Pathways to Adaptation and Resilience in Pacific SIDS

SUBREGIONAL REPORT

Asia-Pacific Disaster Report 2022 for ESCAP Subregions

ESCAP
MOVING FORWARD TOGETHER
75

*The shaded areas of the map indicate ESCAP members and associate members.**

The Economic and Social Commission for Asia and the Pacific (ESCAP) is the most inclusive intergovernmental platform in the Asia-Pacific region. The Commission promotes cooperation among its 53 member States and 9 associate members in pursuit of solutions to sustainable development challenges. ESCAP is one of the five regional commissions of the United Nations.

The ESCAP secretariat supports inclusive, resilient and sustainable development in the region by generating action-oriented knowledge, and by providing technical assistance and capacity-building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development.

**The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.*

Pathways to Adaptation and Resilience in Pacific SIDS

SUBREGIONAL REPORT

Printed in Bangkok
ST/ESCAP/3012

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 ('riskscape') from natural and biological hazards in the Asia-Pacific region. The full-length publication is available at link . 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 the Pacific SIDS.

Photo credits
Cover: Burdem/istock.com
Page 1: Chameleonseye/istock.com
Page 10: Michael Ziegler/istock.com
Page 15: Cn0ra/istock.com
Page 24: BlueOrange Studio/shutterstock.com
Page 33: Ruben Ramos/istock.com

Disclaimer

The designations employed and the presentation of materials on the maps do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Recommended citation

United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP) (2022).
https://www.unescap.org/kp/2021/asia-pacific-disaster-report-2021

Acknowledgements

The *Asia-Pacific Disaster Report* (APDR) is a biennial flagship publication of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). Its 2021 issue was prepared under the leadership and guidance of Armida Salsiah Alisjahbana, Under-Secretary-General of the United Nations and Executive Secretary of ESCAP. Kaveh Zahedi, Deputy Executive Secretary, Tiziana Bonapace, Director, ICT and Disaster Risk Reduction Division (IDD) and Andie Fong Toy, Head, ESCAP Subregional Office for the Pacific provided direction and advice.

The report was prepared by Akash Shrivastav, Armita Behboodi, Fatemeh Safaripaskiaby, Lanieta Vereivuna Rokotuiwakaya, Madhurima Sarkar-Swaisgood, Maria Bernadet K. Dewi, Rahul Suman, Sapna Dubey, Shashwat Avi, Soomi Hong and Temily Isabella Baker under the guidance of Sanjay Srivastava and Sudip Ranjan Basu.

The report was enriched by the review and comments received from Mosese Sikivou, Karlos Lee Moresi, Exsley Taloiburi from Pacific Islands Forum Secretariat (PIFS) and Gabrielle Emery from United Nations Office for Disaster Risk Reduction (UNDRR). Jasmine Wai Mun Hong, Nobuko Kajiura and Ranhee Kim from ESCAP Subregional Office for the Pacific also provided valuable inputs.

Anoushka Ali edited, proofread and finalized the document for publication. Daniel Feary designed the layout and graphics. Natacha Pitaksereekul provided administrative assistance.

Template map production, guidance and clearance were provided by Guillaume Le Sourd and Heidi Postlewait in the Geospatial Information Section of the United Nations Office of Information and Communications Technology.

Contents

Boxes

Figures

Tables

Introduction

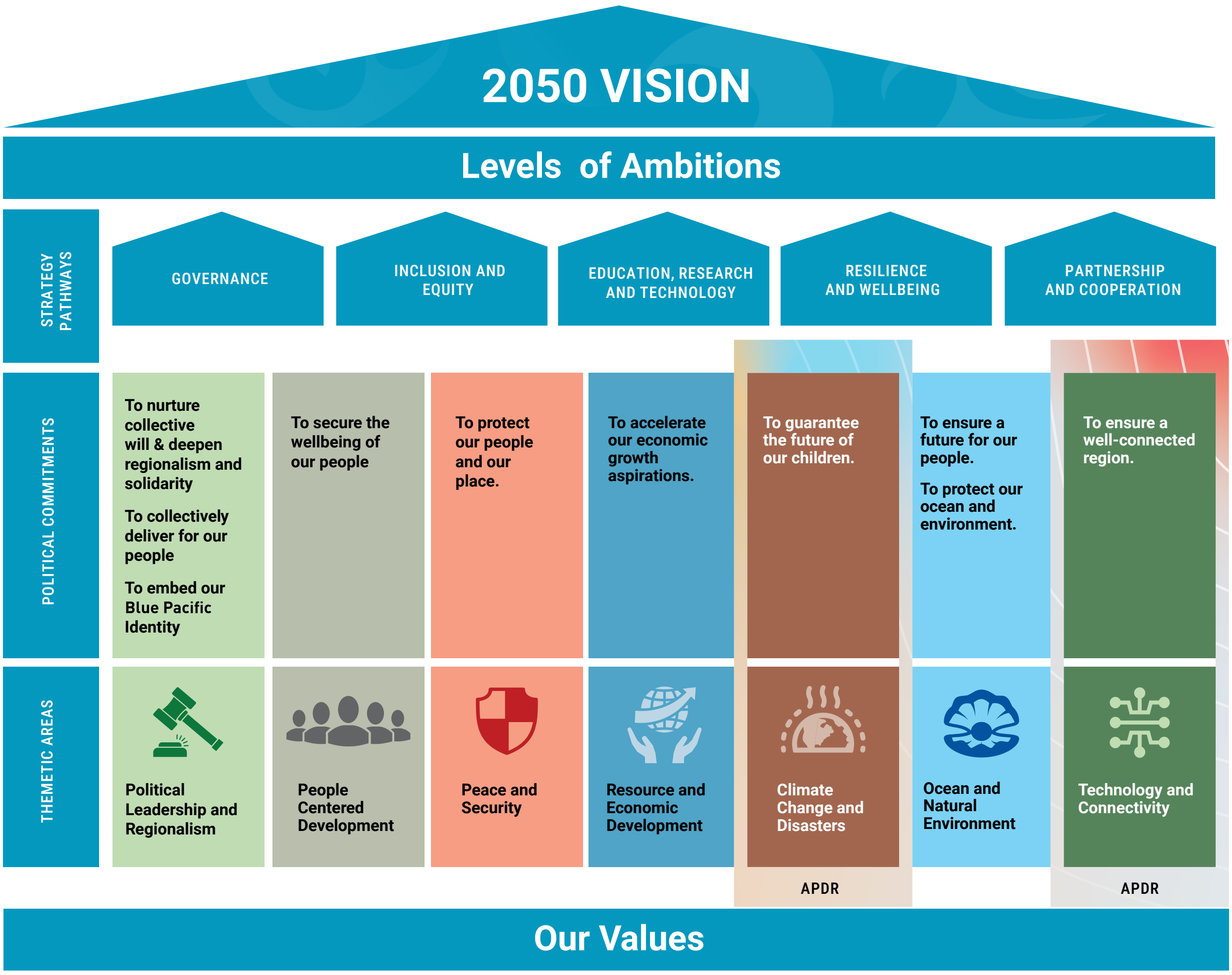
The Pacific SIDS are among the smallest and most remote countries on earth. Together they comprise a land area of only half a million square kilometers scattered in the world's largest ocean, with a significant portion of that land made up of low-lying atolls that do not reach more than a few meters above current sea level. That's the reason of specific vulnerability of Pacific SIDS.

The Pacific SIDS remain a special case for sustainable development due to their unique vulnerabilities that constrain them from achieving the social, economic, and environmental objectives. Climate change impacts along with the vulnerabilities stemming from the combination of physical characteristics, remoteness and poor infrastructure has a profound impact on development across all sectors in the Pacific SIDS. For instance, the intersection of natural hazards like the volcanic eruption in Tonga, 2022 along with the COVID-19 pandemic led to prolonged health and economic disruptions in the region[1].

Noting these complex and systemic risks, the 2050 Strategy for the Blue Pacific Continent, adopted in July 2022, outlines key thematic areas for urgent, immediate and appropriate action. The Strategy aims to combat the above-mentioned threats to secure the wellbeing of people.[2] The seven thematic areas that include therewith, will be key in building resilience in the region.

With a focus on the Pacific SIDS, this report is one of the first to provide analytics, solutions, and key recommendations to operationalize these strategic pathways in the Climate Change and Disasters and related areas of Technology as noted below.

2050 Strategy for the Blue Pacific Continent: Thematic Areas aligned with APDR 2022:



1 UNOCHA, Asia Pacific Humanitarian Update, Tonga: Volcanic Eruption – Flash Update # 3, Available at: https://reports.unocha.org/en/country/asia-pacific/card/5KF8hCc5Aq/.

2 Pacific Islands Forum, Fifty-First Pacific Islands Forum, Communique of the 51st Pacific Islands Forum Leaders Meeting, Available at: https://www.forumsec.org/2022/07/17/report-communique-of-the-51st-pacific-islands-forum-leaders-meeting/.

CHAPTER 1

The shifting contours of the Pacific small island developing States (SIDS) disaster riskscape

Blue Pacific 2050 Climate Change and Disasters

Strategic pathways: Governance, Partnerships and Cooperation

*This chapter provides the **evidence-base** to strengthen regional collaboration to limit global warming and advocate with all stakeholders to ensure that all commitments address the needs of the region on climate change, disaster risk reduction and their cascading impacts.*

Highlights

- The disaster riskscape of the Pacific SIDS is being reshaped by cascading and converging hazards under a new disaster-climate-health nexus and increasing vulnerability of populations to cascading hazards.
- ESCAP's Risk and Resilience Portal shows that under the worst-case climate change scenarios, economic losses are projected to double to US$ 322 billion in the future for the subregion.
- The projected economic losses from natural and biological hazards will impact the achievement of the Sustainable Development Goals (SDGs), particularly Goal 13 (all targets), Goal 14 (Target 14.2), and Goal 15 (Target 15.3), with knock on impacts on Goal 1 (Target 1.5), Goal 2 (Target 2.4), Goal 3 (Target 3.d), Goal 9 (Target 9.1), and Goal 11 (Target 11.5).

The disaster riskscape of the Pacific SIDS

Over the past 50 years, natural hazards have affected over 26.6 million people in the Pacific SIDS. Primarily due to the 2015–2016 El Nino drought,[3] Papua New Guinea recorded the highest number of people affected in the subregion, amounting to over 60 per cent of the total subregional figure (Figure 1-1). However, when assessed as a percentage of population the picture changes, with Micronesia having the highest percentage of their population affected by disasters, followed by Fiji and Tonga. Most recently, the devastating Tonga Hunga Ha'aipai volcanic eruption, on the 15 January 2022, affected over 80 per cent of the population or 87,000 people. It also triggered tsunami waves in neighbouring Pacific countries, namely Fiji, Samoa, Vanuatu, Solomon Islands.

Disasters, such as the Tonga eruption, not only affect the lives of thousands of people, but also result in a number of fatalities in the subregion. In the Pacific SIDS, Papua New Guinea has suffered the highest number of casualties due to disasters, accounting for nearly 70 per cent of all the fatalities in the last decade, over half of which occurred during the 2018 earthquake in Papua New Guinea.

While many people continue to suffer from natural hazards, significant progress has been made in the Pacific SIDS in the number of fatalities caused by disasters. Over the course of the past three decades, there has been around a 70 per cent decrease in the number of fatalities; from just over 3000, between 1991 and 2000, to just over a 1000 between 2011 and 2020 (Figure 1-2). When looking at the number of people affected, a similar trend can be seen in the long-term with a 70 per cent decrease in the number of people affected in the past three decades, but the trend looks different when comparing only the last two decades. In the last decade, there has been some reversal of the progress made in mitigating the number of people affected by disasters. **The number of people affected rose to 5.5 million, between**

3 EM-DAT - The International Disaster Database. Available at: http://www.emdat.be (Accessed on 1 December 2021).

2011 and 2020, from 1.2 million, between 2001 and 2010. This shift is primarily due to an increase in climate-related hazards, such as drought and storms in the past decade, signalling the risk of reversing progress in disaster risk reduction due to increased climate variability.

FIGURE 1-1 Number of fatalities and people affected in Pacific, 2011–2020

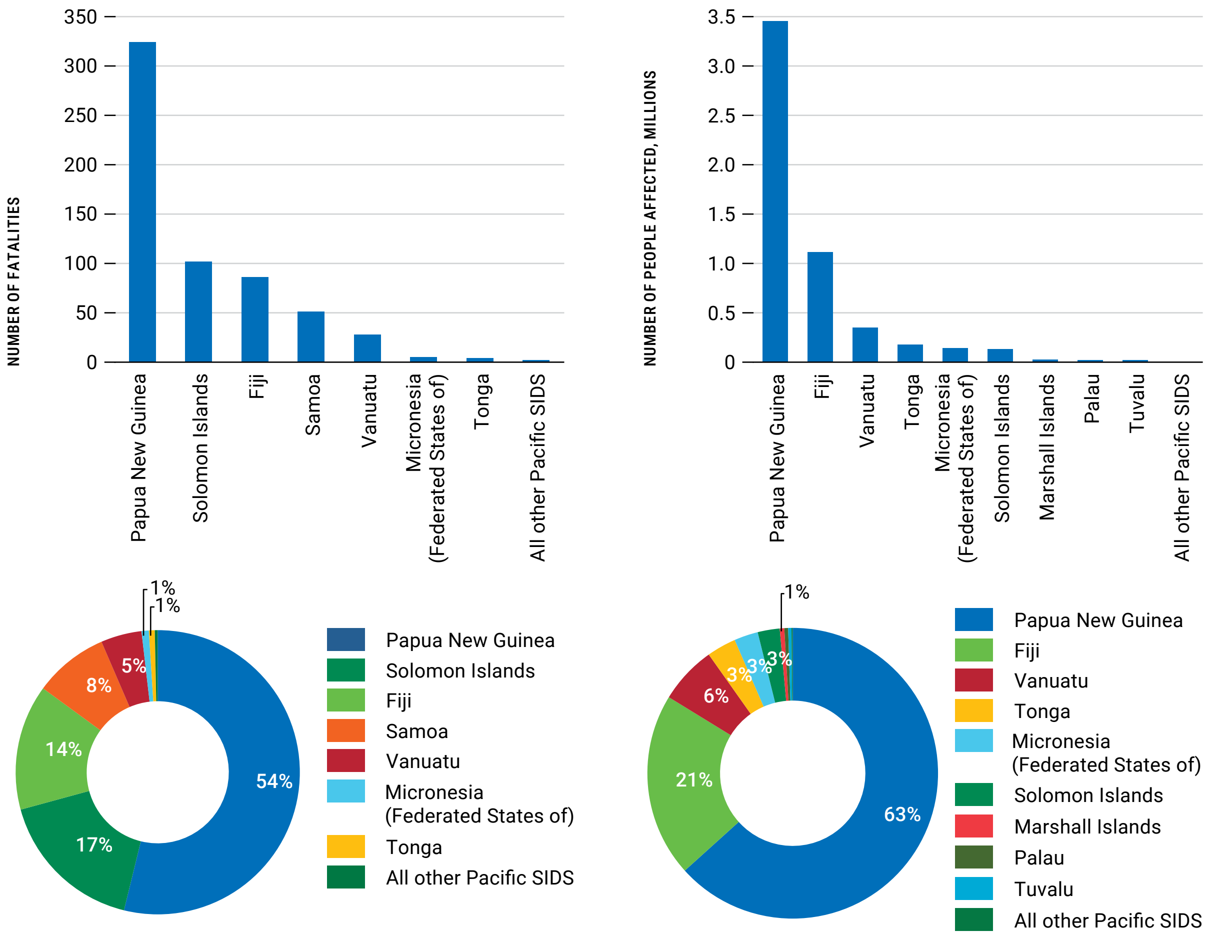
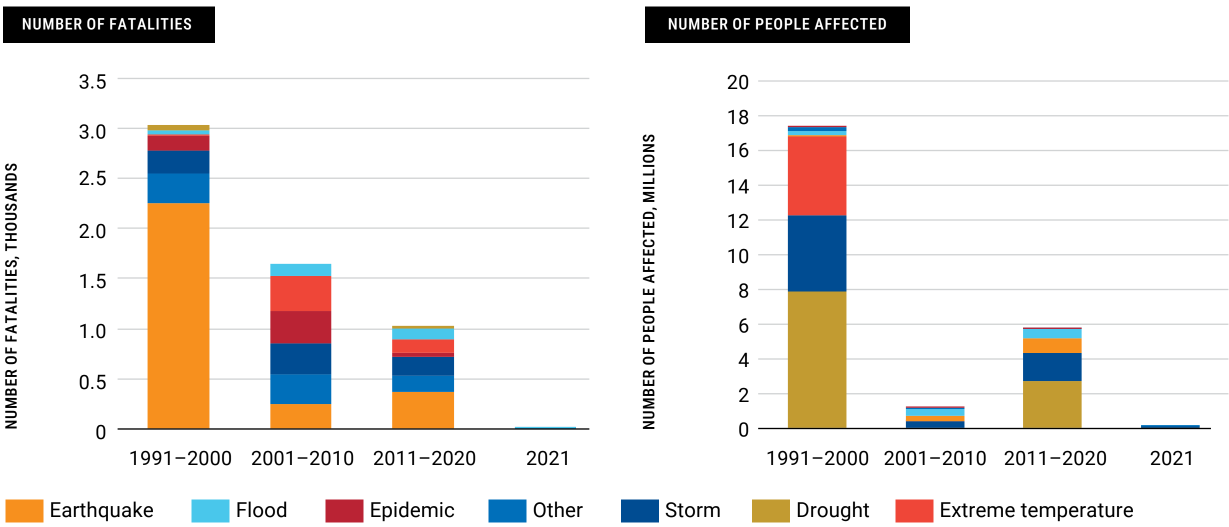


