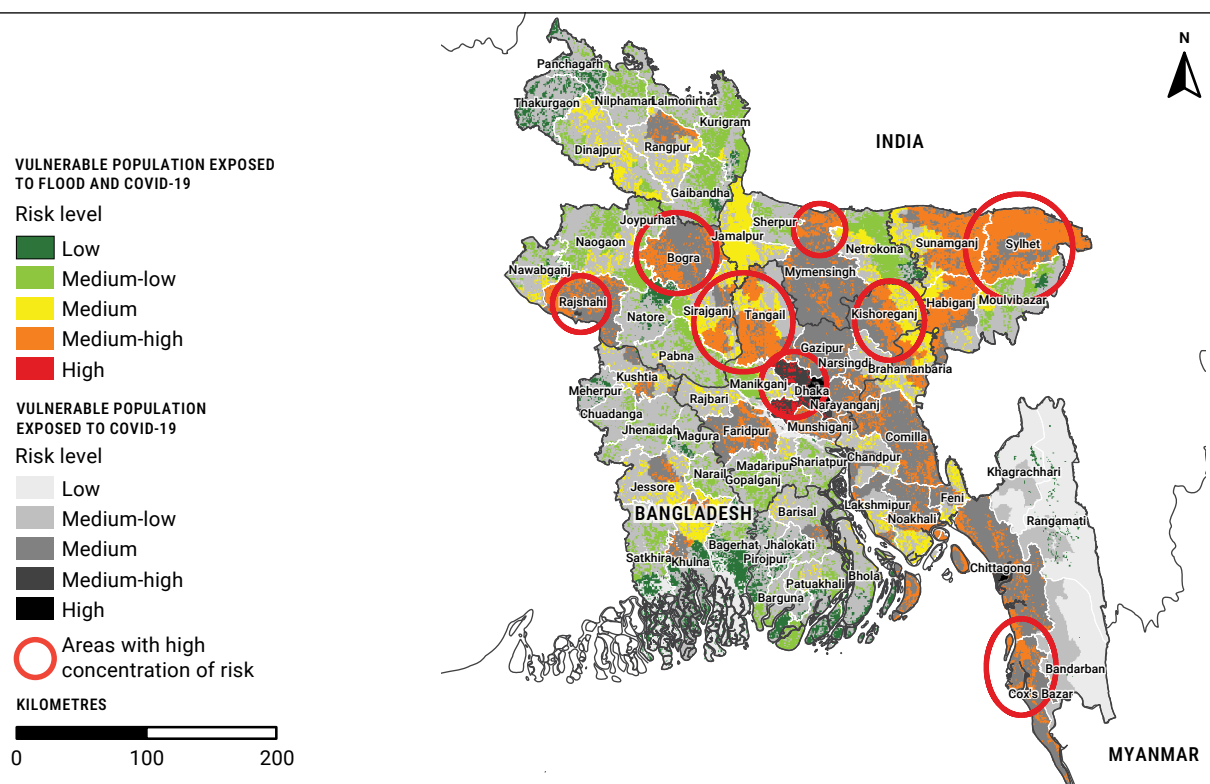
Cox's Bazaar, for example, needed immediate intervention to contain the spread of the virus among the Rohingya community.^c Many refugee families were moved to a permanent settlement on Bhasan Char, a remote island, where precautions, and surveillance within the camps by the Government, in partnership with local and international organizations, proved successful.^d

These scenario-based, composite risk matrices can support future planning for all possible risk events and help integrate disaster and health management systems, and encourage stronger cooperation between planning ministries and line ministries of health and disaster management.

BOX 4-2

FIGURE 4-2B Percentage of health facilities in priority areas that are at risk of flooding and affected by COVID-19

Source: United Nations Economic and Social Commission for Asia and the Pacific, "Scenario based risk analytics for managing cascading disasters: A pathway to manage risks and protect people in South Asia", Asia Pacific Disaster Report 2021, Working Paper 01. November 2020b. Available at <https://www.unescap.org/sites/default/d8files/knowledge-products/Working%20paper%20on%20Scenario%20based%20risk%20analytics%20to%20manage%20cascading%20risks%2C%20APDR%202021%2C%20WP01.pdf>

FIGURE 4-2C Location of vulnerable populations

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.

- Asia-Pacific Disaster Resilience Network, "Weaving a stronger fabric: Managing cascading risk for climate resilience", policy brief, August 2021. Available at <https://www.unescap.org/kp/2021/weaving-stronger-fabric-managing-cascading-risks-climate-resilience>
- United Nations Economic and Social Commission for Asia and the Pacific, "Scenario based risk analytics for managing cascading disasters: A pathway to manage risks and protect people in South Asia", Asia Pacific Disaster Report 2021, Working Paper 01. November 2020b. Available at <https://www.unescap.org/sites/default/d8files/knowledge-products/Working%20paper%20on%20Scenario%20based%20risk%20analytics%20to%20manage%20cascading%20risks%2C%20APDR%202021%2C%20WP01.pdf>
- Ibid.
- Md. Kamrujjaman and others, "SARS-CoV-2 and Rohingya Refugee Camp, Bangladesh: Uncertainty and How the Government Took Over the Situation", Biology, vol 10, No. 2 (2021). Available at <https://doi.org/10.3390/biology10020124>

BOX 4-3 Importance of protecting the Sundarbans

One of the world's largest mangrove ecosystems, the Sunderbans, spans the borders of India and Bangladesh. This area is frequently hit by tropical cyclones, typhoons and related coastal flooding. These and other disasters are likely to intensify as a result of climate change. However during the period 1992–2019, Bangladesh alone lost around 19 per cent of its mangrove cover. This was partly due to the expansion of urban areas and agricultural land, mostly in the periphery of the mangrove forests, the conversion of forest area into commercial aquaculture, and overexploitation for fodder, combined with sea level rise, and coastal erosion (Figure 4-3A and Figure 4-3B).^a Indeed, damage to critical blue carbon ecosystems, such as mangroves, not only disturbs the ecological balance but also affects communities that rely on them for their livelihoods and resources.^b

FIGURE 4-3A Sunderbans, Bangladesh, changes in mangrove cover due to expansion of agriculture and coastal aquaculture, 2001–2020



FIGURE 4-3B Sunderbans, Bangladesh, changes to mangrove forested area due to coastal erosion or sea level rise, 1985–2020

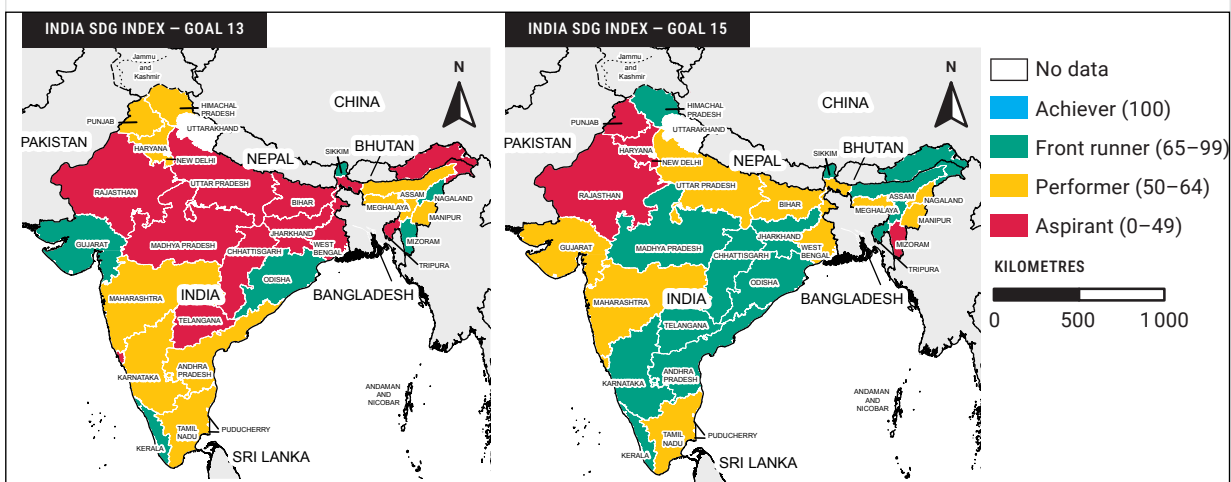


Source: Image Landsat/Copernicus

- a C. Giri and others, "Mangrove forest distributions and dynamics (1975–2005) of the tsunami-affected region of Asia", *Journal of Biogeography*, vol. 35, No. 3 (25 October 2007) pp. 519–528.
- b United Nations Educational, Scientific and Cultural Organization (UNESCO) and others, "3rd Mekong Mangrove Forum: Blue Carbon Ecosystem Conservation, Restoration and Sustainable Utilization in the Greater Mekong Sub-region and beyond", 1 October 2020. Available at: <https://bangkok.unesco.org/sites/default/files/assets/article/Natural%20Sciences/files/flyer-3rd-mekong-mangrove-forum-1st-october-2020-unesco-17-sep.pdf>

BOX 4-4 The impact of climate-related hazard risks on SDGs in India

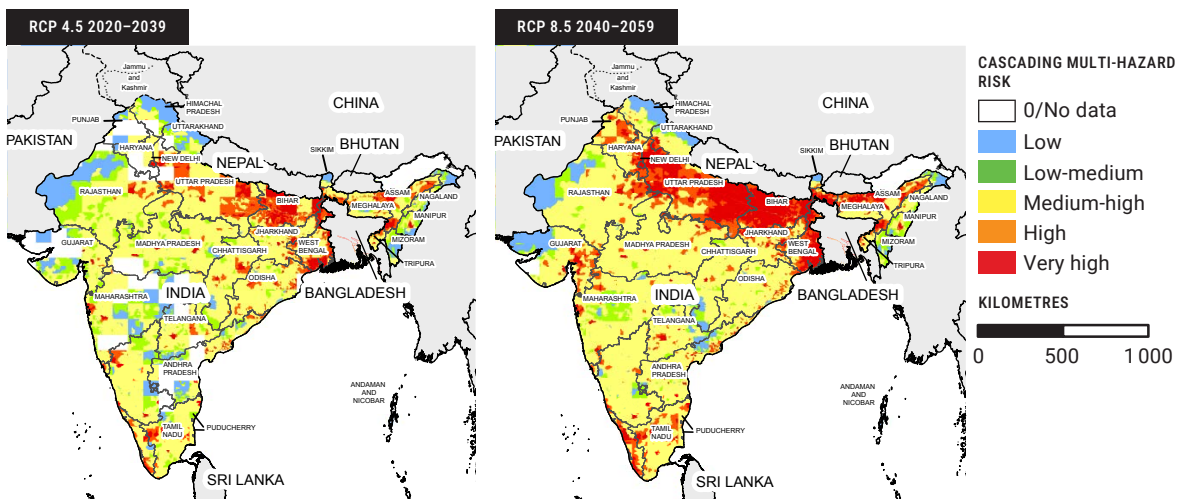
Climate-related hazards and their subsequent risks will impact the achievement of the Sustainable Development Goals, particularly those related to Climate action (SDG13), Life below water (SDG 14) and Life on land (SDG 15). For example, the SDG India Index, the first Government-led measure of SDG progress at the sub-national level in the world, is a tool for SDG progress. ESCAP analysis shows that areas with slower progress on Goals 13 and 15 are also areas of disaster risk hotspots with high multi-hazard risks from floods, drought, and heatwaves under climate change scenarios, both for RCP 4.5 and RCP 8.5. The hotspots are intensifying under RCP 8.5 and could further impact the achievement of these SDGs.

FIGURE 4-4A Hotspots of climate and disaster risks and SDG deceleration in India

Source: SDG India Index National Institution for Transforming India (NITI) Aayog 2020 and UN Geospatial.

Note: Performance of SDG India Index is classified into four categories: Achiever (100), Front Runner (65–99), Performer (50–64) and Aspirant (0–49).

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 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; and UN Geospatial.

Note: 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 RCP 8.5 in 2040–2059 by Population and DALYs for related multi-hazard.

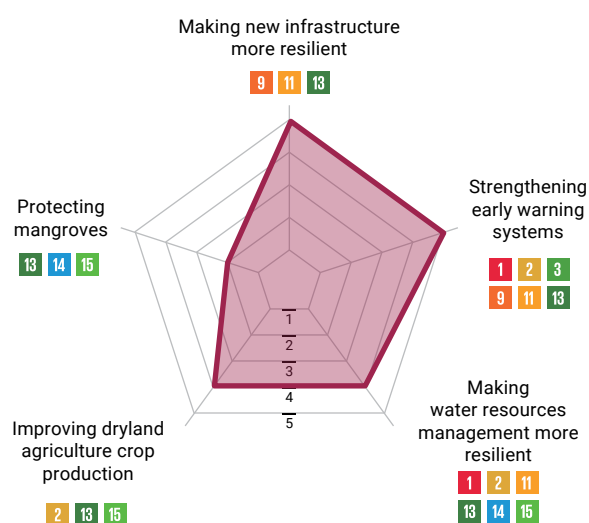
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir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

BOX 4-4

Thus, building climate adaptation and resilience is key to achieving the targets of Goals 13 and 15, in India which will also, in turn, positively impact the achievement of other SDGs, such as SDG 1 (No poverty), SDG 2 (Zero hunger) and SDG 11 (Sustainable cities and communities). ESCAP's Risk and Resilience Portal^a customizes the climate adaption measures for each country in the Asia Pacific region using multiple proxy indicators. In India, the top three climate adaption priorities are (1) strengthening early warning systems; (2) making new infrastructure resilient; and (3) making water resources management more resilient (Figure 4-4B).

Putting in place adaption measures for these top priorities is estimated to cost around 1.1 per cent of the national GDP. The latest SDG figures show that India's expenditure on environmental protection is around 0.09 per cent of total government expenditure.^a India's average annual loss from natural and biological hazards is estimated to be around 3.3 per cent of the GDP in the current scenario and will be around 8.1 per cent of its GDP under the worst-case climate change scenario of RCP 8.5.^b Investing 1.1 per cent of its GDP or an additional 0.2 per cent (in addition to the 0.9 per cent already expended) into these three adaptation priorities will ensure that the losses are less than the estimated projections and can further build resilience.

FIGURE 4-4B Climate adaption cost and priorities of India, ESCAP Risk and Resilience Portal

CLIMATE ADAPTATION PRIORITIES

Adaptation	Priority score	US \$, millions	% GDP
Making water resources more resilient	4	7 987.3	0.3
Improving dryland agriculture crop production	4	7 987.3	0.3
Protecting mangroves	1	5 990.4	0.2
Strengthening early warning systems	5	9 984.1	0.4
Making new infrastructure resilient	4	9 984.1	0.4

- a Government of India, "Sustainable Development Goals: National Indicator Framework- Progress Report 2021", Ministry of Statistics and Programmed Implementation, 31 March 2021. Available at <http://www.indiaenvironmentportal.org.in/files/file/SDG%20NIF%20Progress2021.pdf>
- b ESCAP, "Risk and Resilience Portal". Available at: <https://rrp.unescap.org/>



CHAPTER 5

Transformative actions to build resilience

Key highlights

- Frontier technologies and digital solutions not only enabled authorities to combat the pandemic but also enhance service provision to citizens through, for example, digital payment ecosystems and shock-responsive cash transfer systems.
- Incorporate risk analytics into policymaking processes and operationalize impact-based forecasting to support risk-informed decision-making and early action.
- Innovation ecosystems with strategic foresight driven by technology are crucial for building back better from the pandemic.

Frontier technology and digital solutions

To manage their COVID-19 responses, countries have been able to take advantage of a number of ‘frontier technologies’ which have been used both in disaster risk reduction and in the health sector. These include artificial intelligence (AI), big data, machine learning, 5G technologies, drones, automated vehicles and robotics.