FIGURE 1-2 Number of fatalities and people affected by natural hazards in Pacific SIDS



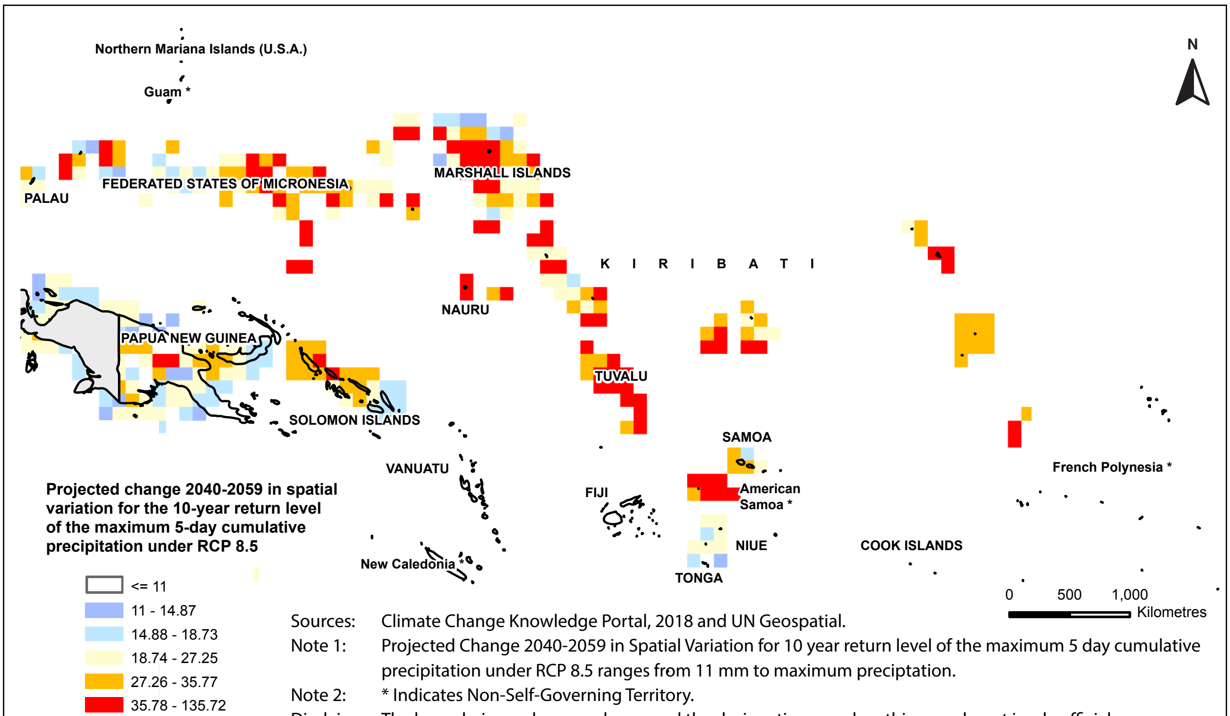
The risk from all hazards, except heatwaves, have been intensifying in the last decade

Climate change is reshaping the disaster riskscape of the Pacific SIDS, with the risks from tropical cyclones, floods, droughts and storms increasing significantly. Some hazards have rapidly intensified and the number of people affected by these hazards has been progressively increasing over time. In the past decade (2012–2021), tropical cyclones affected nearly 1.6 million people and caused 176 fatalities in the Pacific SIDS while floods affected nearly 496,000 people and caused 110 fatalities.[4]

Studying flood projections show that countries in the Pacific SIDS will experience an increase in the occurrence and intensity of floods, with the occurrence of more than 27 mm of maximum 5-day cumulative precipitation in American Samoa, the Federated States of Micronesia, Kiribati, the Marshall Islands, Nauru, Palau, Papua New Guinea, Samoa, and Tuvalu.[5] More people will be affected decade by decade, amounting to over 100,000 people every decade. Some of the worst floods in history have occurred in the past decade, including the 2014 floods in the Solomon Islands.[6]

Climate change projections from the Intergovernmental Panel on Climate Change (IPCC) are based on a series of scenarios using 'representative concentration pathways' (RCPs).[7] The business-as-usual, worst-case scenario is RCP '8.5'. Figure 1-3 demonstrates the growing risk posed by floods under the worst-case climate change scenario. Countries, such as Tuvalu and American Samoa, which have had no recorded flood events in the past two decades will be at highest risk under this worst-case climate change scenario.[8] This worst-case scenario will result in global warming at an average of 8.5 watts per square metre across the planet and, compared with pre-industrial temperatures, an increase of about 4.3˚C, by 2100.

FIGURE 1-3 **Maximum 5-day cumulative precipitation amount projected to return in a 10-year period in Pacific, RCP 8.5, 2040–2059**



Sources: Climate Change Knowledge Portal, 2018 and UN Geospatial.
Note 1: Projected Change 2040-2059 in Spatial Variation for 10 year return level of the maximum 5 day cumulative precipitation under RCP 8.5 ranges from 11 mm to maximum preciptation.
Note 2: * Indicates Non-Self-Governing Territory.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

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

5 ESCAP, based on Climate Change Knowledge Portal.

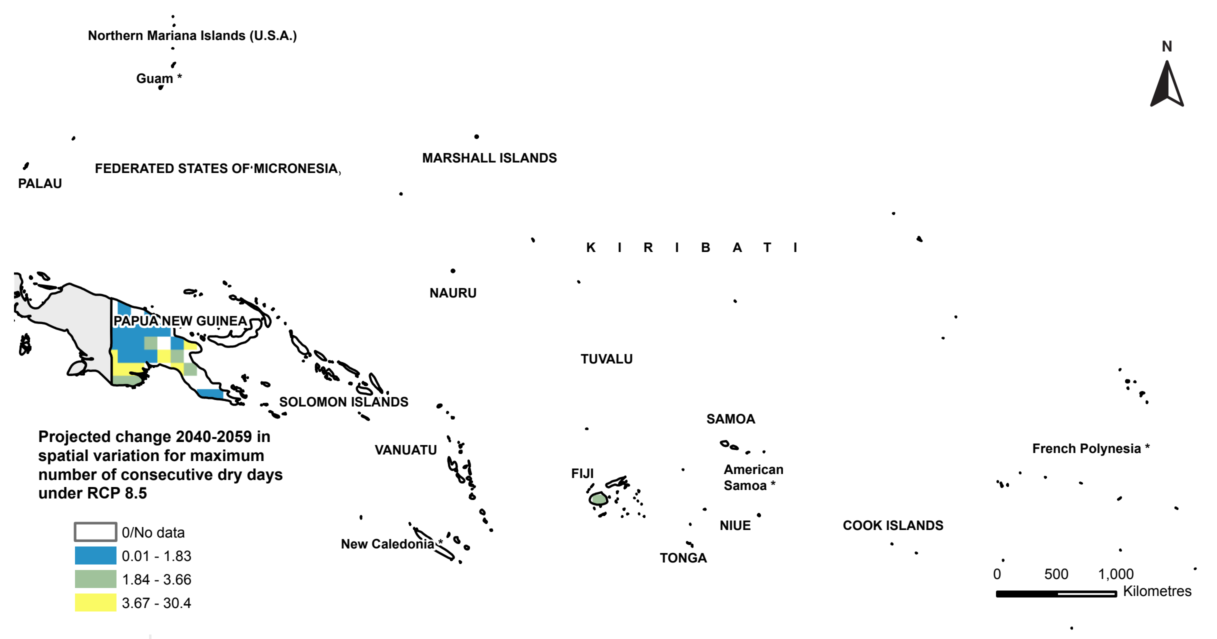
6 United Nations Office for the Coordination of Humanitarian Affairs (OCHA), "Solomon Islands: Worst flooding in history", 30 April 2014. Available at https://www.unocha.org/story/solomon-islands-worst-flooding-history.

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

8 EM-DAT - The International Disaster Database. Available at http://www.emdat.be (Accessed on 1 December 2021).

Similarly, drought has also been a significant threat to some countries in the Pacific SIDS. During the very strong El Niño in 2015–2016,[9] six local government areas of Papua New Guinea, with approximately 162,000 in combined population, were severely affected by drought.[10] Moreover, 28 other local government areas were also highly affected by drought. The recurring El Niño cycle needs better preparedness as it continues to intensify with climate change. Figure 1-4 illustrates the projected maximum number of consecutive dry days for 2040 to 2059 under the worst-case climate scenario (RCP 8.5). It projects an increase in annual consecutive dry days from 2 to 11 days in Papua New Guinea and about 2 to 4 days in Fiji.[11]

FIGURE 1-4 **Number of consecutive dry days: projected change in Pacific RCP 8.5, 2040–2059**



Sources: Climate Change Knowledge Portal, 2018 and UN Geospatial.
Note 1: Projected change 2040-2059 in Spatial Variation for Maximum Number of Consecutive Dry Days under RCP 8.5 ranges from 0 to maximum number of days.
Note 2: * Indicates Non-Self-Governing Territory.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

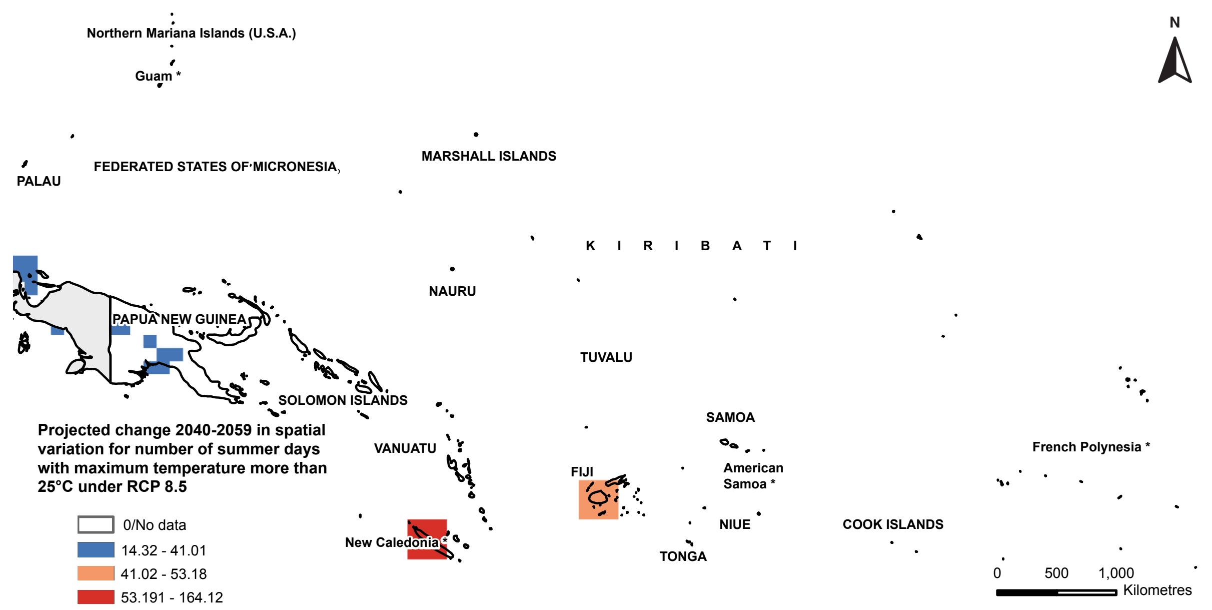
In the Pacific SIDS, the risk of heatwaves is likely to increase as well, which will also have substantial impacts on various sectors including agriculture, health and water management. Under RCP 8.5, the number of summer days with a maximum temperature of more than 25°C is projected to increase in New Caledonia, Fiji and Papua New Guinea (Figure 1-5).

9 Jan Null, "El Niño and La Niña Years and Intensities", March-April-May 2021. Available at https://ggweather.com/enso/oni.htm

10 World Food Programme, "Food Assistance to El-Niño affected populations in Papua New Guinea", 2016. Available at https://www.wfp.org/operations/200966-food-assistance-el-nino-affected-populations-papua-new-guinea and https://documents.wfp.org/stellent/groups/internal/documents/projects/wfp284301.pdf?_ga=2.28499260.1853860904.1642045876-120962107.1642045876.

11 ESCAP calculations, based on the World Bank, Climate Change Knowledge Portal. Available at https://climateknowledgeportal.worldbank.org

Figure 1-5 Projected change in number of days with temperature over 25˚C, RCP 8.5, 2040–2059

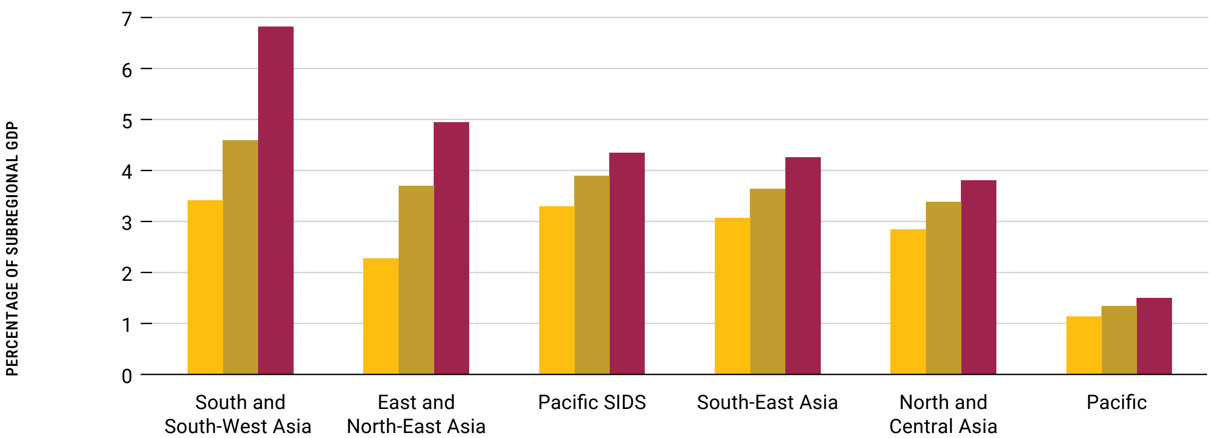


Sources: Climate Change Knowledge Portal, 2018 and UN Geospatial.
Note 1: Projected Change 2040-2059 in Spatial Variation for Number of Summer Days with Maximum Temperature more than 25°C under RCP 8.5 ranges from 14 days to maximum number of days.
Note 2: * Indicates Non-Self-Governing Territory.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The economic cost of cascading hazards and climate change

ESCAP has estimated the economic costs stemming from the combined impacts of the disaster-climate-health nexus. For this purpose, it considers two climate change scenarios using 'representative concentration pathways' (RCPs). **In the Pacific SIDS, the total average annual losses (AAL) from the new expanded disaster riskscape, in the current scenario, is estimated at $1.1 billion. This estimation increases to $1.3 billion under the moderate climate change scenario and to $1.4 billion under the worst-case climate change scenario.** When looking at these figures as a percentage of subregional GDP, the Pacific SIDS will suffer the third highest losses, with average annual losses under the worst-case climate change scenario increasing to 4.3 per cent of GDP from the current 3.3 per cent (Figure 1-6).