These technologies are critical for disaster risk reduction, including for developing a resilient health sector and addressing some of the existing gaps in managing systemic risks. Technological innovations expand the connectivity of people, things and information, for instance, in cloud computing, 5G mobile technology, wireless mesh networks, mobile messaging, the Internet of Things, and blockchain. Furthermore, presentation through augmented and virtual reality will also be improved. AI and machine learning applications have already substantially reduced uncertainties in the forecasts of coastal inundations due to sea level rise. For instance, elevation data from the Coastal Digital Elevation Models (Coastal DEM) indicates that by 2100, land currently home to 200 million people could fall permanently below the high-tide line, with the greatest number of people being affected in Bangladesh and India in the South and South-West Asia subregion (Figure 5-1).⁴⁴

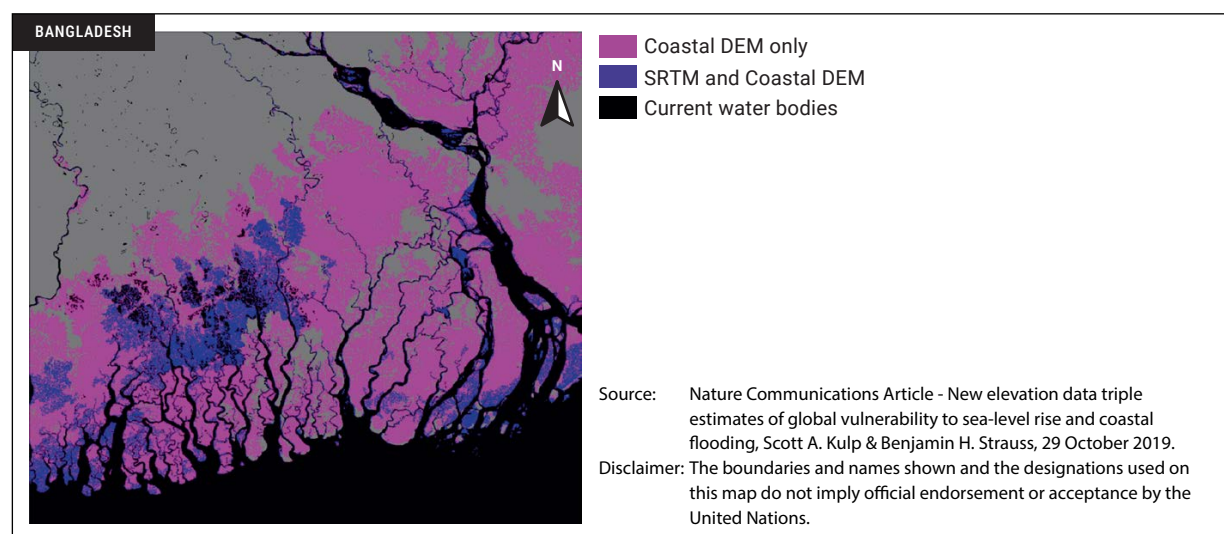
Digital solutions can be used to support social protection during a disaster. Countries with well-developed digital payments ecosystems, and shock-responsive social cash transfer systems, have been able to respond rapidly to help poor and vulnerable communities when disasters hit. Digital transfers provide a further advantage, during a pandemic, by reducing physical contact when people collect their payments.

In countries within South and South-West Asia, a number of these technologies have also helped to warn, track and monitor the transmission of COVID-19, provide rapid diagnoses, and develop tele-medicine services for treatment. 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.⁴⁵ However, this does require the system to have been largely set up before the crisis. In this case, since one billion accounts were linked to people’s Aadhaar identity numbers, the Government was able to transfer funds to those in need with remarkable efficiency (Table 5-1).

44 Scott A. Kulp and Benjamin H. Strauss, “New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding”, *Nature Communications*, vol 10, No 4844 (2019). Available at <https://www.nature.com/articles/s41467-019-12808-z>

45 “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>

FIGURE 5-1 Permanent inundation surfaces predicted by Coastal Digital Elevation Model (Coastal DEM) and Shuttle Radar Topography Mission (SRTM) digital elevation model for the RCP 8.5, 2100 sea-level projection in Bangladesh



Source: Scott A. Kulp and Benjamin H. Strauss, "New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding", *Nature Communications*, vol 10, No 4844 (2019). Available at <https://www.nature.com/articles/s41467-019-12808-z>

TABLE 5-1 Frontier technologies used for disaster risk reduction and in the health sector in South and South-West Asia

Technology	Disaster risk reduction	Health sector
Big data	<p>Iran (Islamic Republic of) – Big data analytics for earthquake damage assessment</p> <p>Change-detection algorithms were applied, using pre-and post-event high-resolution satellite imageries in the 2003 earthquake in Bam (Iran) and were able to classify damaged buildings correctly in 93 per cent of cases.^{46, 47}</p>	
Internet of Things	<p>India – Flood forecasting and early warning system (FFEWS)</p> <p>This is a robust cloud-based early warning system that provides real-time data on flooding, temperature, air quality, and other climate-related variables in order to assist stakeholders in making informed decisions. This system is accessible from any location through web browsers and mobile phone apps, and provides warnings and real-time information.⁴⁸</p>	<p>India – Co-WIN digital platform for COVID-19 vaccination</p> <p>Co-WIN is a digital platform set up by the Government of India to enable citizens to register for their COVID-19 vaccination using their mobile number, or Aadhaar number or any other identity document, and schedule their vaccination slots at the nearest vaccination centre. Co-WIN also helps users get vaccination certificates once the process is over. Co-WIN Dashboard also provides updated information about vaccination details from more than 57,000 vaccination centres across the country.</p>
Satellite data	<p>Bangladesh – Use of satellite data for flood detection and structural damage</p> <p>In July and August 2020, damage maps were used to identify inundated agricultural fields and potentially damaged houses in Nageshwari city of Rangpur division, and Islampur and Bakshiganj upzilas of Jamalpur district of Mymensingh division.</p>	

46 Niloofar Khodaverdizahraee, Heidar Rastiveisa and Arash Jouybari, "Segment-by-segment comparison technique for earthquake-induced building damage map generation using satellite imagery", *International Journal of Disaster Risk Reduction*, vol. 46 (June 2020). Available at <https://doi.org/10.1016/j.ijdr.2020.101505>

47 Asian Development Bank, "Leveraging Technology and Innovation for Disaster Risk Management and Financing", December 2020. Available at: <https://www.adb.org/publications/technology-innovation-disaster-risk-mgt-financing#:~:text=Leveraging%20Technology%20and%20Innovation%20for%20Disaster%20Risk%20Management%20and%20Financing,-Publication%20%7C%20December%202020&text=This%20joint%20report%20by%20ADB,affordability%20of%20financial%20protection%20tools>

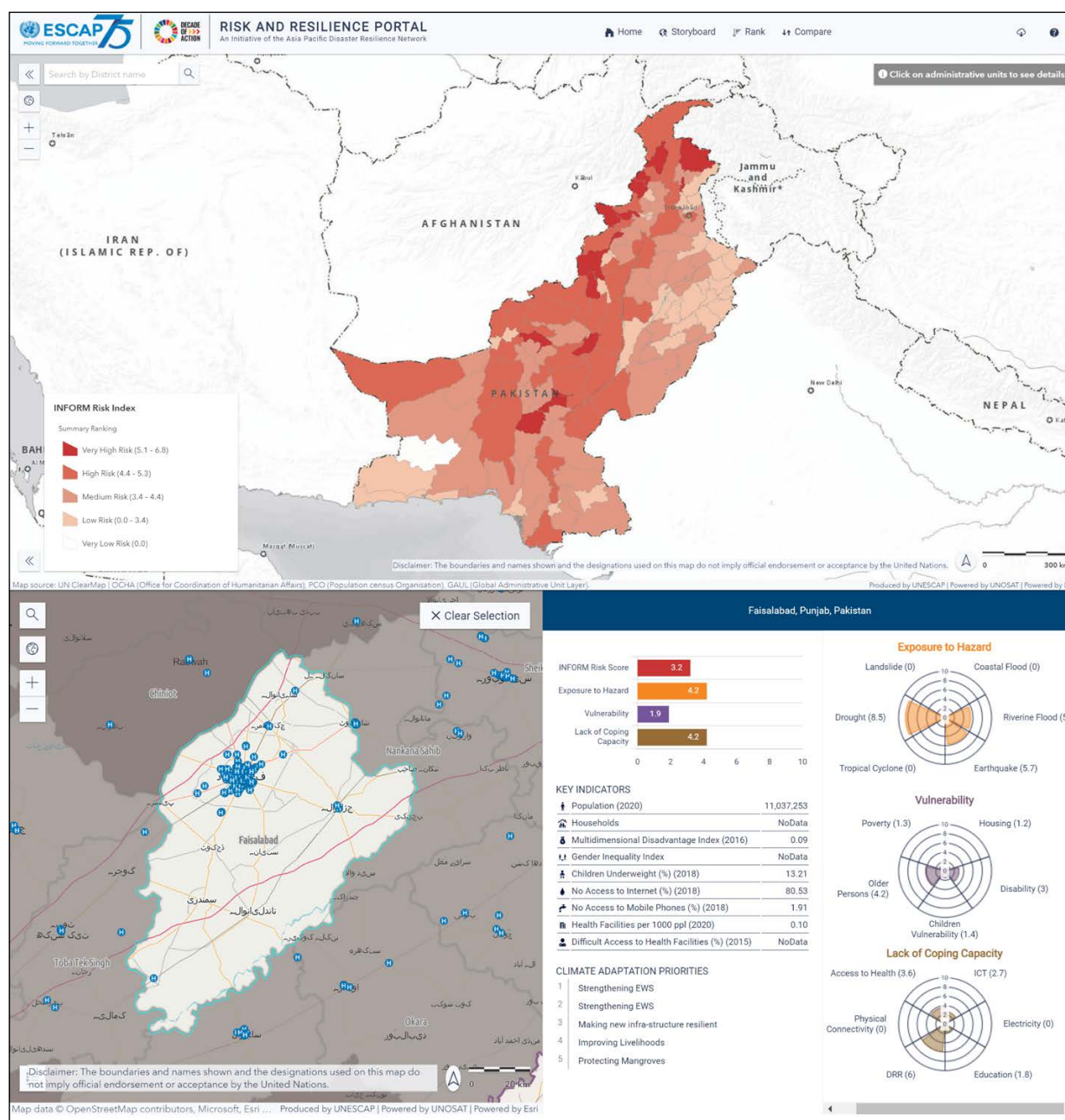
48 Asian Development Bank, "Toward Resilient Kolkata: Introducing India's First Comprehensive City-Level Flood Forecasting and Early Warning System", September 2018. Available at: <https://www.adb.org/sites/default/files/publication/452576/toward-resilient-kolkata.pdf>

Risk analytics

During extreme events – meteorological, climatic or biological – risk analytics can now use multiple data platforms and distributed models, to gather information from sensor webs and the Internet of Things, as well as from social media.⁴⁹ This can generate a greater variety and volume of data at high velocity that can be fed into a cloud-based high-speed computational infrastructure to provide real-time solutions.

For instance, the decision support system of ESCAP's Risk and Resilience Portal provides a contextual analysis of risk based on the INFORM Sub-National Risk Index to support informed decision-making of selected countries (Figure 5-2).

FIGURE 5-2 ESCAP Risk and Resilience Portal: A decision support system for Pakistan



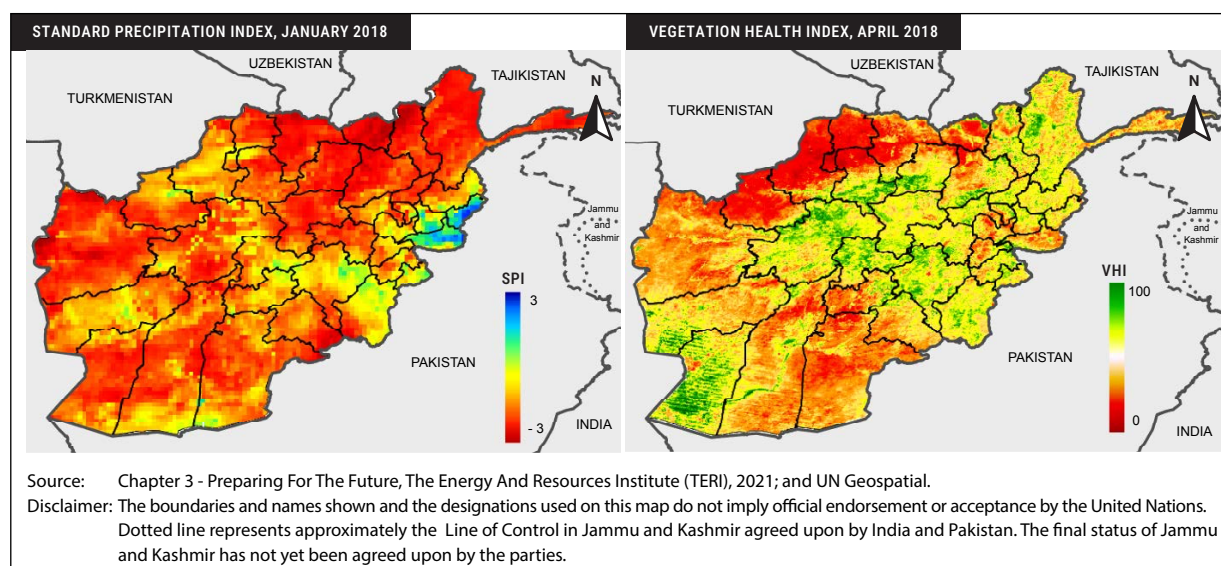
Source: ESCAP, "Risk and Resilience Portal". Available at: rrp.unescap.org

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

49 Alexander Y. Sun and Bridget R. Scanlon, "How can Big Data and machine learning benefit environment and water management: A survey of methods, applications, and future directions", *Environmental Research Letters*, vol 14, No. 7 (1 July 2019). Available at <https://iopscience.iop.org/article/10.1088/1748-9326/ab1b7d>

Further, in 2018, Afghanistan was hit by a severe drought that covered 25 of the 34 provinces, displaced around 300,000 people, and affected two-thirds of the population. In this case, decision makers rapidly gathered information from the Afghanistan Drought Early Warning Systems (AF-DEWS), a cloud-based, online platform that uses the Google Earth engine and the Google cloud platform. The AF-DEWS tool comprehensively assessed the situation using various drought indices, identifying the people at risk and the agricultural damage.⁵⁰ In the future, the AF-DEWS tool should be able to provide better early warnings of drought, offering the Government more time for preparing their responses.

FIGURE 5-3 **AF-DEWS tool assessing meteorological drought in Afghanistan, 2018**



Source: International Water Management Institute (IWMI), Sri Lanka, 2021.

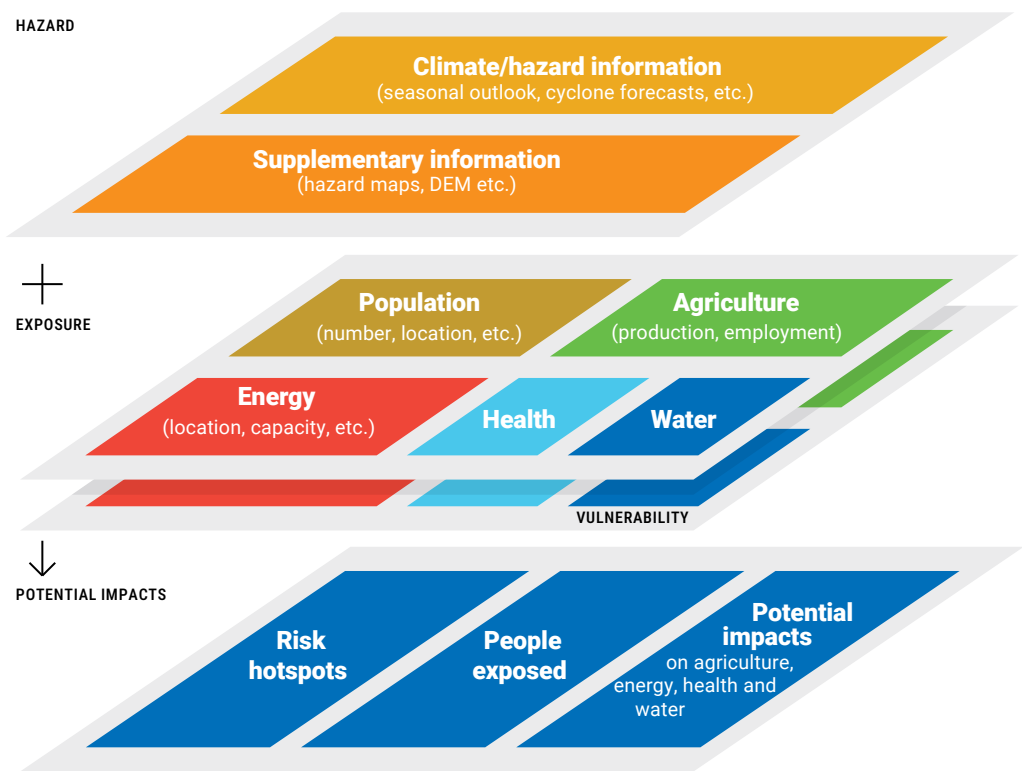
Impact-based forecasting

Well-functioning end-to-end early warning systems can significantly reduce disaster risks. **Early warning information containing potential impacts of biological or other natural hazards can support various stakeholders in making appropriate decisions and taking early action.** Moving from broadcasting ‘what the weather will be’ to ‘what the weather will do’, by combining hazard information with exposure and vulnerability data, impact-based forecasting can provide easy-to-understand customised information for critical sectors, such as disaster risk management agriculture, energy, health and water resources management.

ESCAP has developed a methodology to operationalize impact forecasting for extreme events and slow-onset disasters. For tropical cyclones, for example, the forecast track with wind speed is overlayed on demographic information to indicate the number and location of people likely to be hit (Figure 5-4).