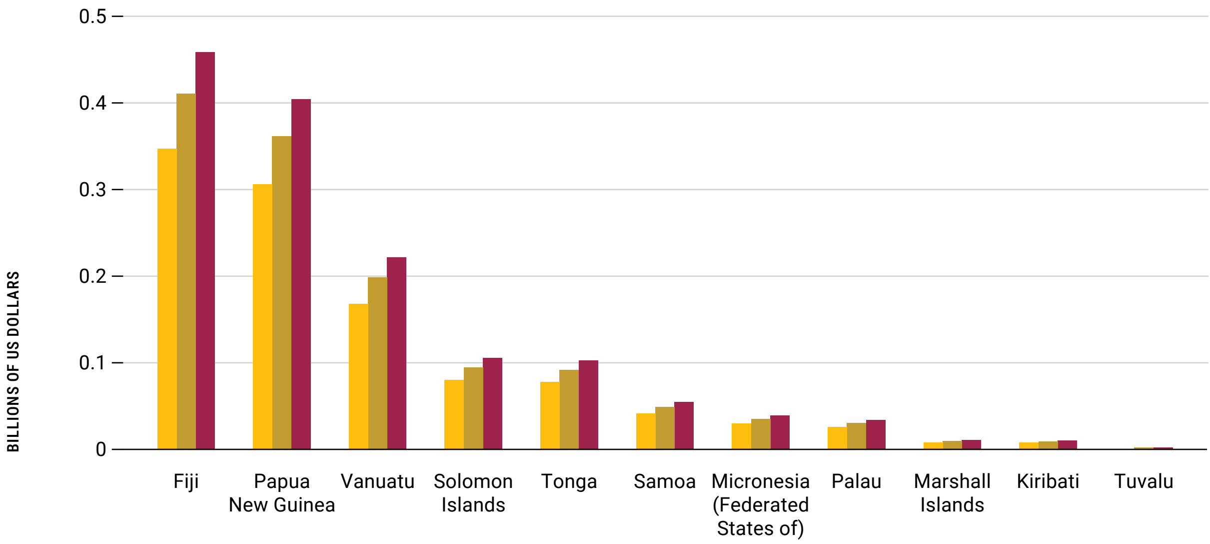
FIGURE 1-6 **Annual Average Losses (AAL) from cascading hazards as a percentage of subregional GDP**



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

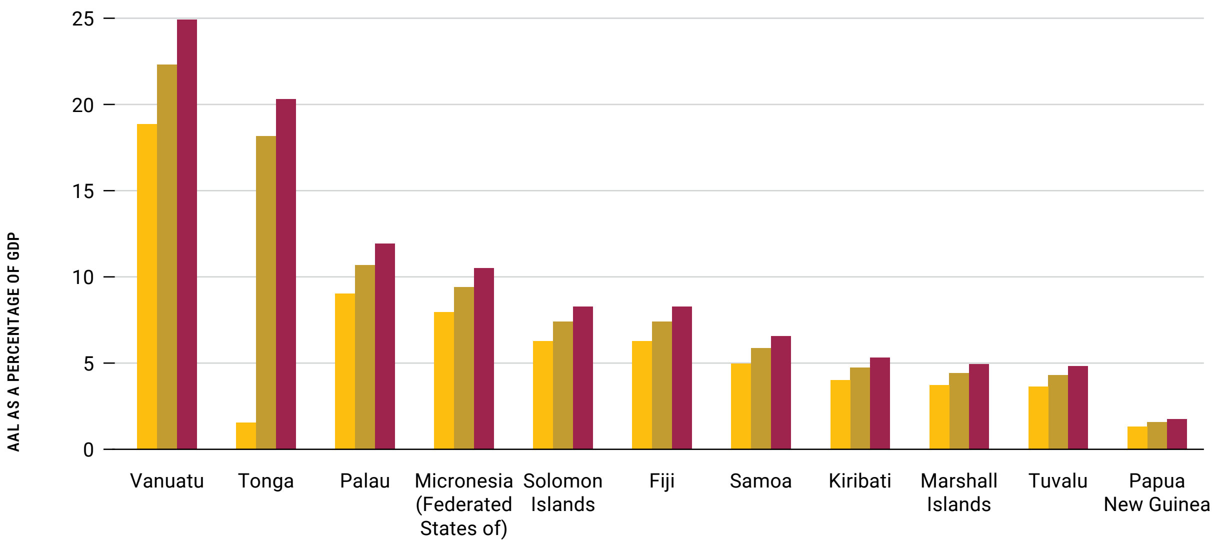
In absolute terms, under the worst-case scenario, Fiji has the highest estimated AAL at $459 million, followed by Papua New Guinea at $404 million and Vanuatu at $222 billion (Figure 1-7). However, when assessed as a percentage of the country's GDP, the picture changes. Vanuatu is now faced with the highest losses, with AAL accounting for 25 per cent of its GDP. Tonga closely follows with losses amounting to 20 per cent of GDP under the worst-case climate change scenario. Palau and the Federated States of Micronesia will also face significant losses equating to 11 per cent of their respective GDPs. Papua New Guinea, which faced the second-highest total losses, faces the lowest losses as a percentage of GDP at 1.8 per cent (Figure 1-8).

FIGURE 1-7 **Average Annual Loss (AAL) in the Pacific SIDS from cascading risks under current, moderate (RCP 4.5), and worst-case (RCP 8.5) climate change scenarios, $ billions**



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

FIGURE 1-8 **Average Annual Losses (AAL) as a percentage of GDP under current, moderate (RCP 4.5), and worst-case (RCP 8.5) climate change scenarios for Pacific SIDS**



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

A riskscape of cascading hazards

The convergence of biological and natural hazards, together with climate change, has added to the stresses of climate-related disasters in the Pacific SIDS, while their increasing frequency, intensity and unpredictability is already battering vulnerable sectors and communities. Overlapping hazards, along with the interconnectedness of economies at different scales, are creating systemic risks that demand more sustained and rigorous approaches.[12]

Climate change not only reshapes hazard risks, 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. Table 1-1 provides a snapshot of how climate change could alter the geography and intensity of various biological hazards and increase their combined impacts in various countries in the Pacific SIDS. These challenges were already identified in the Sendai Framework for Disaster Risk Reduction 2015–2030. The Framework recognized the importance of health threats, including biological hazards, which encouraged the development of the field of 'health emergency and disaster risk management'.[13]

In the recent decades, there has been an increase in the risk of climate-related diseases leading to illness and death.[14] 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.[15] **In the last two decades, the Pacific SIDS have seen a rising number of malaria cases; from less than 200,000 per year, in the early 2000s, to over 500,000 in 2016 and 2017 (Figure 1-9).** In Papua New Guinea alone, cases have risen from close to 80,000, in 2000, to 478,000, in 2017 and 2016.[16] This increase is happening while the Asia-Pacific region is experiencing an overall decrease in the cases of malaria.

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

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

13 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.

14 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", 2019. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/climsci.pdf.

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

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

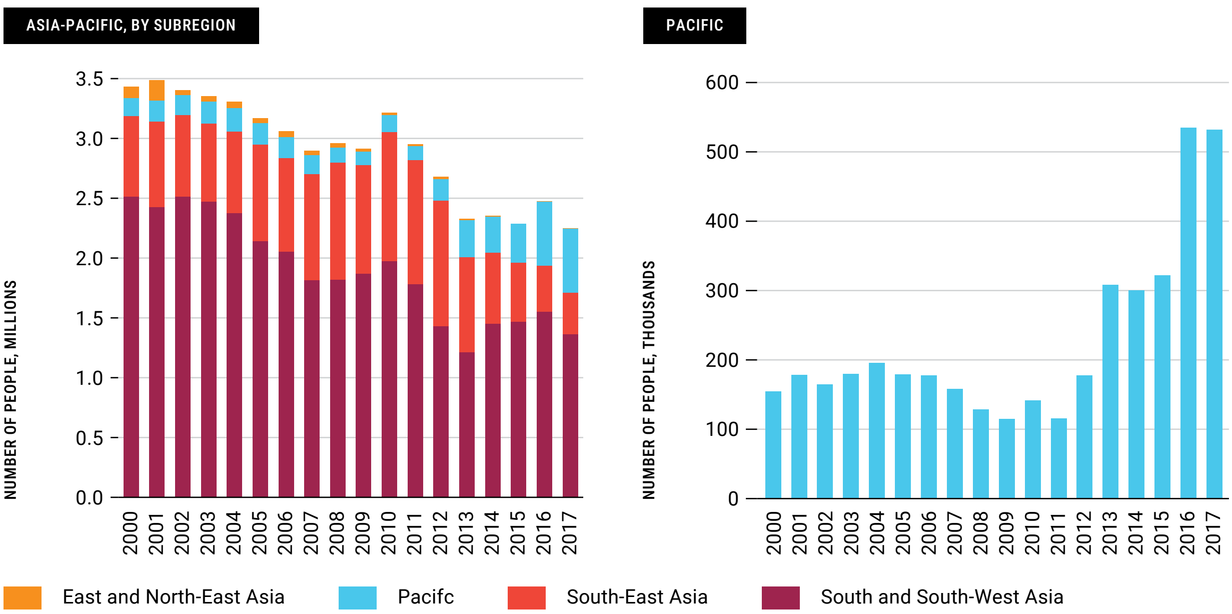
TABLE 1-1 Impacts of climate change on natural and other biological hazards

Pacific small island developing States

Countries	Climate Change Risk	Related biological and health crisis
Marshall Islands	Increase in flooding and in risk of rise in sea level	Freshwater resources affected by a 0.4-meter rise in sea level
Fiji	Increase precipitation and flooding	Increase in diarrhoea by 3%
		Increase in typhoid with a 0.63 strength of association with a 2-year lag
	Drought	Increase in dengue fever and diarrhoeal disease with an odds ratio of 5.17 and 9.0, respectively, in the month following drought
	Floods caused by tropical depressions	Increase in the odds ratio of dengue fever to 10.57 in the month following drought
Palau	Increase in precipitation	Increase in number of leptospirosis cases
		Increase in number of dengue cases
Solomon Islands	Increase in maximum temperature	Increased likelihood of incidences of malaria in temperatures of 30°C and 31.5°C
		Increase in respiratory diseases
Cook Islands	Increase in average temperature	Increase in rate of Ciguatera
Kiribati	Increase in average temperature and heatwaves	An increase in temperature of 1°C can increase diarrhoea by 5%
	Increase in sea surface temperate	Increase in rates of Ciguatera fish poisoning
Micronesia (Federated States of)	Increase in monthly average temperatures	Increase in respiratory disease and diarrhoeal disease with a monthly maximum temperature threshold of 32–33°C

Source: World Health Organization (WHO), Western Pacific Region, "Human health and climate change in Pacific island countries", meeting report, 4 November 2015. Available at: https://www.who.int/publications-detail-redirect/human-health-and-climate-change-in-pacific-island-countries.

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 6 February 2021).

CHAPTER 2

Managing disasters during a global pandemic

Blue Pacific 2050 Climate Change and Disasters

Strategic pathways: Inclusion and Equity

*This chapter presents how **cascading hazards disrupt lives and livelihoods**. This analysis can support policymakers in targeting action to ensure protection and practices for people on climate and disaster risk reduction, and mobility including relocation, migration and displacement.*

Highlights

- The deluge of weather events, including cyclones and floods, that are occurred simultaneously with the COVID-19 pandemic have compounded impacts on livelihoods, economies and populations in the Pacific SIDS.
- Pacific SIDS are 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 the Pacific SIDS, like other subregions in Asia and the Pacific, countries faced the dual challenge of addressing the COVID-19 pandemic and managing natural hazards. The impacts of this biological hazard were compounded by tropical cyclones, floods landslides and drought, making it more difficult to respond effectively.

Concurrently, countries all over the world are still coping with the COVID-19 pandemic, a disaster of unimaginable proportions and the worst biological shock of the century. While the Pacific SIDS were initially spared the large-scale COVID-19 outbreaks, the ripple effects of the pandemic significantly affected the economies of Pacific SIDS.[17] This was superimposed with the devastating impact of tropical cyclones, such as Cyclone Harold, together with flooding and droughts across the Pacific SIDS.[18]

While the COVID-19 pandemic intensified in the Pacific SIDS, countries continued to experience other natural hazards, most of which were hydrometeorological. These complex and cascading disaster risks made it difficult for countries in the Pacific SIDS to respond to these challenges.

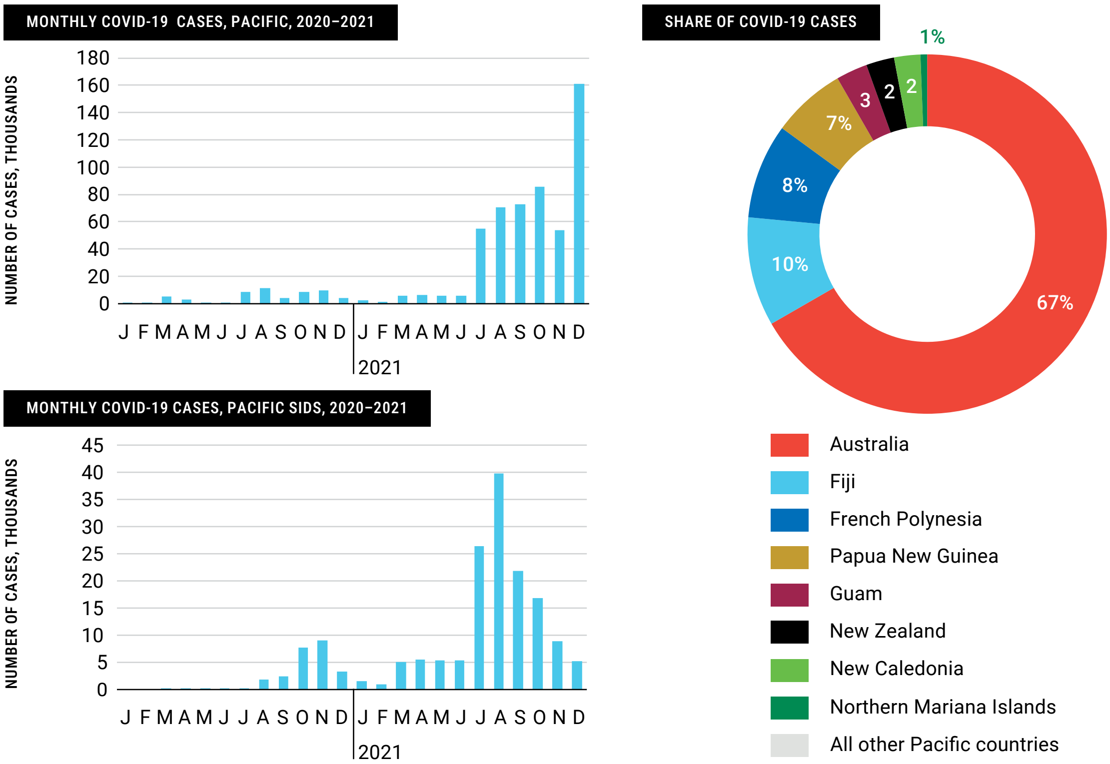
In April 2020, Cyclone Harold, a category 5 cyclone, hit four Pacific SIDS; the Solomon Islands, Vanuatu, Fiji and Tonga. Tropical Cyclone Harold had a particularly harsh impact in Vanuatu, destroying between 80 and 90 per cent of the homes, displacing over 27 per cent of the nation's population and affecting over half of the country's population. In both Vanuatu and Fiji, shelters saw over a thousand people needing refuge from the cyclone and its effects. This occurred at the onset of the COVID-19 pandemic as governments faced paralyzing conditions and economic uncertainty that was triggered by the pandemic. Cyclone Harold was closely followed by Tropical Cyclone Yasa and Ana, magnifying the effects on the people of the Pacific SIDS. Response and recovery efforts were severely hindered with the restrictions put in place to contain the spread of COVID-19, forcing governments to often look internally for resources. Restrictions and lockdowns limited mobility and access to vulnerable populations while reducing the availability of shelters for people affected by the natural disasters. Furthermore, restrictions on the movement of goods

17 Center for Strategic & International Studies, "The Pacific Islands Are a Covid-19 Priority", 15 September 2020. Available at https://www.csis.org/analysis/pacific-islands-are-covid-19-priority.

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

made it difficult for the Pacific SIDS to gain access to essential supplies. Although many hardships were faced in the response and recovery to the disasters that intersected with COVID-19, nonetheless, the Pacific SIDS ultimately rose above the challenges by building local resilience.