50 G. Amarnath, “Leveraging Google Earth Engine for developing Drought Early Warning Tool in Afghanistan”, International Water Management Institute (IWMI), Sri Lanka, 2021.

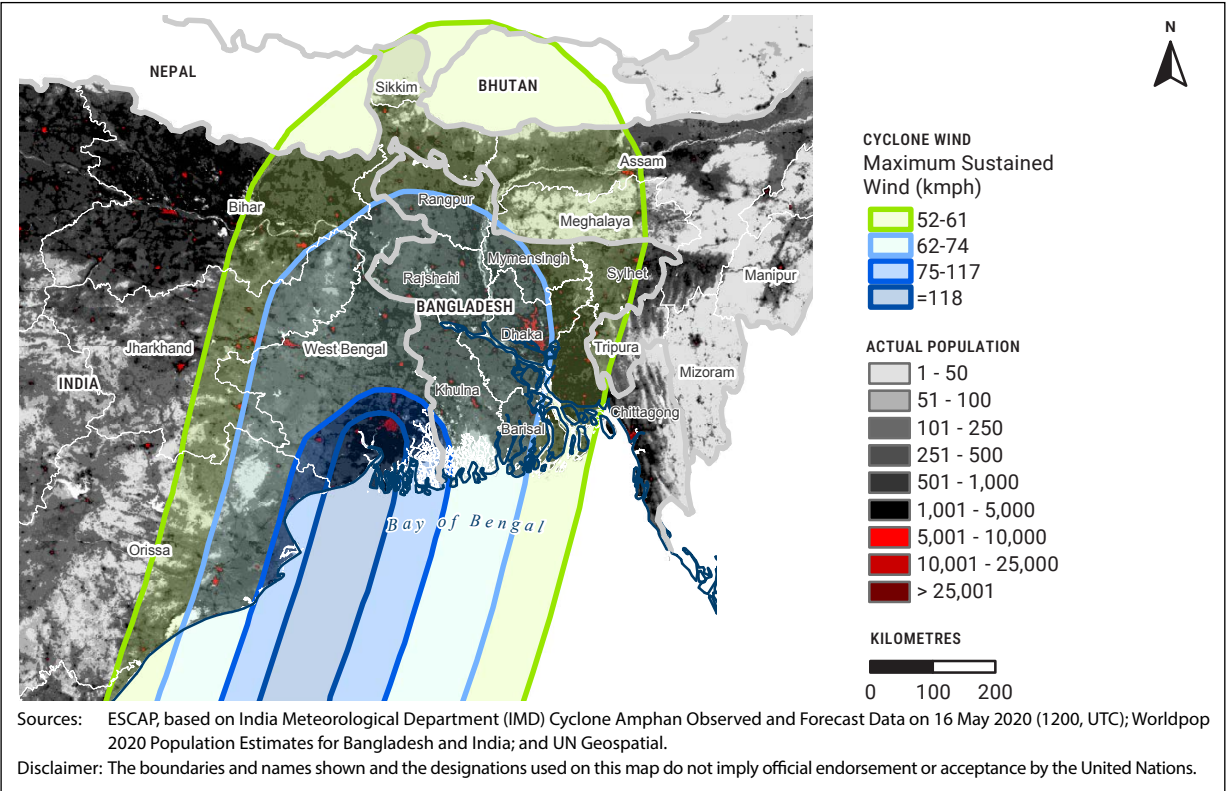
FIGURE 5-4 Methodology to operationalize impact forecasting



Source: See ESCAP/CDR/2021/INF/1.

For instance, in May 2020, India and Bangladesh were hit by cyclone Amphan. By overlaying socio-economic population characteristics, such as age, gender, income level, and standards of education and health, ESCAP was able to provide advance information on the characteristics of the exposed population (Figure 5-5).

FIGURE 5-5 People exposed to cyclone Amphan in 2020



Innovation ecosystems

Building back better from COVID-19 will require innovations across sectors, as well as in the overall process of planning for disasters.⁵¹ Success will also depend on strategic foresight, and policy coherence to mitigate trade-offs between competing priorities and to ensure that the complete package is cost-effective and risk-informed.⁵²

India, for example, has announced a National Digital Health Mission (NDHM) as part of Atmanirbhar Bharat – 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 5-6).⁵³ This system assigns a unique ID and holds the individual's electronic medical records. It also holds registers of health facilities and doctors.⁵⁴ The pandemic has clearly demonstrated the value of digital health systems, though their legal and privacy issues need to be carefully addressed. In doing so, and powered by technology, the NDHM allows the health sector as well as government institutions to collaborate for effective service delivery to the citizens.

FIGURE 5-6 **India's Digital Health Framework**



Source: Adapted from Government of India, "National Digital Health Blueprint", Ministry of Health and Family Welfare, 15 July 2019.

51 Global Centre on Adaptation, "Adaptation Finance in the Context of Covid-19: The role of development finance in prompting a resilient recovery", January 2021. Available at <https://gca.org/wp-content/uploads/2021/01/GCA-Adaption-in-Finance-Report.pdf>

52 Organization for Economic Cooperation and Development (OECD), "Building a coherent response for a sustainable post-COVID-19 recovery", policy brief, 23 November 2020. Available at https://read.oecd-ilibrary.org/view/?ref=376_376369-eayqu00bfg&title=Building-a-coherent-response-for-a-sustainable-post-COVID-19-recovery

53 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

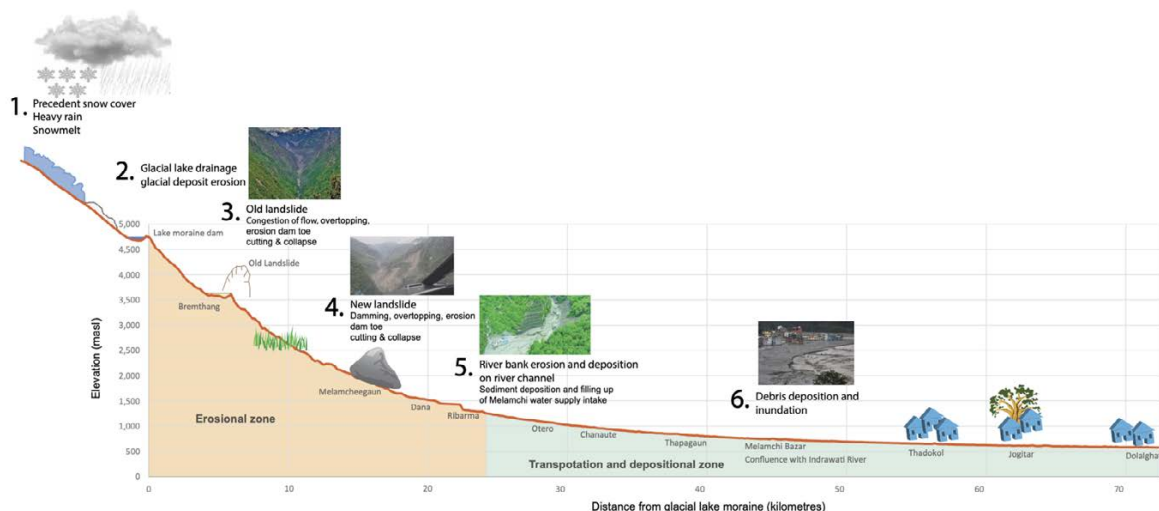
54 Make in India, "National Digital Health Mission", (n.d.). Available at <https://www.makeinindia.com/national-digital-health-mission>

BOX 5-1 The Melamchi flood disaster: Cascading hazard and the need for multi-hazard risk management

Cascading hazards are becoming more common in Nepal and in the Hindu Kush Himalaya.^a This brings forth the need for a holistic approach in hazard assessment and risk management. The Melamchi disaster of 15 June 2021 was triggered by a glacial lake outburst flood (GLOF) and subsequent landslide dam outburst floods.^b It was the result of multiple anthropogenic and climatic factors and processes that occurred at various locations along the Melamchi River. The Melamchi-Indrawati watershed receives high precipitation, which increases along with altitude, towards the north. This disaster was initiated by intense precipitation in the upstream areas, which triggered cascading hazards along the river corridors, causing loss of life and devastation to settlements, markets, roads and bridges and local livelihoods.

Though there was no formal early warning system in place, early warning via informal risk communication from upstream communities helped to reduce loss of lives and livelihoods in downstream communities. This highlights the need to establish early warning systems in the watershed with strong involvement from upstream and downstream communities, supported by local and national government entities.

FIGURE 5-1A Progression of Melamchi flood disaster: a cascading hazard

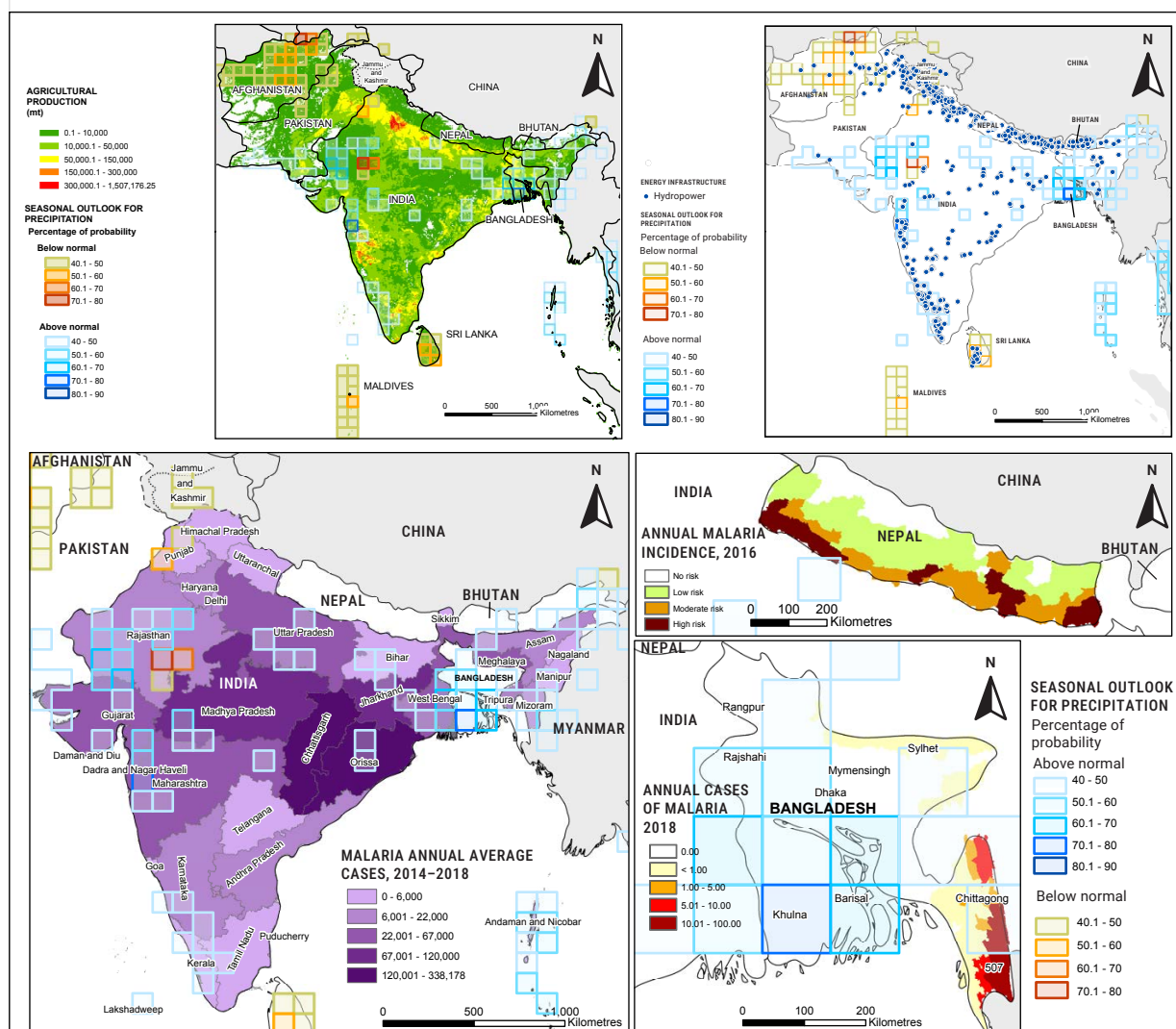


Source:

- a Ramesh Ananda Vaidya and others, "Disaster Risk Reduction and Building Resilience in the Hindu Kush Himalaya", in *The Hindu Kush Himalaya Assessment*, P. Wester, A. Mishra, A. Mukherji and A. Shrestha (eds). (Springer, Cham, 2019). Available at https://doi.org/10.1007/978-3-319-92288-1_11
- b Sudan Maharjan and others, "The Melamchi flood disaster Cascading hazard and the need for multihazard risk management", International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, August 2021.

BOX 5-2 Multi-sector impact-based forecasting in India

For the monsoons in India, geospatial modelling can be used for multi-sector, impact-based forecasting across the seasons, which is an example of operationalizing the WMO global framework for climate services.^a Combining the seasonal precipitation forecasts from South Asia Climate Outlook Forums with the risk profiles from the *Asia-Pacific Disaster Report 2019*, ESCAP facilitated the production of impact-based forecasts for agriculture, energy, health and water management (Figure 5-2A). This enhanced policy preparedness and response. Furthermore, since the weather parameters are associated with water- and vector-borne diseases these forecasts can also provide better early warning systems for biological hazards.

FIGURE 5-2A Impact-based forecasting for 2020 monsoons in India

Sources: SASCOF Seasonal Outlook Precipitation Data for October to December 2021; Global Spatially-Disaggregated Crop Production Statistics Data of 2010 (MapSPAM) V2r0 2020; and UN Geospatial; Asia-Pacific Energy Portal, 2020; and UN Geospatial; Ministry of Health and Family Welfare of Bangladesh - Health Bulletin 2019; Government of India - Ministry of Health & Family Welfare. National Health Profile 2019; Epidemiology and Disease Control Division (EDCD), Department of Health Services (DoHS), Government of Nepal, 2016; and UN Geospatial.

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Source: United Nations Economic and Social Commission for Asia and the Pacific, "Seasonal outlook to socio-economic impact-based forecasting", Asia-Pacific Disaster Report 2021, Working Paper 02. December 2020c. Available at <https://www.unescap.org/kp/2020/seasonal-outlook-socio-economic-impact-based-forecasting>

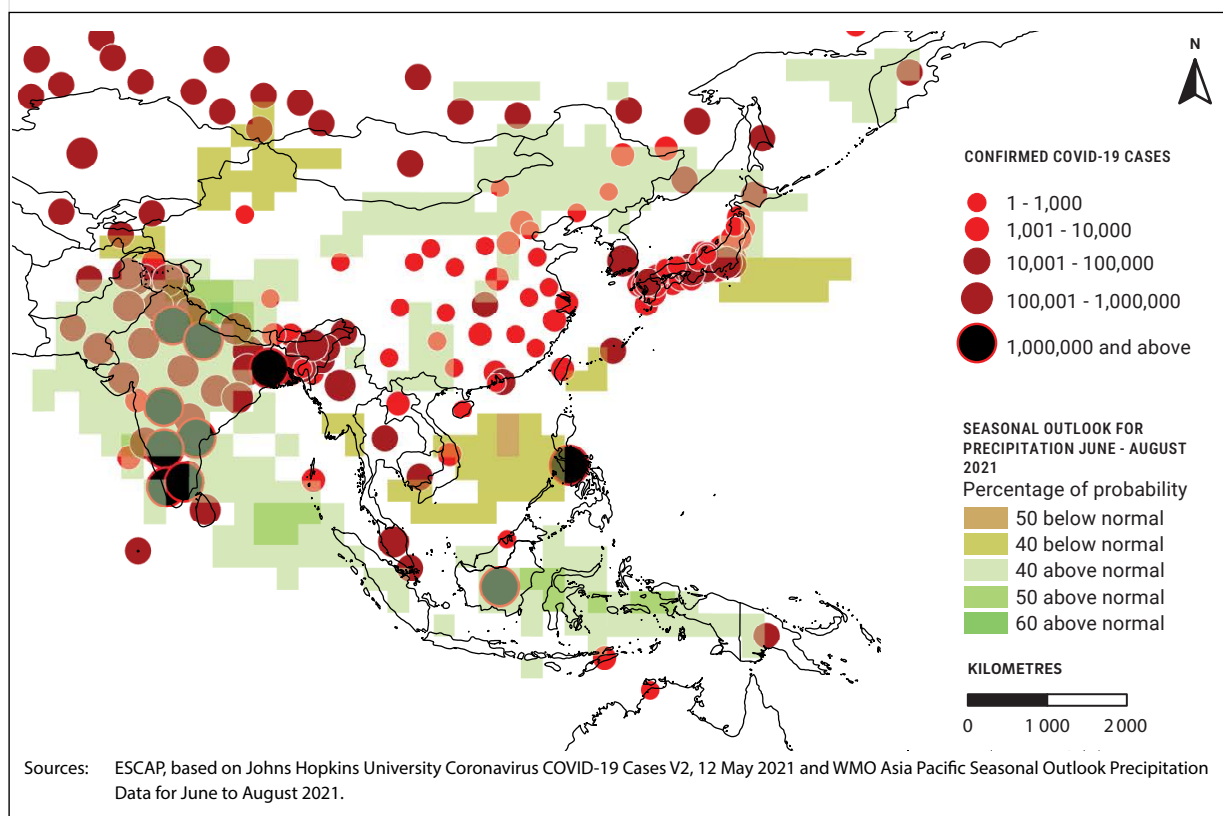
a United Nations Economic and Social Commission for Asia and the Pacific, "Seasonal outlook to socio-economic impact-based forecasting", Asia-Pacific Disaster Report 2021, Working Paper 02. December 2020c. Available at <https://www.unescap.org/kp/2020/seasonal-outlook-socio-economic-impact-based-forecasting>