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



Source: Data from World Health Organization (WHO), "WHO Coronavirus (COVID-19) Dashboard". Available at https://covid19.who.int (accessed 1 March 2022).

COVID-19 limits mobility and access to vulnerable populations

Lockdowns and restrictions on mobility imposed due to COVID-19 prevented the normal flow of humanitarian aid workers to reach the Pacific SIDS following Cyclones Harold, Yasa and Ana. Prior to Tropical Cyclone Harold, government officials in all Pacific SIDS had asked humanitarian workers to vacate to prevent the spread of COVID-19. This resulted in a shortage of response workers who lacked the technical skills needed for the recovery after Tropical Cyclone Harold hit. Quarantine measures further delayed the availability of response workers as many incoming humanitarian workers had to undergo a 14-to-28-day quarantine.[19]

With the lack of humanitarian aid works, the Pacific SIDS were forced to look internally for volunteers to carry out national response efforts. However, even internally, accessing affected locations was at times difficult due to restrictions on intra-island transit, making it difficult to get national health workers and supplies where it was most needed. During the pandemic there was an outflux of people moving from urban areas to their rural home islands and regions. Thus, accessing the populations in rural areas and islands became increasingly important during the pandemic and after the cyclones. In Tuvalu, for example, in March and April 2020, the outer islands experienced an average population increase of about 35 per cent.[20]

19 Kayly Ober and Stefan Bakumenko, "A New Vulnerability: COVID-19 and the Tropic Cyclone Harold Create the Perfect Storm in the Pacific", Issue brief, Refugees International, 3 June 2020. Available at https://www.refugeesinternational.org/reports/2020/6/1/a-new-vulnerability-covid-19-and-tropical-cyclone-harold-create-the-perfect-storm-in-the-pacific.

20 Taukiei Kitara and others, "Reducing COVID-19 risk through population relocation and closed borders: effects of pandemic measures in a small island state", blog, International Organization for Migration (IOM), 1 June 2020. Available at https://environmentalmigration.iom.int/blogs/reducing-covid-19-risk-through-population-relocation-and-closed-borders-effects-pandemic-emergency-measures-small-island-state.

Disrupted supply chains result in a lack of emergency supplies

The looming effect of COVID-19 not only disrupted the mobility of humanitarian workers but restricted access to emergency supplies. The Pacific SIDS put in place strict sanitary restrictions on supplies being imported into their countries to mitigate the spread of COVID-19. In Vanuatu, goods delivered to ports had to be individually sprayed and put in quarantine for a minimum of 36 hours.[21] As a result, there were significant delays in the delivery of lifesaving supplies, delaying relief by approximately two weeks. In Tuvalu, two desalination units at the Public Works Department, needed to supply water to households during the 2021 drought, were not operational because the suppliers, located in New Caledonia, could not go to Tuvalu to assemble the units due to border restrictions.[22] Similarly, after Tropical Cyclone Yasa hit Fiji, restrictions prevented the Red Cross from providing hard-hit communities with water tanks and construction materials, leaving thousands of people in temporary shelters without safe drinking water.[23]

These import protocols also deepened the food insecurity caused by crop and livestock damage from the cyclones. Domestic food supply was scant and restrictions on import made it difficult to import the needed produce. Thus, many residents found it difficult to access adequate and nutritious food in Vanuatu. In Fiji and Solomon Islands, home-grown farms which often help stave off hunger were severally damaged, leaving many vulnerable to undernourishment.[24] This is particularly concerning in the Pacific SIDS, where undernourishment is widely prevalent, with one in three children under 5 years of age either undernourished or overweight.[25] Climate-related disasters, such as tropical cyclones, floods and droughts, can severely aggravate the situation, especially for children and adolescents from the poorest and most marginalized communities.

Shelter management and the risk of COVID-19 spread

Shelter management in the time of COVID-19 was an increasingly difficult task. Disaster responders tried to weigh the risks posed by overcrowding and spread of the pandemic in shelters versus the risk of exposure to disasters. As a result, many affected countries in the aftermath of Tropical Cyclone Harold, operated with a reduced number of shelters. In Vanuatu, 80 to 90 per cent of the island's homes were destroyed resulting in over 27 per cent of the nation's population being displaced. However, due to COVID-19 limitations, shelters were operating at reduced capacity, resulting in only 13 per cent of those in need of shelter having received it.[26] Others were forced to rely on relatives and makeshift shelters set up alongside damaged homes. In Fiji, even six months after Tropical Cyclone Yasa, thousands of people remained homeless and thousands are still living in temporary shelters. The conditions in these shelters have worsened due to lack of safe drinking water and hygiene equipment, increasing the risk of the spread of COVID-19.[27]

21 Kayly Ober and Stefan Bakumenko, "A New Vulnerability: COVID-19 and the Tropic Cyclone Harold Create the Perfect Storm in the Pacific", Issue brief, Refugees International, 3 June 2020. Available at https://www.refugeesinternational.org/reports/2020/6/1/a-new-vulnerability-covid-19-and-tropical-cyclone-harold-create-the-perfect-storm-in-the-pacific.

22 International Federation of Red Cross and Red Crescent Societies, "Emergency Plan of Action (EPoA) Tuvalu: Impending Drought", 24 August 2021a. Available at: https://reliefweb.int/sites/reliefweb.int/files/resources/MDRTV002do.pdf.

23 International Federation of Red Cross and Red Crescent Societies, "Fiji TC Yasa: Six months on COVID-19 slows recovery efforts", News and press release, 21 June 2021b. Available at https://reliefweb.int/report/fiji/fiji-tc-yasa-six-months-covid-19-slows-recovery-efforts.

24 Kayly Ober and Stefan Bakumenko, "A New Vulnerability: COVID-19 and the Tropic Cyclone Harold Create the Perfect Storm in the Pacific", Issue brief, Refugees International, 3 June 2020. Available at https://www.refugeesinternational.org/reports/2020/6/1/a-new-vulnerability-covid-19-and-tropical-cyclone-harold-create-the-perfect-storm-in-the-pacific.

25 United Nations Children's Fund (UNICEF), "Poor diets damaging children's health in Pacific, warns UNICEF", Press release, 15 October 2019. Available at https://www.unicef.org/pacificislands/press-releases/poor-diets-damaging-childrens-health-pacific-warns-unicef.

26 United Nations Office for the Coordination of Humanitarian Affairs (OCHA), "Pacific Humanitarian Team – Tropical Cyclone Harold Situation Report #12 (final)", Situation report, 7 May 2020. Available at https://reliefweb.int/report/vanuatu/pacific-humanitarian-team-tropical-cyclone-harold-situation-report-12-final-7-may.

27 International Federation of Red Cross and Red Crescent Societies, "Fiji TC Yasa: Six months on COVID-19 slows recovery efforts", News and press release, 21 June 2021b. Available at https://reliefweb.int/report/fiji/fiji-tc-yasa-six-months-covid-19-slows-recovery-efforts.

COVID-19 and intersecting natural hazards

With attention focussed on the pandemic, the disasters in the Pacific SIDS garnered far less international attention than usual, receiving very little international media coverage. Since international media attention on disaster events are critical in mobilizing donor engagement for relief and recovery efforts,[28] the lack of media coverage resulted in the Pacific SIDS receiving far less financial and humanitarian assistance than usual. In the aftermath of Tropical Cyclone Pam, in 2015, World Vision Vanuatu was able to secure $4.6 million in funding within 72 hours. In contrast for Tropical Cyclone Harold, at the end of the first week they had yet to secure $660,000.[29] This was superimposed by the lack of international aid workers that were unable to arrive in affected countries due to travel restrictions. As a result, Governments in the Pacific SIDS declared that responses will be led nationally. For example, Papua New Guinea faced the worst flooding in over 30 years where 60,000 people lost their homes and livelihoods, after grappling with a COVID-19 state of emergency.[30] Faced with travel restrictions due to the pandemic, Papua New Guinea responded nationally, through coordination between the provincial COVID-19 Command Centre and the National Disaster Centre to ensure that the new challenges posed by COVID-19 did not hinder the immediate response to the flooding.

The COVID-19 pandemic forced many Pacific SIDS to become more self-reliant in their responses to natural disasters. Although, COVID-19 restrictions will eventually be lifted, the Pacific SIDS have demonstrated their internal capacity to respond to disaster risk without the usual reliance on the international community. This new approach to disaster resilience works through guidance by local institutions, channels local capacity and, when necessary, uses international technical expertise.[31] Although the Pacific SIDS still need to work toward building resilience when faced with converging and cascading risks, the pandemic has provided an opportunity for governments to build local resilience through regional cooperation.

28 Kayly Ober and Stefan Bakumenko, "A New Vulnerability: COVID-19 and the Tropic Cyclone Harold Create the Perfect Storm in the Pacific", Issue brief, Refugees International, 3 June 2020. Available at https://www.refugeesinternational.org/reports/2020/6/1/a-new-vulnerability-covid-19-and-tropical-cyclone-harold-create-the-perfect-storm-in-the-pacific.

29 Ibid.

30 Rebecca Kuku, "Flooding leaves 60,000 homeless", The National, 7 April 2020. Available at https://reliefweb.int/report/papua-new-guinea/flooding-leaves-60000-homeless.

31 Kira Osborne, "Localisation for who? Pacific resilience in the wake of the COVID-19 pandemic", blog, Australia Pacific Security College, 10 June 2021. Available at: https://pacificsecurity.net/localisation-for-who-pacific-resilience-in-the-wake-of-the-covid-19-pandemic/.

CHAPTER 3

Hotspots of exposure and vulnerability to cascading risks under 1.5 and 2 degree global warming

Blue Pacific 2050 Climate Change and Disasters

Strategic pathways: Governance, Education-Research-Technology, Partnerships and Cooperation

*This chapter provides the **evidence-base** to strengthen regional collaboration to limit global warming and advocate with all stakeholders to ensure that all commitments address the needs of the region on climate change, disaster risk reduction and their cascading impacts. It also highlights the importance of **utilizing latest climate science** and hence, strengthening investment in participatory science and innovative research.*

Highlights

- Under the most recent Shared Socioeconomic Pathway (SSPs) climate models, the Pacific SIDS will face an increase in annual wind speed of tropical cyclones and associated health hazards.
- Identifying vulnerable groups who are susceptible to the threats of increasing cyclones and the related biological hazards, under 1.5°C and 2°C climate change, and providing adaptation measures, such as expanding mangrove protection, is critical for building resilience to climate change and accelerating implementation of SDG 13 (Climate action).

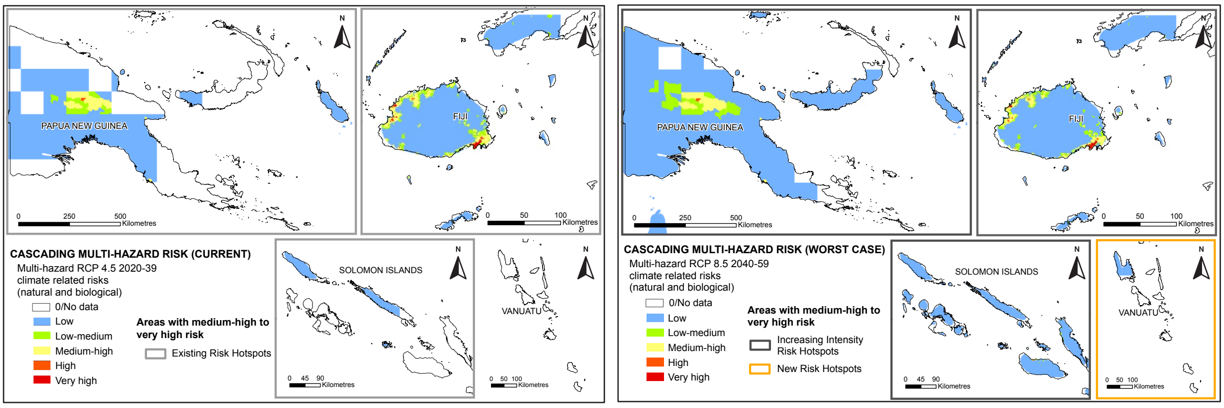
Climate change is threatening to expand hotspots of cascading hazards

The Pacific SIDS are extremely vulnerable given the intensifying impacts of climate change. Climate-related hydro-meteorological disasters, such as tropical cyclones, floods and droughts, are increasing in frequency and intensity. This has led to a new and expanding set of flood and tropical cyclone risk hotspots in the Pacific SIDS, with the most exposed populations concentrated in Papua New Guinea, Fiji and the Solomon Islands. These areas, already vulnerable to natural hazards, are now faced with a more complex riskscape from changing climate conditions and its associated risks from biological hazards. Countries in these hotspots need to thoroughly assess the impact of systemic and cascading risks and highlight priority areas for action.

Climate-related, multi-hazard risks

Figure 3-1 illustrates the exposure to risks associated with climate-related hazards and the related diseases under a moderate climate change scenario (RCP 4.5) and a worst-case climate change scenario (RCP 8.5). Under the worst-case scenario, not only will existing hotspots expand and become more complex in Papua New Guinea and Fiji, but new hotspots will emerge in the Solomon Islands and Vanuatu. **Under the worst-case climate change scenario over 3 million people, or 27 per cent of the subregional population will be exposed to multi-hazard risks from climate-related hazards.** In Fiji, the exposure of the population will be much higher with over half a million people exposed, or 64 per cent of the national population (Figure 3-2).

FIGURE 3-1 Emerging multi-hazard risk hotspots for climate-related disasters under moderate (RCP 4.5) and worst-case (RCP 8.5) climate change scenarios in the Pacific SIDS



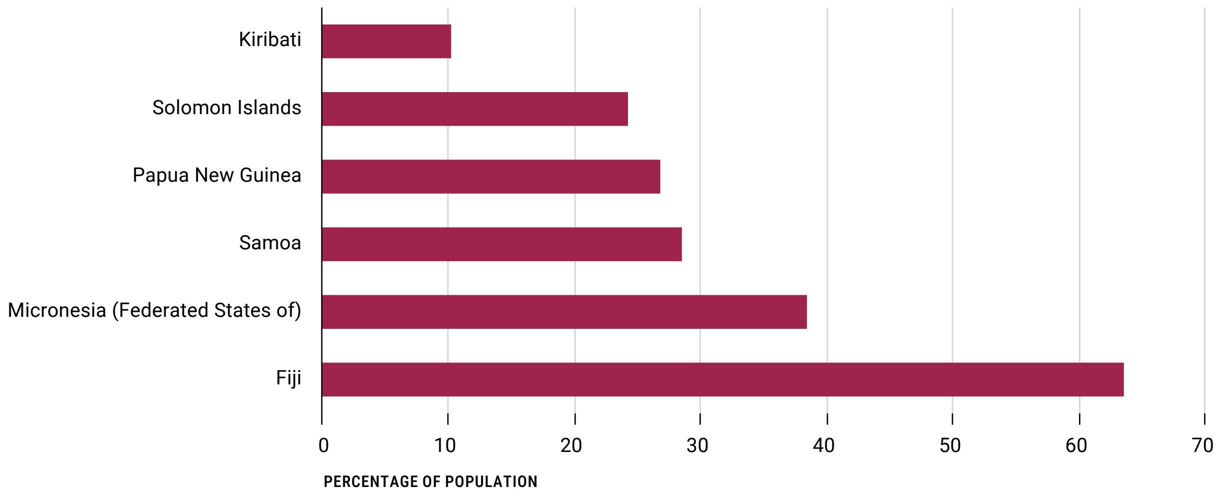
Sources: ESCAP calculations, based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Knowledge Portal, 2018; Disability-Adjusted Life Years (DALYs) estimates 2000-2019; and UN WPP-Adjusted Population Density 2020, v4.11; and UN Geospatial.

Notes: 1. Cascading Hazard Risk is obtained from multi-hazard file that consists of highest intensity of GAR Cyclone Wind within 100 year return period: Climate projection data for flood, drought and heatwaves under RCP 45 in 2020-2039 and under RCP 8.5 in 2040-2059 by Population and DALYS for related mult-hazard.

2. Current scenario refers to RCP 4,5 in 2020-2039. The worst case scenario refers to RCP 8.5 in 2040-2059.

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

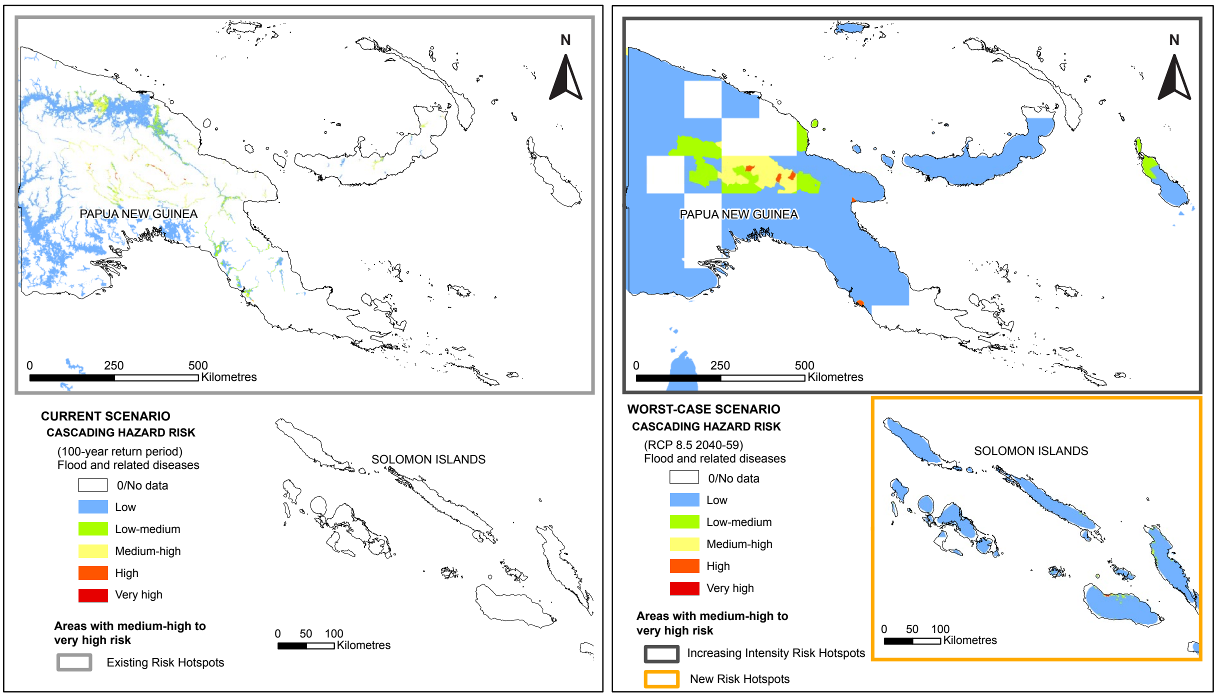
FIGURE 3-2 Population exposure to multi-hazard risk and related diseases under the worst-case climate change scenario (RCP 8.5)



Floods and climate-related diseases

Countries in the Pacific SIDS are becoming more vulnerable to additional risks from floods and related diseases, which directly affect human health and have high economic and social costs. Countries that were previously unaffected by floods will become hotspots of flood exposure with climate change. Under the worst-case climate change scenario, the number of people exposed to floods will increase from just over 200,000 to over 2.5 million in the Pacific SIDS. Figure 3-3 demonstrates the expansion of the flood riskscape in two Pacific SIDS countries, Papua New Guinea and the Solomon Islands.

FIGURE 3-3 **Expansion of the floods riskscape under current and worst-case (RCP 8.5) scenarios in Papua New Guinea and the Solomon Islands**



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

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

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

The expanding flood hotspots will intersect with the existing socioeconomic vulnerabilities in most Pacific SIDS. Kiribati, the country with the lowest GDP/capita within the Pacific SIDS, will have close to 30 per cent of its population exposed to floods under the worst-case climate change scenario.[32] Floods can severely impact peoples' livelihoods especially in countries that rely on agriculture and fisheries, such as Kiribati. The Federated States of Micronesia will have the highest rate of exposure to floods with close to 40 per cent of its population exposed under the worst-case climate change scenario.

Climate risks basis new IPCC models

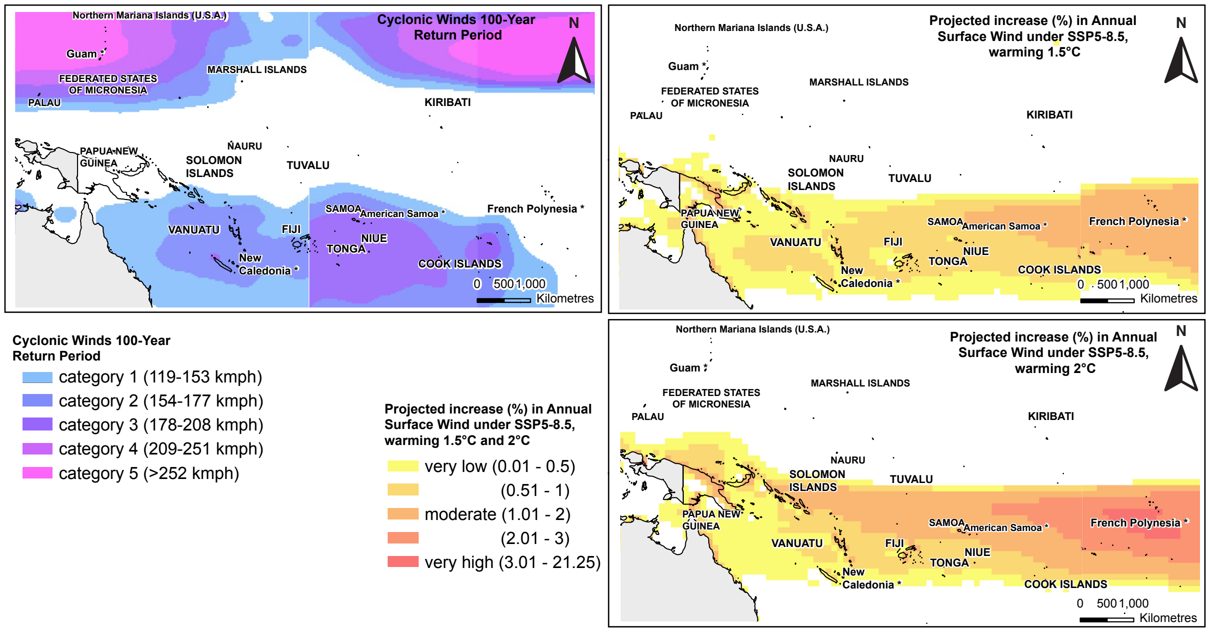
Every increment of a degree between 1.5°C and 2°C translates into increased risks of tropical cyclones in the Pacific SIDS. The following analysis presents tropical cyclones and climate-related diseases overlapping with hazards under the new Intergovernmental Panel on Climate Change (IPCC) models (6th Coupled Model Intercomparison Project (CMIP6) and Shared Socioeconomic Pathway (SSP)).

The Pacific SIDS are currently at risk of cyclones; Guam and Northern Mariana Islands are prone to very strong or category 5 cyclones; the Federated States of Micronesia are prone to category 4 cyclones; and American Samoa, Fiji, New Caledonia, Palau, Samoa and Tonga are prone to category 3 cyclones.[33] These countries may face higher risk of cyclones in the future.

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

33 ESCAP, *Asia-Pacific Disaster Report 2021* (United Nations publication, 2021a).

FIGURE 3-4 **Intensifying cyclone risks under new climate change scenarios (Shared Socio-economic Pathways)**



Sources: ESCAP based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; IPCC WGI Interactive Atlas - Coupled Model Intercomparison Project Phase 6 (CIMP6), 2021; and UN Geospatial.

Notes: 1 Cyclone data consists of all cyclone wind categories with a return period of 100 years and an intensity of 119 to more than 252 km/h. Cyclonic wind intensity categories are based on Saffir-Simpson scale.
2. Projected increase in Annual Surface Wind Change under SSP5-8.5 ranges from 0 and above.
3. The reference period for the projected change in Annual Surface Wind Change under SSP 5-8.5 is 1995-2014.
4. *Indicates Non-Self-Governing Territory.

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

Based on the analysis of the (CMIP6) model and the Shared Socioeconomic Pathways (SSPs), the Pacific SIDS will face an increase in the annual wind speed of tropical cyclones and in their associated health hazards. The IPCC's 6th Coupled Model Intercomparison Project (CMIP6) uses climate change projections and socioeconomic scenarios to evaluate climate impacts and adaptation measures.

Under the climate scenario with very high greenhouse gas (GHG) emissions (SSP 5-8.5) and warming of 1.5°C, these intensifying annual wind speeds may occur in French Polynesia (high increase); American Samoa, New Caledonia, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu (moderate increase); and Fiji, Papua New Guinea, and New Caledonia (low increase).[34] Under this scenario, 996,000 people, or 8.3 per cent of total population of the Pacific SIDS, will be exposed to between moderate and very high projected increase in surface winds. The highest population exposure will be in Papua New Guinea (685,000 people), followed by French Polynesia (238,000 people), Vanuatu (48,000 people), and the Solomon Islands (25,000 people). In addition, 12.5 per cent of total agriculture production value will be at risk.

Furthermore, under the scenario with very high GHG emissions (SSP 5-8.5) and warming of 2°C, French Polynesia may experience a very high increase in the intensity of surface winds; American Samoa and Samoa may experience high increase in the intensity of surface winds; and Fiji, New Caledonia, Papua New Guinea, Solomon Islands, Tonga and Vanuatu may experience a moderate increase in the intensity of surface winds. Under this scenario, there will be more than 4 million people, or 33.4 per cent of total population of the Pacific SIDS, exposed to moderate to very high projected increase in surface winds. The highest population exposure will be in Papua New Guinea (2.7 million people), followed by Fiji (511,000 people), Solomon Islands (298,000 people), French Polynesia (242,000 people). Furthermore, 43.4 per cent of the total agriculture production will also be exposed.

34 Intergovernmental Panel on Climate Change (IPCC), Working Group I (WGI): Interactive Atlas - Coupled Model Intercomparison Project Phase 6 (CMIP6), 2021b. Available at https://interactive-atlas.ipcc.ch/ (accessed in November 2021).

Identifying vulnerable groups

Identifying and protecting the most vulnerable population is a key principle of disaster risk management. In the Pacific SIDS, climate change can impact the most vulnerable populations including women and people with disabilities. Furthermore, vulnerability to hazards intensifies the disaster risk for people already at intersections of different types of vulnerabilities, making it critical for countries to include these vulnerable groups in their disaster risk reduction (DRR) strategies.

Women

Historically, women have been disproportionately affected by disasters, due to pre-existing gender inequalities.[35, 36] These vulnerabilities will exacerbate, especially for the Pacific SIDS which are vulnerable to the impacts of climate change.[37] The intersection of gender, disability and poverty creates a set of challenges and discrimination which often puts women and girls at higher risk during disasters. The intersection of vulnerabilities is shown through the higher likelihood for women with disabilities to live in poverty, as seen in Tuvalu where women with disabilities are twice as likely to live in hardship as compared to men with disabilities.[38, 39]

The existing vulnerabilities faced by women intersect with disaster risk, making women more susceptible during and after natural hazards. Tropical Cyclone Harold, for example, disproportionately affected women and girls through adverse impacts on food security, nutrition, health, livelihoods, and protection.[40] Furthermore, women are often employed in sectors heavily impacted by disasters, leaving them jobless when disasters hit. This was also seen in the aftermath of Tropical Cyclone Harold, where the majority of women employed in the tourism industry and agriculture sector in Vanuatu, Solomon Islands and Fiji lost their jobs.[41] The loss of primary household income and economic independence is extremely concerning as it directly affects women's wellbeing, and possibly leads to an increase in gender-based violence.[42] Reinforcing the effects on women, the Rapid Gender Analysis Report (2020) shows that due to the synchronicity of the outbreak of COVID-19 and Tropical Cyclone Harold there has been an adverse impact on women through losses in jobs, in both formal and informal sectors, and increasing women's workload (as primary caregivers with significant domestic responsibilities).

People with disabilities

People with disabilities are particularly vulnerable to disasters. They are disproportionately impacted by disasters and are more likely to lose their life or be injured during a disaster as compared to people without disabilities.[43] For instance, 74 per cent of women with disabilities and 50 per cent of men with disabilities reported barriers in accessing evacuation centres during Tropical Cyclone Pam (2015), in Vanuatu.[44] Thus,

35 M. M. Ariyabandu, "Sex, Gender and Gender Relations in Disasters", in Women, Gender and Disaster: Global Issues and Initiatives, Elaine Enarson and P. G. Dhar Chakrabarti, eds. (New Delhi: Sage Publications India Pvt. Ltd., 2009) pp. 05-17.

36 Elaine Enarson, "Gender and Natural Disasters", Crisis Response and Reconstruction Working Paper No.1, International Labour Organization, 1 September 2000. Available at https://www.ilo.org/employment/Whatwedo/Publications/WCMS_116391/lang--en/index.htm.

37 United Nation Framework Convention on Climate Change, "Vulnerability and Adaptation to Climate Change in Small Island Developing States", background paper for the expert meeting on adaptation for small island developing States. Available at https://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200702_sids_adaptation_bg.pdf.

38 Pacific Disability Forum, "From Recognition to Realisation of Rights: Furthering Effective Partnership for an Inclusive Pacific 2030", Pacific Disability Forum SDG-CRPD Monitoring Report 2018, Fiji, 2018. https://www.internationaldisabilityalliance.org/sites/default/files/pdf_sdg.crpd_report_.pdf

39 H. Tavola, "Tuvalu Study on People with Disability", DFAT/Pacific Women Shaping Pacific Development, 2018. Available at https://pacificwomen.org/wp-content/uploads/2018/08/Tuvalu-Study-on-People-With-Disability-Full-Report-July-2018.pdf.

40 Megan Williams, "Tropical Cyclone Harold Rapid Gender Analysis", CARE International. 14 April 2020. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/TC%20Harold%20Rapid%20Gender%20Analysis%2014.04.20.pdf.

41 Government of Vanuatu. "Post-Disaster Needs Assessment", October 2020, Available at: https://www.preventionweb.net/publication/vanuatu-tropical-cyclone-harold-and-covid-19-post-disaster-needs-assessment.

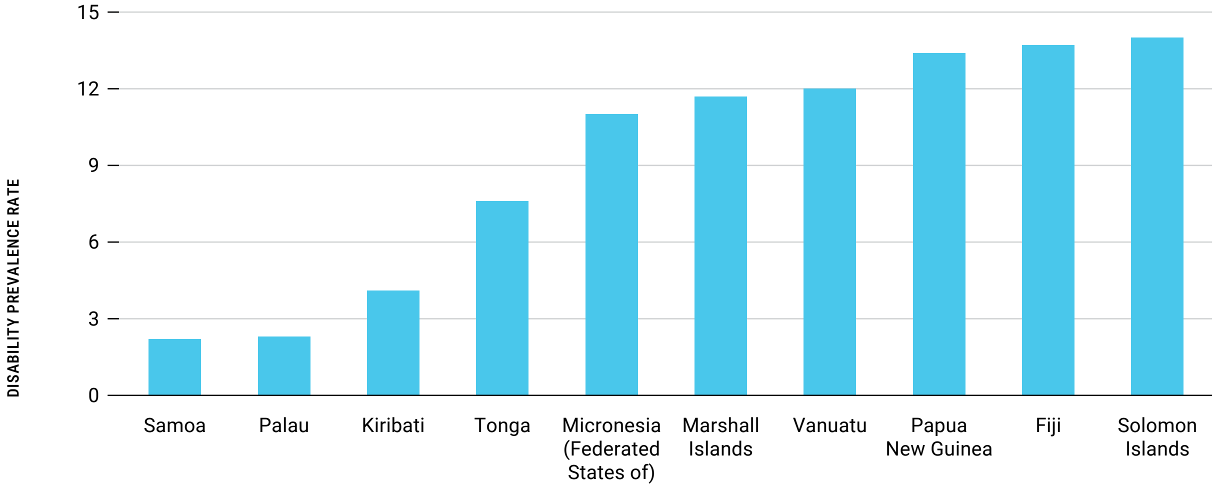
42 Ibid.

43 Katsunori Fujii, "The Great East Japan Earthquake and Persons with Disabilities Affected by the Earthquake - Why is the Mortality Rate so High?" Interim report on JDF Support activities and proposals, Disability Information Resources (DINF). Available at https://www.dinf.ne.jp/doc/english/resource/JDF_201503/1-1-1.html.