BOX 5-3

Forecasting cascading risk scenarios at different time scales

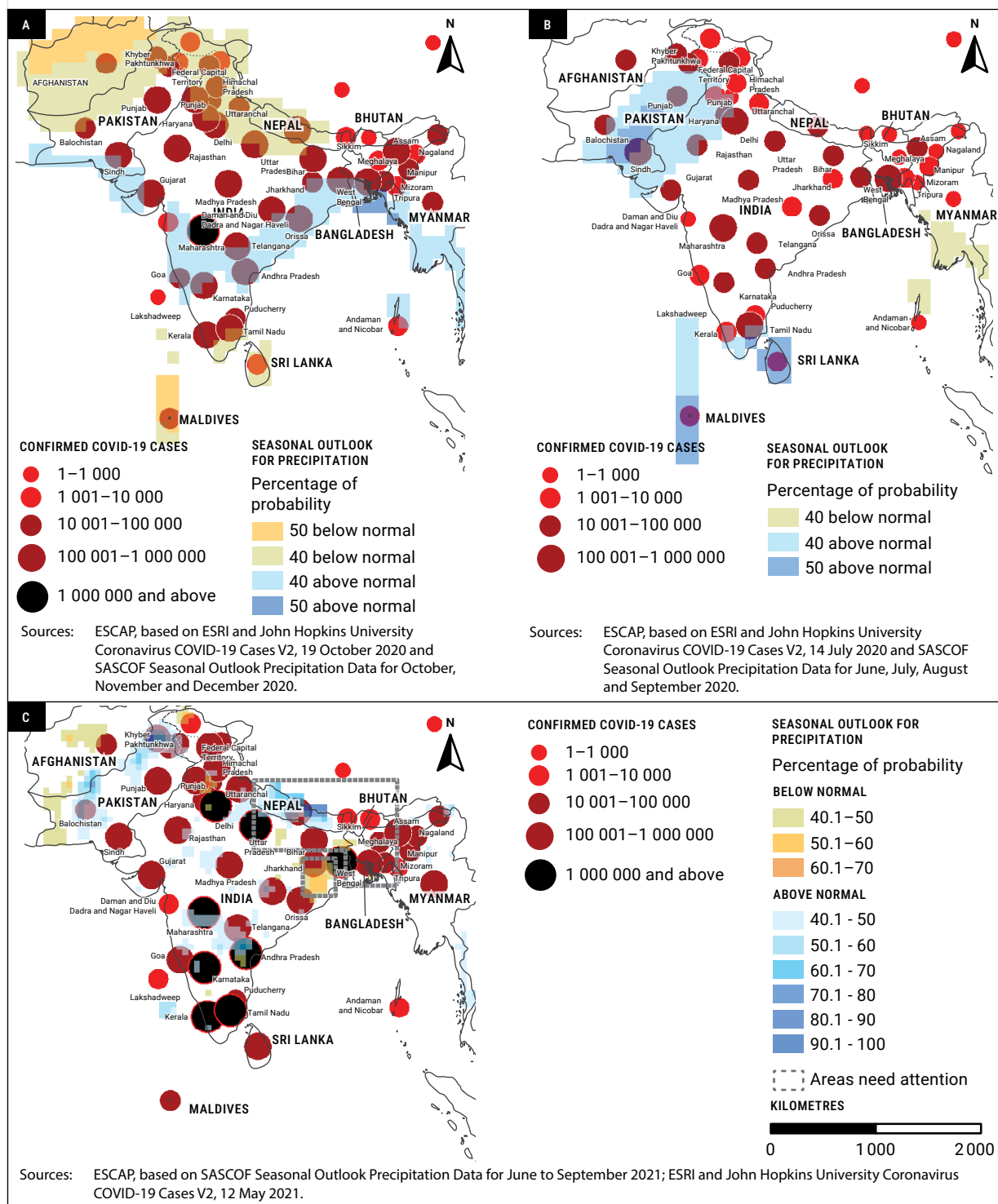
The predictive analytics solution by the Asia-Pacific Disaster Resilience Network (APDRN) captures cascading risk scenarios at the regional level, and zooms in on South Asia, where the intersection of the COVID-19 pandemic and extreme weather events is likely to intensify in the coming months. The solution is derived from the integration of the WMO seasonal outlook for June, July and August 2021, issued in April with the COVID-19 cases on the ground (Figure 5-3A). During this period, above-normal precipitation is expected in Pakistan, India, Nepal.

FIGURE 5-3A Convergence of precipitation anomaly with COVID-19 in Asia for June-August 2021



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 from a pandemic, 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, damage to people’s health and livelihoods and their prospects of escaping poverty.

BOX 5-3

FIGURE 5-3B Convergence of precipitation anomaly with COVID-19 in South Asia for June–September 2020, October–December 2020, and 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.:

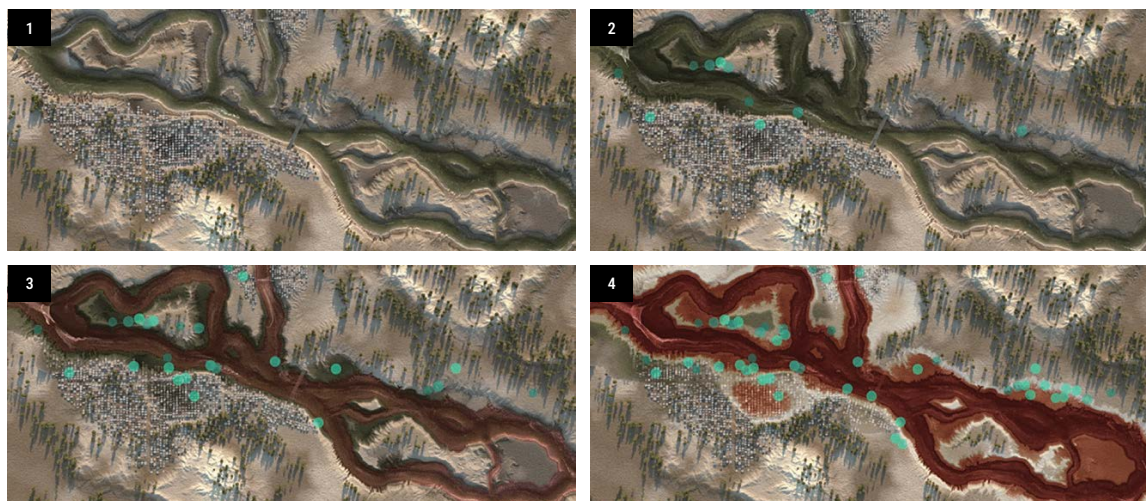
- United Nations Economic and Social Commission for Asia and the Pacific, "Seasonal outlook to socio-economic impact-based forecasting", *Asia-Pacific Disaster Report 2021*, Working Paper 02, 28 December 2020c. Available at <https://www.unescap.org/kp/2020/seasonal-outlook-socio-economic-impact-based-forecasting>
- World Meteorological Organization Lead Centre for Long-Range Forecast Multi-Model Ensemble, "Seasonal Outlook Precipitation from June to August 2021". Available at: https://www.wmolc.org/seasonPmmeUI/plot_PMME (accessed May 2021).
- Regional Climate Centre, Indian Meteorological Department, Pune, "South Asian Climate Outlook Forum (SASCOF-22) for the Summer Season and Climate Services User Forum (CSUF)", 22nd Session, 26–28 April 2022. Available at <http://rcc.imdpune.gov.in/Sascof.html>
- ESRI, "COVID-19 Overview: Coronavirus COVID-19 Cases V2", 2020. Available at <https://coronavirus-resources.esri.com/maps/1cb306b5331945548745a5ccd290188e/about> and John Hopkins University, "COVID-19 Dashboard". Available at <https://coronavirus.jhu.edu/map.html> (accessed 15 July 2020, 20 October 2020, and 13 May 2021).