44 University of Melbourne, "Disability Inclusion in Disaster Risk Reduction: Experiences of people with disabilities in Vanuatu during and after Tropical Cyclone Pam and recommendations for humanitarian agencies", July 2017. Available at https://mspgh.unimelb.edu.au/__data/assets/pdf_file/0011/2567576/WEB-DIDRR-Report-14112017.pdf.

including people with disabilities into DRR planning is particularly important in the Pacific SIDS, as the subregion has the highest rate of disability prevalence amongst the Asia-Pacific subregions (Figure 3-5). This objective also resonates with Goal 4 of the Pacific Framework for the Rights of Persons with Disabilities which stresses that climate change adaptation and disaster risk management policies and plans must be inclusive of special needs of persons with disabilities.[45]

FIGURE 3-5 **Disability prevalence in the Pacific SIDS**



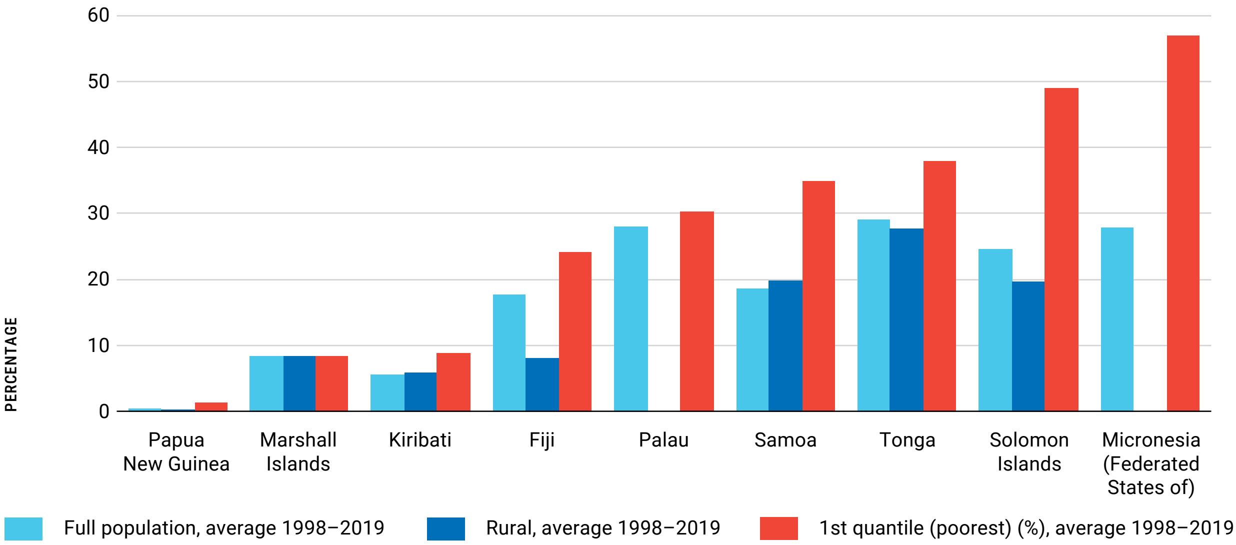
Source : Data from *Disability at a Glance: Investing in Accessibility in Asia and the Pacific – Strategic Approaches to Achieving Disability-inclusive Sustainable Development* (United Nations publication, 2019b). Available at: https://www.unescap.org/sites/default/d8files/knowledge-products/SDD-DAG-2019.pdf.

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

Although the inclusion of vulnerable groups in DRR strategies is vital to ensure the inclusiveness of disaster responses, it is equally important for countries to ensure that vulnerable groups have sound social protection before, during and after disasters hit. Vulnerable groups often need much deeper, shock-resistant social protection as their circumstances make it difficult for self-procurement of essential services. In the Pacific SIDS, governments have worked continuously to ensure that their populations are well-protected. **In most Pacific SIDS, the level of social protection offered to the poorest quantile of the population is higher than the average for the entire population, signalling that there is social protection that is targeted to these vulnerable groups** (Figure 3-6). This is less prevalent for rural populations where, in several countries, the level of social protection is lower than the population average. Governments need to include rural populations in their social protection programs and implement programs targeting the specific needs of their rural populations. The risks of cascading hazards posed to vulnerable groups are likely to increase with the effects of climate change, making it critical for governments to ensure that their vulnerable population groups are well-protected.

45 Pacific Islands Forum Secretariat (PIFS), Pacific Framework for the Rights of Persons with Disabilities 2016-2025, Available at: https://www.forumsec.org/wp-content/uploads/2018/05/PFRPD.pdf.

FIGURE 3-6 Social protection for vulnerable groups in Pacific SIDS countries



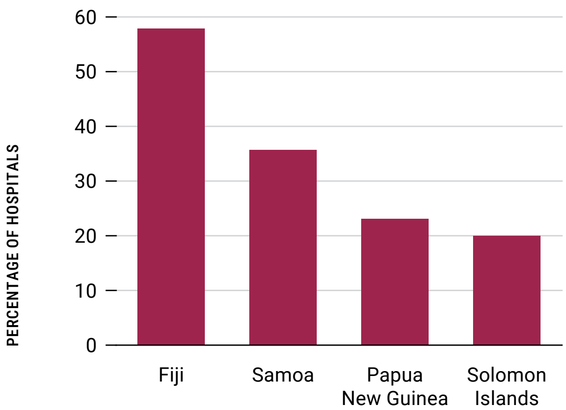
Source: ESCAP calculations based on Global Assessment Report (GAR) Risk Atlas, 2015; Global Assessment Report on Disaster Risk Reduction 2015 (United Nations publication, 2015). Available at https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2015

The risks to critical infrastructure

Health-care infrastructure

Disasters impose multiple pressures on the health systems and disrupt health services exposing people to greater risks in regions with poor health conditions.[46] The disaster-health nexus results in a double threat to health facilities; exposure to natural disasters limits the resources available to cope with biological hazards. At the same time, the use of health facilities for the pandemic results in fewer health facilities available for response to the people affected by disasters. In the aftermath of Cyclone Harold, 60 per cent of Vanuatu's health facilities were severely damaged, making it difficult for those in need of medical attention to obtain it. The exposure of health facilities to such disasters not only made it difficult to respond to the impacts of the cyclone but resulted in less resources being available for the COVID-19 pandemic. The impacts from COVID-19 highlight the urgent need to merge disaster risk reduction strategies into health preparedness systems, especially to support the most vulnerable populations.

FIGURE 3-7 Health facilities exposed to multi-hazard risk under the worst-case climate change scenario (RCP 8.5)



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.

To anticipate the future needs of health-care facilities, Figure 3-7 locates the health-care facilities at risk from multiple hazards under RCP 8.5. In Fiji, close to 60 per cent of health facilities will be exposed to multi-hazard risk. This is followed by Samoa with over 35 per cent of the nation's health facilities at risk.

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

To cope with cascading risks from natural and health hazards, health-care infrastructure needs to be risk-informed, and health systems should be sufficiently resilient to adapt to a changing climate, particularly when they serve poor and low-income populations.

Energy infrastructure

In the Pacific SIDS, nearly 60 per cent of all infrastructure assets are within 500m of the coastline[47], hence their high exposure to natural hazards. Energy infrastructure is universally considered to be essential for raising the quality of life of people, making it vital for countries to prioritize building resilient infrastructure. Extreme weather events can damage energy infrastructure, and reduce the capacity of transmission lines, transformers, and substations as well as water volumes for hydropower plants. Also, the links between energy consumption and socioeconomic disadvantage are generally underappreciated, but shutoffs and power outages can clearly have direct impacts on health sectors.

FIGURE 3-8 **Energy infrastructure exposed to multi-hazard risks under the worst-case climate change scenario (RCP 8.5) in Pacific SIDS**

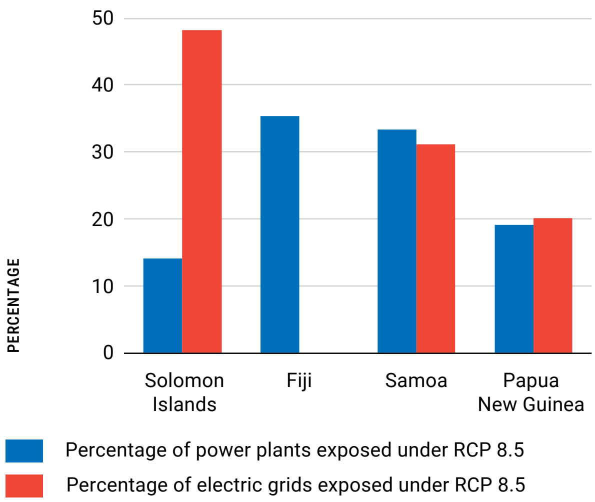


Figure 3-8 presents exposure of energy infrastructure. Overlaying multi-hazard risk data with data on energy infrastructure enables identification of the most exposed areas in the Pacific SIDS. The Solomon Islands will have close to 50 per cent of the nation's electrical grids exposed to multi-hazard risk under the worst-case climate change scenario. This is closely followed by Fiji with over 35 per cent of its electrical grids exposed. Energy resilience is a top priority for the Pacific SIDS where the infrastructure is susceptible to storm surges, rising sea-levels and coastal flooding. In their Nationally Determined Contributions, 13 out of the 14 Pacific SIDS have quantified renewable energy targets.[48]

Out of the silos

The pandemic has been a stark reminder of the links and intersections between health and other natural hazards. Governments 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 the Pacific SIDS can best respond to the growing disaster-climate-health nexus.

47 UN Strategic Framework for the Pacific (UNSFP) 2018-2022, Common Country Analysis (CCA) – Meta Analysis, Available at: https://fscluster.org/sites/default/files/documents/pacific_cca_-_draft_final_18_9_16.pdf.

48 International Renewable Energy Agency (IRENA), " Pacific Islands Unite Around Enhanced Renewables Ambition Under Climate Goals", Press release, 28 February 2021. Available at: https://www.irena.org/newsroom/pressreleases/2021/Feb/Pacific-Islands-Unite-Around-Enhanced-Renewables-Ambition--Under-Climate-Goals.

CHAPTER 4

Recovering from a pandemic: moving towards a bluer and more resilient Pacific

Blue Pacific 2050 Climate Change and Disasters

Strategic pathways: Governance, Resilience and Wellbeing

*In addition to providing the **evidence-base** to strengthen regional collaboration and increase innovative financing measures, this chapter also supports **targeting policies to build capacity and resilience** of communities to tackle climate change impacts and for disaster risk reduction.*

Highlights

- To decrease economic losses from natural and biological hazards, the estimated cost of adaption is only 0.15 per cent of the estimated losses, and 1.3 per cent of the subregional GDP.
- The economic recovery from the COVID-19 pandemic must include investing in climate adaptation to building 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's Risk and Resilience Portal shows that the top adaptation solutions for the Pacific SIDS to support the SDGs, in order of preference, are:
  - Protecting mangroves (Supports SDG 14: Target 14.2)
  - Improving dryland agriculture (Supports SDG 15: Target 15.3)
  - Strengthening early warning systems (Supports SDG 13: All targets)
  - Making water management systems more resilient (Supports SDG 13: Target 13.1; SDG 15: Target 15.3)
  - Making new infrastructure resilient (Supports SDG 13: All targets)

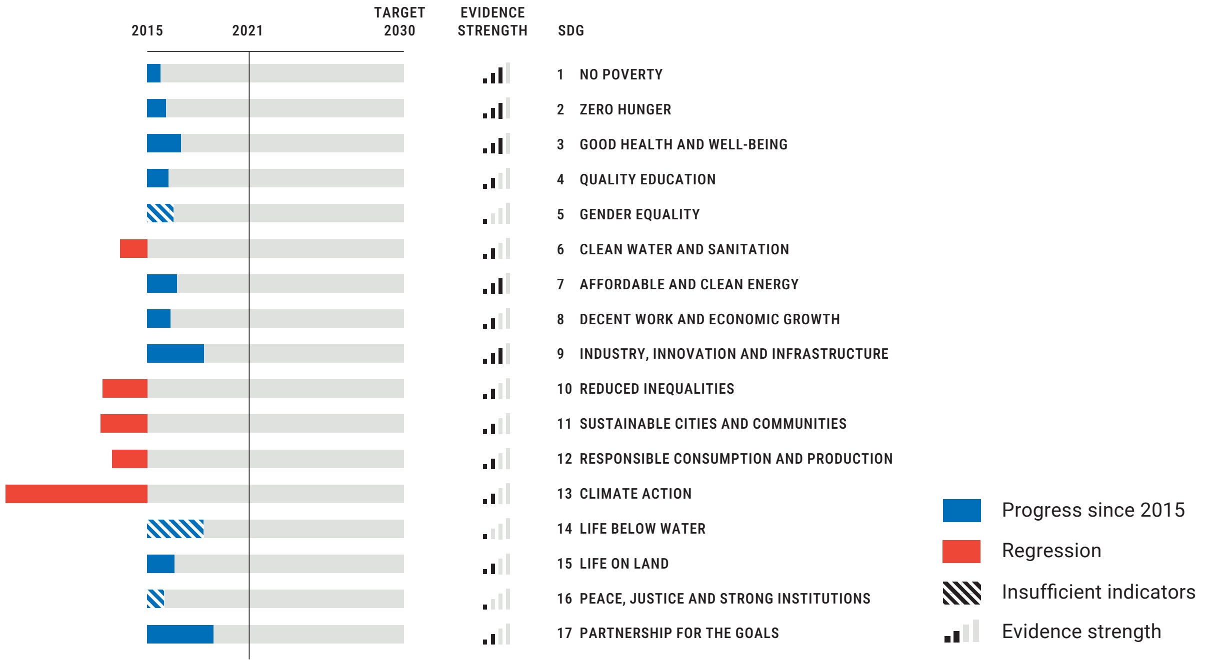
SDG progress and resilience in the Pacific SIDS

Significant progress has been made towards the achievement of several of the Sustainable Development Goals in the Pacific SIDS (Figure 4-1). Nevertheless, gaps remain, especially in the achievement of the SDG targets related to disaster risk reduction. All disaster risk-related SDGs, for which there is data, have either seen a reverse trend or are currently falling short of meeting the goals of the 2030 Agenda. This calls for governments to step up their investments in disaster risk reduction, specifically in resilience-building to minimize losses from disasters.

In addition, the Multi-Vulnerability Index of the Sustainable Development Solutions Network identifies the Pacific SIDS like American Samoa, Fiji, French Polynesia, Kiribati, Marshall Islands, Micronesia (Federated States of), Northern Marina Islands, Samoa, Tonga, Tuvalu and Vanuatu with high Environmental Vulnerability, defined by the country's exposure to climate change and natural disasters. Among these SIDS, Kiribati, Marshall Islands, Micronesia (Federated States of), Samoa, Tonga and Tuvalu are also noted with high economic vulnerability.[49] This analysis further substantiates the need for policymakers to target progressing on multiple SDG in the SIDS.

49 Sustainable Development Solutions Network, "The Decade of Action and Small Island Developing States: Measuring and addressing SIDS' vulnerabilities to accelerate SDG progress", 12 July 2021, Available at: https://resources.unsdsn.org/the-decade-of-action-and-small-island-developing-states.

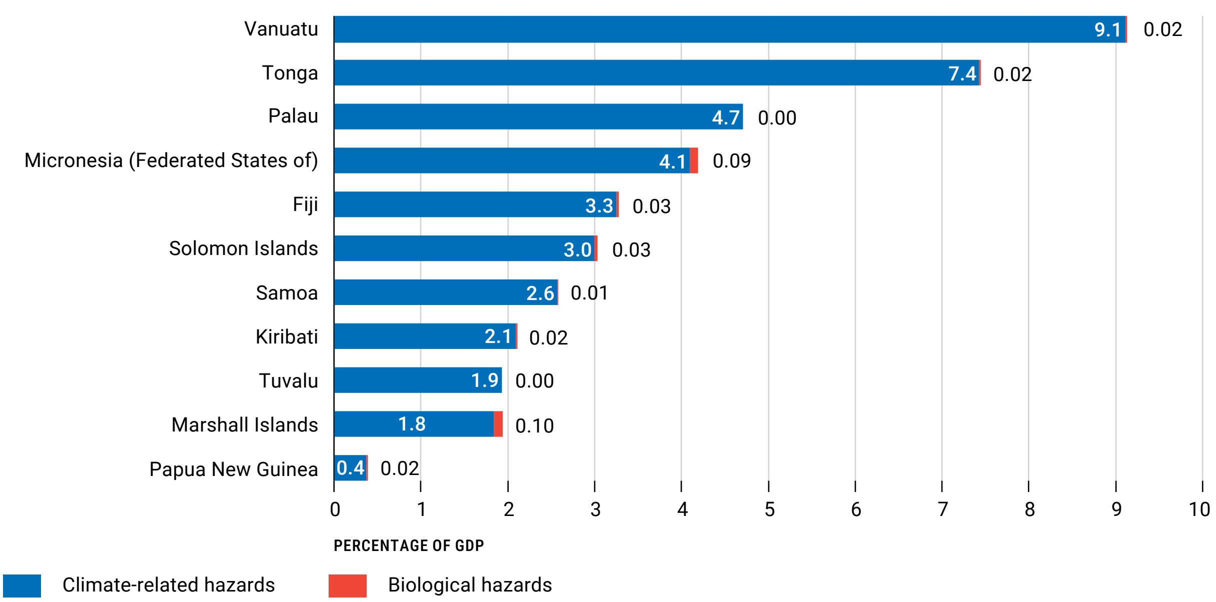
FIGURE 4-1 Snapshot of SDG progress in the Pacific SIDS, 2021



Source: ESCAP SDG Report 2021, SDG Data Gateway

To address the disaster-related SDGs, ESCAP has estimated the full cost of adaptation[50] for climate-related and biological hazards under the worst-case climate scenario RCP 8.5, for each country. **For the Pacific SIDS, the total annual adaptation cost is estimated at $487 million with $480 million as the adaptation cost for climate-related hazards, and $7 million as the adaptation cost for biological hazards.** At the country level, the highest total adaptation cost is estimated for Fiji at $181.6 million, followed by Papua New Guinea with $88.9 million, and Vanuatu with $81.1 million. Figure 4-2 presents the costs of adapting to climate change as a percentage of GDP which varies from almost 9.1 per cent in Vanuatu, to less than 0.5 per cent in Papua New Guinea. Regional cooperation can be a useful tool in pooling common resources to help countries, that have higher costs of adaption as a percentage of GDP and less ability to pay, to reach their adaptation goals.

FIGURE 4-2 Cost of adapting to climate-related and biological hazards in Pacific SIDS, as percentage of GDP

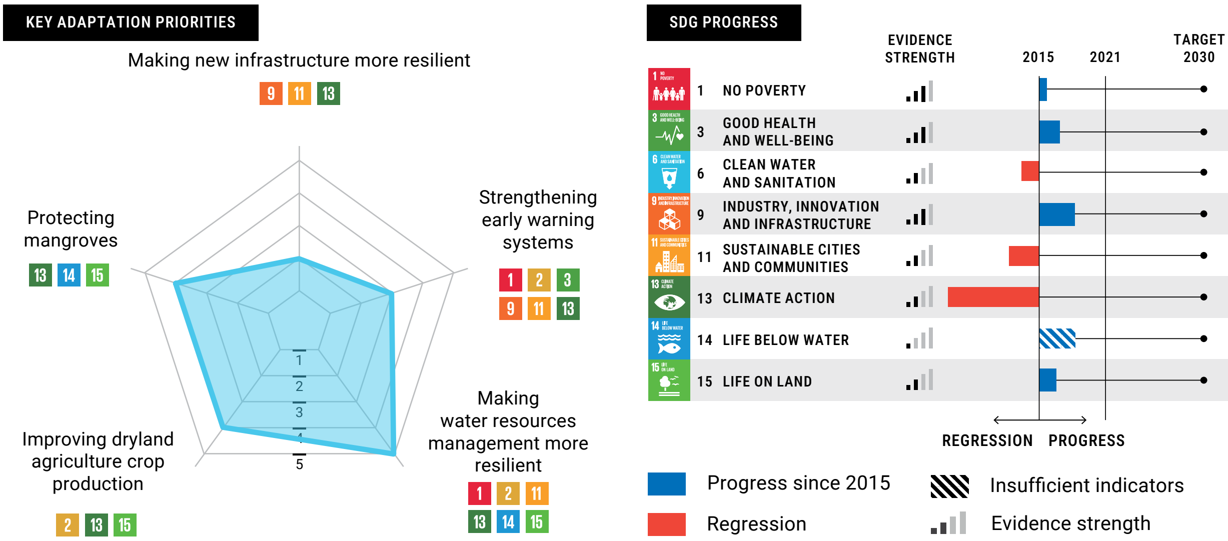


50 World Bank, An Investment Framework for Clean Energy and Development (Washington, D.C., World Bank, 2006).

Key adaptation measures

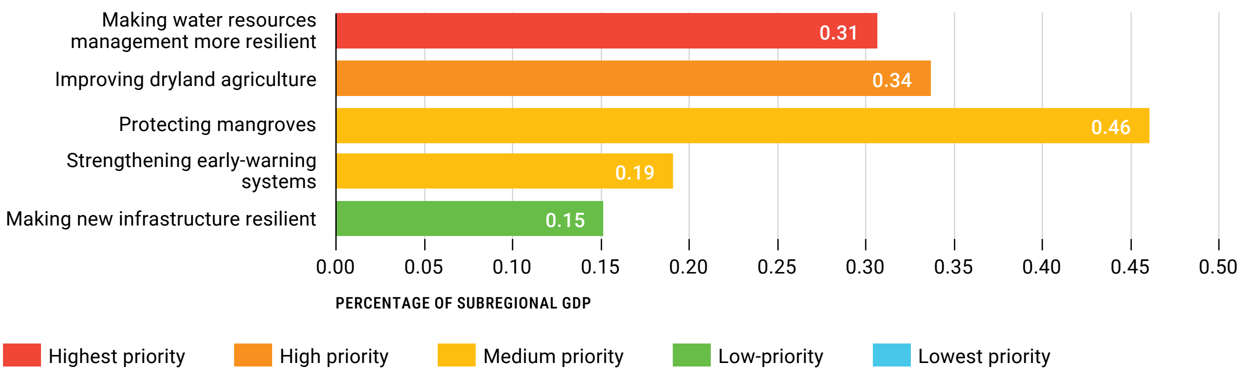
Countries need to invest in key adaptation priorities specific to their respective disaster riskscape. The Global Commission on Adaptation has established five key priorities that yield a high cost-benefit ratio for building resilience: strengthening early-warning systems; making new infrastructure resilient, making water resource management more resilient, improving dryland agriculture crop production and protecting mangroves.[51] Building on these five priorities, the following adaptation investment priorities are recommended for the Pacific SIDS in the order of their priorities together with their linkages to the Sustainable Development Goals (Figure 4-3).

FIGURE 4-3 **How the five priority adaption measures support achieving the SDGs in the Pacific SIDS**



ESCAP's Risk and Resilience Portal presents the adaptation priorities at the subregional and national level.[52] For Pacific SIDS, the top adaptation priority is making water management systems more resilient, protecting mangroves and improving dryland agriculture crop production followed by strengthening early warning systems and making new infrastructure more resilient. Figure 4-4 shows that the adaptation cost by priority is rather small. For example, it is estimated at 0.31 per cent of subregional GDP for making water resources resilient and 0.34 per cent of subregional GDP for improving dryland agriculture crop production . **In addition, each country in the Pacific SIDS also has their own risk profile with a unique set of adaptation priorities.** A country-level overview of Pacific SIDS countries can be seen in Figure 4-5.

FIGURE 4-4 **Estimated adaptation cost and priorities for the Pacific SIDS**

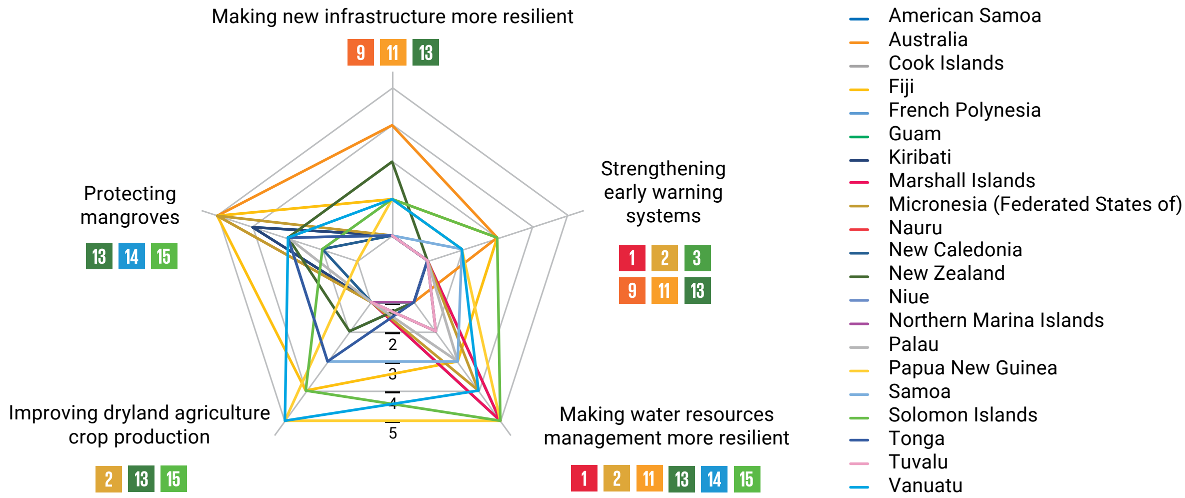


Source: ESCAP, "Risk and Resilience Portal". Available at: rrp.unescap.org.

51 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 26 March 2021).

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

FIGURE 4-5 **Estimated adaptation cost and priorities for countries in the Pacific SIDS**



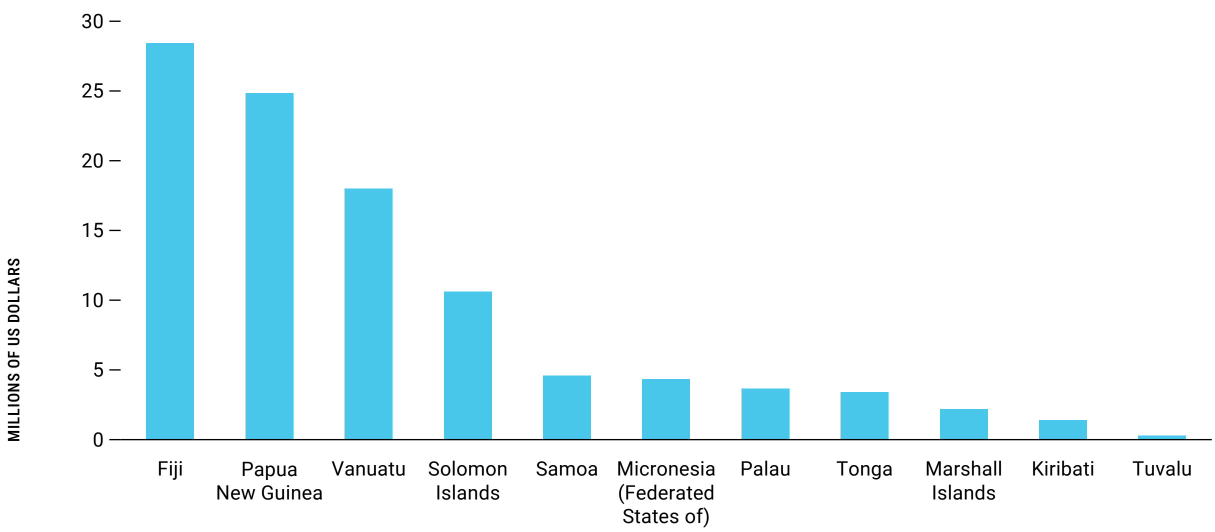
Source: ESCAP, "Risk and Resilience Portal". Available at: rrp.unescap.org.

Making water management systems more resilient

Pacific SIDS are particularly vulnerable to water-related natural hazards, such as floods, droughts and tropical cyclones. Thus, **establishing resilient water resources management is proposed as the top priority for the Pacific SIDS.** It will help to address water-related disasters (**SDG 2:** Zero hunger, **SDG 14:** Life below water, and **SDG 15:** Life on land), protect the most vulnerable (**SDG 1:** No poverty, **SDG 11:** Sustainable cities and communities), and help adapt to climate change (**SDG 13:** Climate action).

Sustainable year-round solutions for water resource management include rainwater harvesting, and reuse of wastewater. It will also be important to strengthen traditional water management systems. It is estimated that around 0.31 per cent of subregional GDP is required for making water resources management more resilient in the Pacific SIDS. Each country in the Pacific SIDS has its respective cost of adaptation for resilient resource management, and governments should put effort in meeting these requirements. In Fiji, $30 million needs to be invested in resilient water resource management, while in Papua New Guinea this figure is just below $25,000 (Figure 4-6).

FIGURE 4-6 **Estimated adaptation cost for making water resources management more resilient in the Pacific SIDS**



Many Pacific SIDS have already taken initiative to invest in making water resource management more resilient. In Kiribati, most of the population depends on portable ground water available in wells and from rainfall, but this limited supply will continue to be impacted by climate change. In response, the Government of Kiribati initiated the Kiribati Adaptation Program, which is a five-year project, with the objective of increasing the island's resilience to the effects of climate change with a focus on the country's fresh water supply and on coastal areas. Under the project, the Government has installed four new rainwater harvesting works and two infiltration gallery works, the detection and repair of leaks in the groundwater pipe system and the rehabilitation of water reserves.[53] This initiative by the Government of Kiribati is an example of the ways in which governments can invest in building resilience in water management to ensure safe and reliable access to drinking water for all.

Improving dryland agriculture

Agriculture continues to be one of the sectors most impacted by extreme weather events.[54] For instance, in Vanuatu, Cyclone Harold resulted in widespread damage to the agriculture sector, leading to losses of main staples and export crops. According to the Food and Agricultural Organization (FAO), nearly 60 per cent of croplands were severely damaged by the cyclone, increasing the likelihood of food insecurity. This highlights the importance of building resilience in the agriculture sector.[55]

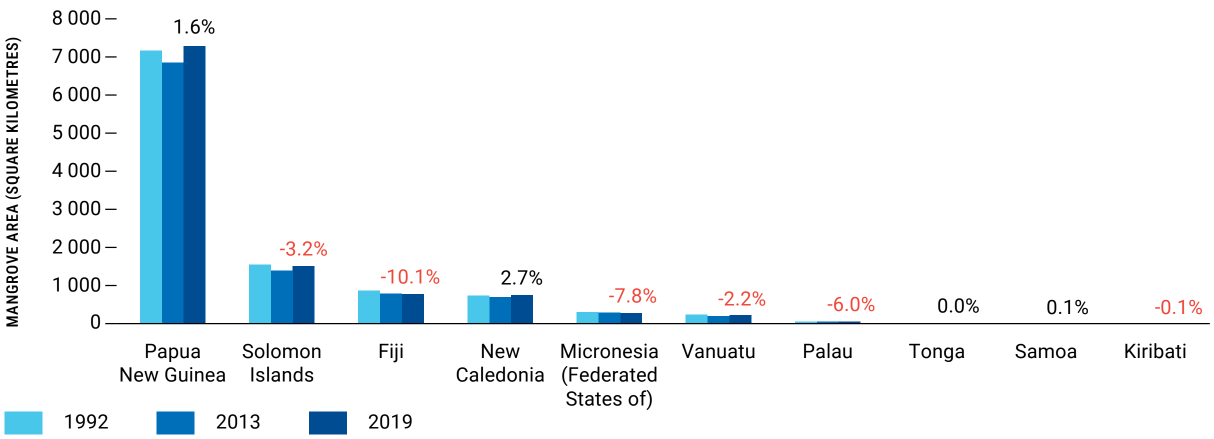
Drylands are also susceptible to degradation, with a decline in the soil's water-holding capacity and fertility, reducing agricultural output and increasing the land's vulnerability to drought. This can be addressed by integrated spatial land-use planning and a multidisciplinary approach to land management. Practices, such as integrated soil fertility management and watershed management to reduce soil erosion and run off, vegetation management and sustainable forest management, can further increase reliance and contribute to the achievement of the SDGs including **SDG 2: Zero hunger**, **SDG 13: Climate action**, and **SDG 15: Life on land**, among others.

Protecting mangroves

One of the most important nature-based forms of climate adaptation is the conservation and restoration of mangroves. Mangroves reduce the impact of tropical cyclones, storm surges, coastal flooding and erosion (**SDG 14: Life below water**), and thus support climate change adaptation (**SDG 13: Climate action**).