BOX 5-4 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 for 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 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, providing more notice to governments and giving tens of millions of people an extra day or so to prepare. Such forecasting 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 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 5-4A Inundation modelling estimates flooded areas and depth of water

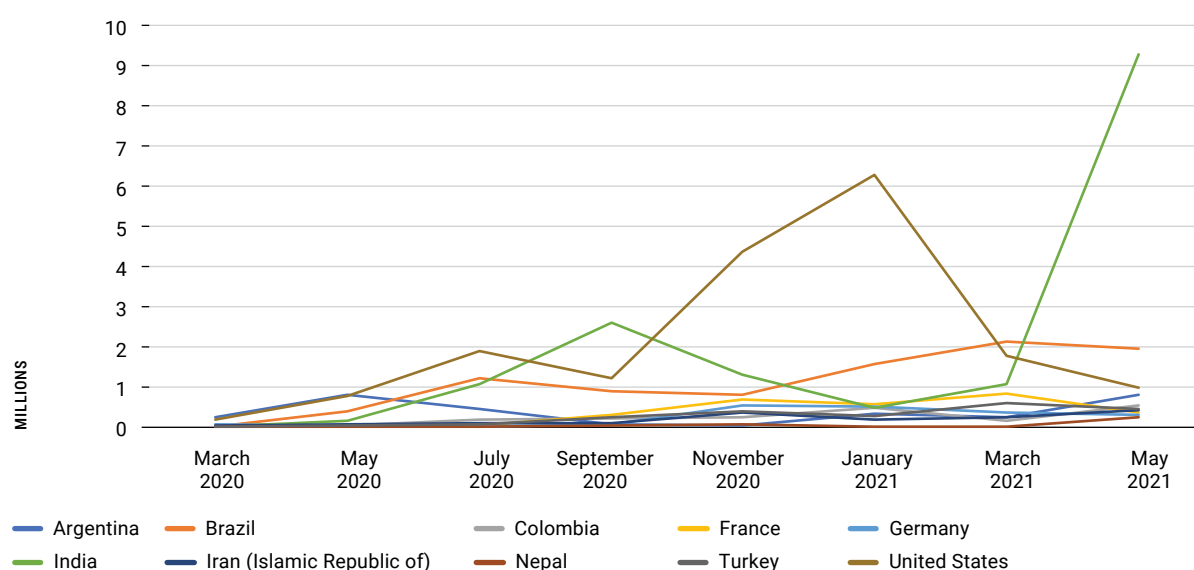


Source: Sella Nevo, "The technology behind our recent improvements in flood forecasting", Google AI Blog, 3 September 2020. Available at: <https://ai.googleblog.com/2020/09/the-technology-behind-our-recent.html>

BOX 5-5 Critical infrastructure services: key policy innovations for future pandemic

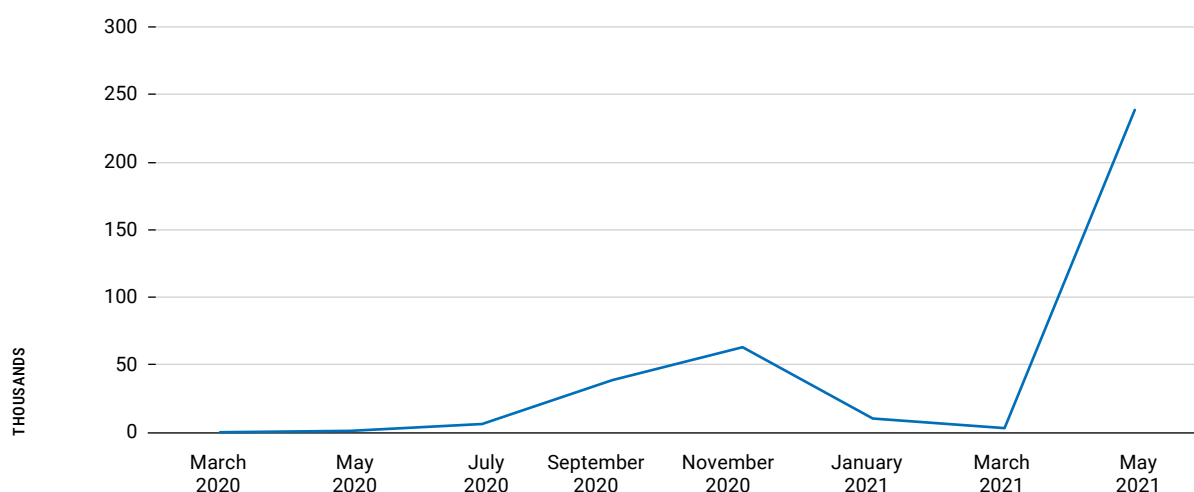
The second wave of the COVID-19 pandemic was devastating for India, reaching world records for the total numbers of cases and deaths, and overwhelming the healthcare system. The most striking aspect of the second wave was the speed with which the virus spread, with monthly caseloads rising from less than 500 thousand in January 2020 to over 9 million by the end of May. The rapid spread of the virus during India's second wave is unique, with an 18,000 per cent growth in cases (Figure 5-5A), a similar speed is being seen in neighbouring Nepal.

FIGURE 5-5A Daily confirmed new cases (monthly 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 14 May 2021).

FIGURE 5-5B Daily confirmed new cases (monthly moving average) in Nepal



BOX 5-5

Oxygen is vital for patients of COVID-19, 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. In India, 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 healthcare facilities, particularly the supply of medicinal oxygen. The crisis reveals three key lessons for preparing for future pandemics:

Anticipators 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 modeling 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 repurposed, using systemic approaches for strengthening disaster resilience across all sectors. Otherwise, disruptions to the supply chain systems, on which various facilities and services depend, will have fatal consequences.

Regional co-operation – 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.

Source: Srivastava, Sanjay (2021). The Oxygen Express: How regional cooperation can help prepare for future pandemics. 17 May. Available at: <https://www.unescap.org/blog/oxygen-express-how-regional-cooperation-can-help-prepare-future-pandemics>

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Representative Concentration Pathways (RCPs)

RCPs are concentration pathways that were 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.^a

Appendix A: Shared Socio-economic Pathways (SSPs)

As used in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, the SSPs are based on five narratives that describe broad socioeconomic trends that could shape future society up to 2100. They lay the foundation for determining which reductions in greenhouse gas emissions will, or will not, be achieved. That is, each SSP looks at how different RCPs could be achieved given certain underlying socioeconomic characteristics and shared policy assumptions of that world. The five SSPs include:

- SSP 1: a "green road" with low challenges to mitigation and adaptation (sustainable development)
- SSP 2: a "middle of the road" with medium challenges to mitigation and adaptation
- SSP 3: a "rocky road" with high challenges to mitigation and adaptation (regional rivalry)
- SSP 4: a "road divided" with low challenges to mitigation and high challenges to adaptation (inequality)
- SSP 5 "taking the highway" with high challenges to mitigation and low challenges to adaptation (fossil-fueled development)^b

ESCAP has analysed the impacts of 1.5°C and 2°C temperature increase under SSP 2 and SSP 3 scenarios.

Sources:

- a Zeke Hausfather, "Explainer: The high-emissions 'RCP 8.5 global warming scenario'", CarbonBrief, 21 August 2019. Available at <https://www.carbonbrief.org/explainer-the-high-emissions-rcp8-5-global-warming-scenario>
- b Zeke Hausfather, "Explainer: How 'Shared Socioeconomic Pathways' explore future climate change", CarbonBrief, 19 April 2018. Available at <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change> and Nerilie Abram and others, "Framing and Context of the Report Supplementary Material", in IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (In Press, 2019). Available at https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/SROCC_Ch01-SM_FINAL.pdf



Pathways to Adaptation and Resilience in South and South-West Asia demonstrate how the South and South-West Asia subregion is being affected by various risk parameters, and where new hotspots of exposure and vulnerability to climate-induced, cascading multi-hazard scenarios are being created. Moving forward, ESCAP recommends that South and South-West Asia implements customized adaptation and resilience pathways with emphasis on risk-informed development policies and investments, technological innovations and subregional cooperation approaches. These measures can accelerate the progress of countries in achieving the Sustainable Development Goals and the targets of the Sendai Framework for Disaster Risk Reduction.