During 1992 and 2019, the mangrove forest areas increased by 2.7 per cent in New Caledonia, by 1.6 per cent in Papua New Guinea, and by 0.1 per cent in Samoa. However, mangrove forest areas decreased by around 10.1 per cent in Fiji, 7.8 per cent in the Federated States of Micronesia, 6 per cent in Palau, 3.2 per cent in the Solomon Islands, 2.2 per cent in Vanuatu and by 0.1 per cent in Kiribati. The mangrove areas of Tonga remained constant (Figure 4-7).

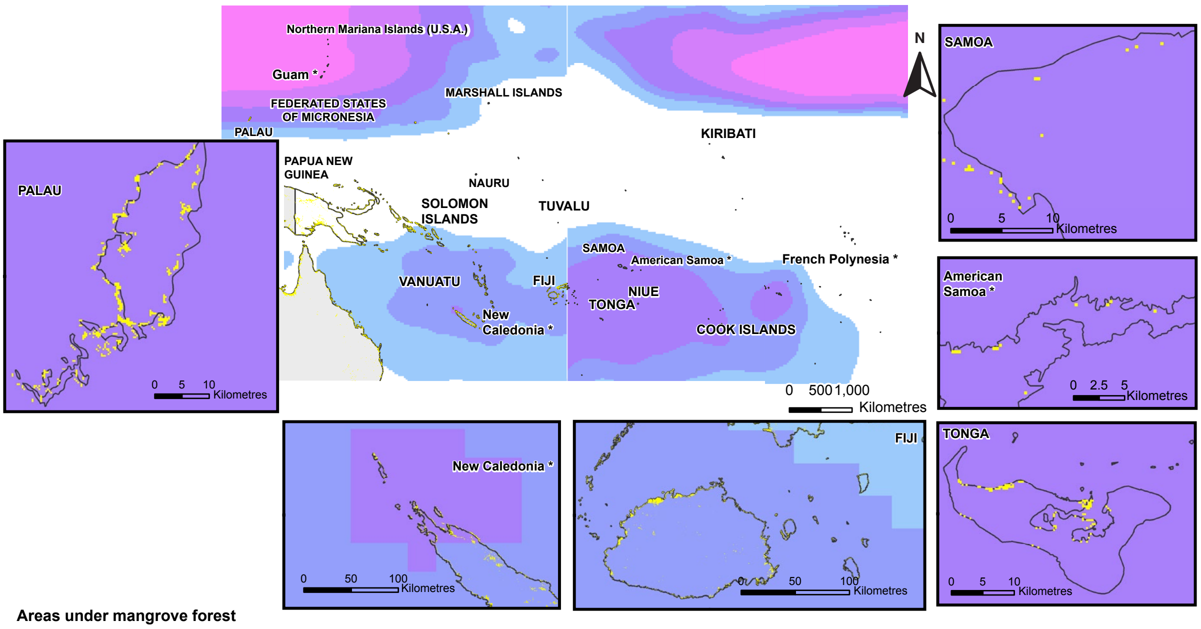
FIGURE 4-7 Changes in mangroves area from 1992 to 2019 (square kilometres)



The importance of mangroves for coastal protection

In 2021, Tropical Cyclone Harold formed near Papua New Guinea and moved south-east, affecting the Solomon Islands, Vanuatu, Fiji, and Tonga. It hit Espiritu Santo, northern Vanuatu, on 6 April 2021 as a category 5 cyclone. The cyclone then passed south of Viti Levu, Fiji's main island, causing extensive infrastructural damage from high winds and coastal and river flooding.[56] Mangroves provide coastal protection, but climate change can negatively affect mangroves through rise in sea level, rise in atmospheric CO_2, rise in air and water temperatures and change in the frequency and intensity of extreme weather events.[57] Nature-based solutions should be a priority for the Pacific SIDS. Mangrove forests currently can be found in American Samoa Fiji, New Caledonia, Palau, Samoa, and Tonga. Given the higher risk of cyclones under the 100-year return period, these countries critically need mangroves for coastal protection (Figure 4-8).

FIGURE 4-8 **Areas under mangrove cover exposed to 100-year return period cyclones**



Areas under mangrove forest

in 2019

Cyclonic Winds 100 - Year Return Period

- category 1 (119 - 153 kmph)
- category 2 (154 - 177 kmph)
- category 3 (178 - 208 kmph)
- category 4 (209 - 251 kmph)
- category 5 (> 252 kmph)

Sources: ESCAP based on Global Assessment Report on Disaster Risk Reduction (GAR) Risk Atlas, 2015; Climate Change Initiative Land Cover, 2019. Map source: UNMap 2020 and OCHA Humanitarian Data Exchange (HDX) 2021; and UN Geospatial.

Notes: 1. Cyclone data consists of all cyclone wind categories with a return period of 100 years and an intensity of 119 to more than 252 km/h. Cycolnic wind intensity categories are based on Saffir-Simpson scale.
2. All pixels under land cover class "Tree cover, flooded, saline water" counted as coastal mangrove. The overall accuracy of the source data is 75.4%.
3. Mangroves data for Cook Islands, French Polynesia, Guam, Northern Mariana Islands and Tuvalu is unavailable.
4. *Indicates Non-Self-Governing Territory.

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

Strengthening early warning systems

Disaster risk reduction and climate change adaptation will largely rely on effective early warning systems. As highlighted in the Sendai Framework for Disaster Risk Reduction 2015–2030, strengthening multi-hazard early warning systems is essential not only for disaster management agencies but also related-sectoral ministries, all stakeholders and the public to identify risk from natural hazards, prepare

56 United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP) (2020). *The Disaster Riskscape across East and North-East Asia: Key Takeaways for Stakeholders.* ST/ESCAP/2882; and World Meteorological Organization, "State of the Climate in South-West Pacific, 2020, WMO-No. 1276, Geneva, 2021. Available at https://library.wmo.int/index.php?lvl=notice_display&id=21990#.Yd-0Sf5Bw2w.

57 World Meteorological Organization, "State of the Climate in South-West Pacific, 2020, WMO-No. 1276, Geneva, 2021. Available at https://library.wmo.int/index.php?lvl=notice_display&id=21990#.Yd-0Sf5Bw2w.

mitigation and response measures in advance. Ensuring the early-warning systems are effective and in place for the health sector is directly in line with SDG 3, Target d: Improving early warning systems for global health risks.

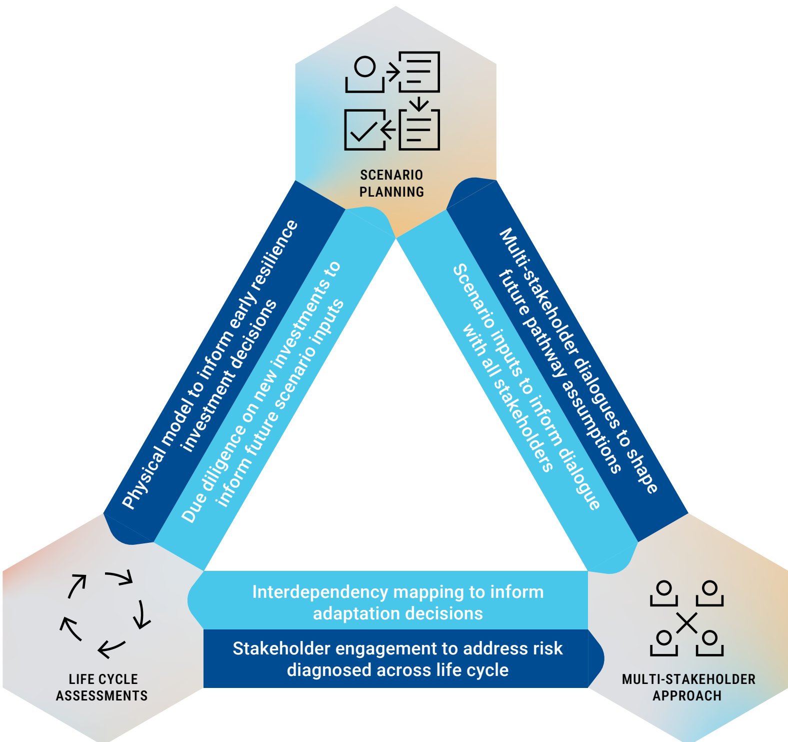
Strengthening early warning systems will provide better protection and services to the vulnerable while directly supporting **SDG 1 (No poverty) and SDG 3 (Good health and well-being)**. It will allow farmers to take early actions **(SDG 2: Zero hunger)**, and critical infrastructure exposed to hazards can also be identified **(SDG 9: Industry, innovation and infrastructure, SDG 11: Sustainable cities and communities)**, especially from extreme weather events **(SDG 13: Climate action)**. As such, establishing effective early warning systems is identified as a top priority in climate action plans of many countries with special needs (CSNs), yet countries often lack the capacity or financial resources to implement them.

In this regard, ESCAP has facilitated technical cooperation on contextualizing and strengthening multi-hazard early warning systems under the Asia-Pacific Disaster Resilience Network. Specifically, ESCAP developed a methodological approach for impact-based forecasting and supported member States in building the capacity for impact-based forecasting. In Papua New Guinea, ESCAP has supported the development of tailored tools for using geospatial information for disaster management.

Making new infrastructure more resilient

All infrastructure investment should 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, it is recommended to take a three-pillared approach: dynamic scenario planning; lifecycle assessments; and multi-stakeholder engagement, with multiple interdependencies among the three pillars (Figure 4-9).[58]

FIGURE 4-9 **A three-pillar approach for 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.

58 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 consider 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. In four Pacific SIDS, the World Bank has launched the Pacific Climate-Resilience Transport Program which is based on a mixed approach between 'hard' infrastructure investments, and 'soft' capacity-building activities to ensure countries can manage resilient infrastructure.[59]

In addition to these three pillars, all new infrastructure, as well as retrofits to existing infrastructure, must consider changing natural ecosystems. The best way to do this is by combining traditional grey infrastructure with green infrastructure. For example, grey infrastructure for water resource management, such as reservoirs, should complement green infrastructure including watersheds that improve source water quality and mangroves which protect the coastal populations. In Kiribati, the Asian Development Bank has proposed a project to construct a seawater desalination plant run on solar water. This plant will not only provide the population with climate-resilient water supply but will increase the access to clean water with little leakages. This is not only a cost-effective approach, but it also empowers communities by engaging local stakeholders and incorporates longer-term flexibility for responding to changing climate conditions.[60] 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.**

BOX 4-1 Melbourne Water Industry Climate Change Committee

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

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

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

a C40 Cities Climate Leadership Group, "C40 Infrastructure Interdependencies + Climate Risks Report, 2017. Available at https://assets.locomotive.works/sites/5ab410c8a2f42204838f797e/content_entry5ab410fb74c4833febe6c81a/5ad4fd8574c4837def5d3f8a/files/C40_Interdependencies_TOOL.pdf?1528290641

59 World Bank, "In Small Island States, Resilient Transport is Providing a Lifeline Against Disasters", 11 June 2019. Available at https://www.worldbank.org/en/news/feature/2019/06/11/in-small-island-states-resilient-transport-is-providing-a-lifeline-against-disasters

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

CHAPTER 5

Transformative actions to build resilience

Blue Pacific 2050 Technology and Connectivity

Strategic pathways: Resilience and Wellbeing

This chapter focuses on pathways to harness new and emerging technologies to reduce risks.

Highlights

- Frontier digital technologies and innovative ecosystems will drive solutions for resilience.
- Digital solutions make possible advancements in risk analytics, social protection, early warning systems for biological hazards, and impact-based forecasting.
- Technological advances in geospatial and risk analytics for risk reduction and resilience building requires sub-regional and regional cooperation.

Frontier technology and digital solutions

For managing their COVID-19 responses, countries in the Pacific SIDS have taken advantage of a number of 'frontier technologies' which have been used in disaster risk reduction and in the health sector. These include Big Data, robotics, 5G mobile technologies, drones and satellite data.

These technologies continue to transform disaster risk reduction and health sector management, and thus address some of the deep uncertainties in managing systemic risk. This will be done by:

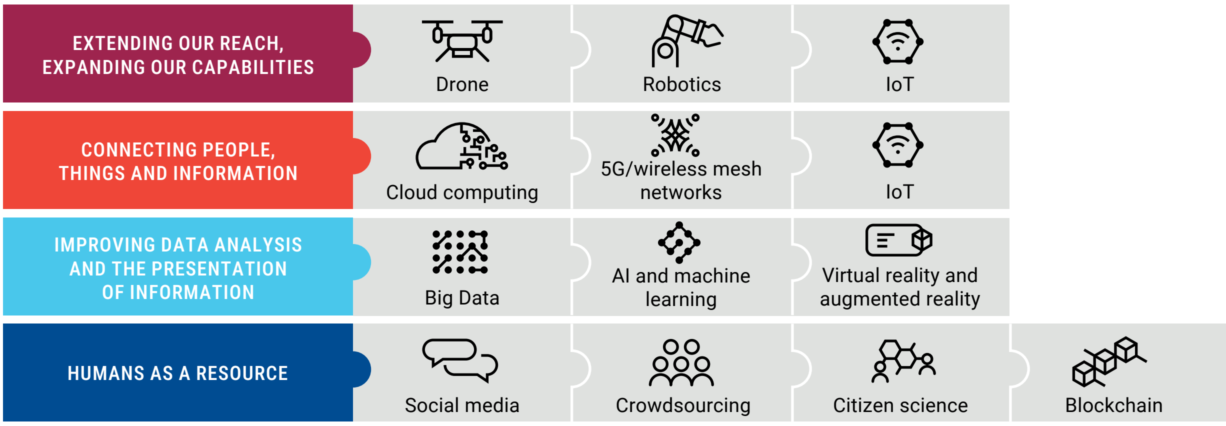
- Extending the reach and expanding the capabilities of unmanned vehicles, robotics, remote and in-situ sensing;
- Connecting people, things and information through 5G mobile technology, wireless mesh networks, mobile messaging, the Internet of Things, and blockchain; and
- Improving impact-based early warning systems.

Users should be able to interactively communicate and contribute to these systems through social media, crowdsourcing, and citizen science.[61] Frontier technologies, thus, open up the prospect of not just of dealing better with disasters, but also of empowering people and encouraging more democratic and inclusive societies (Figure 5-1).

Frontier technologies and digital solutions can be used to support and extend the provision of social protection. Countries in the Pacific SIDS took advantage of frontier technologies and digital solutions for social protection during the COVID-19 pandemic. **Frontier technologies and digital solutions can also be utilized to accelerate disaster early warning, surveillance, impact assessment and post-disaster mobilization** (Table 5-1). Cross-sectoral collaboration is important in embedding the latest technologies into the disaster management strategies of governments. For example, financial resilience can be very useful in mobilizing the budget needed for post-disaster activities. Programs, such as The Pacific Disaster Risk Financing and Insurance Program, are being used to ensure governments of the Pacific SIDS are able to receive the funds needed for disaster recovery.

61 United Nations Department of Economic and Social Affairs, Division For Public Institutions and Digital Government, and United Nations Office of Disaster Risk Reduction Global Education and Training Institute, "Risk-informed Governance and Innovative Technology for Disaster Risk Reduction and Resilience", Training Module, 2020.

FIGURE 5-1 Frontier technologies for disaster risk reduction and health care



Source: Revised from United Nations Department of Economic and Social Affairs, Division For Public Institutions and Digital Government, and United Nations Office of Disaster Risk Reduction Global Education and Training Institute, "Risk-informed Governance and Innovative Technology for Disaster Risk Reduction and Resilience", Training Module, 2020.

TABLE 5-1 Frontier technologies in the disaster risk reduction and achievement of SDG goals

Technology	Disaster risk reduction	Sustainable Development Goals
Big Data	**Across Pacific SIDS: Pacific Catastrophe Risk Information System (PacRIS)**	**Kiribati and Vanuatu: Computer-assisted personal interviewing (CAPI):** New data management system and survey monitoring dashboard used during pandemic to conduct national population and housing census for both nations.[62]
Robotics	**Fiji: Aerial mapping:** After Cyclone Harold hit Fiji in 2020, drones were used to survey the affected regions, which in turn helped authorities carry out post-disaster damage assessments. This located damaged and the destroyed rooftops, fallen trees, blocked roads, and river flooding.[63] **Kiribati: The Argo floats:** Over 13 robots have been deployed in the equatorial waters near Kiribati to monitor the ocean processes behind El Niño and La Nina events.[64]	**Samoa: Drones for Agriculture:** Unmanned aerial vehicles (UAV), with special sensors, can collect multispectral images, enable the users to view crop changes which cannot be captured by human eyes. For example, palm tree counts and coconut oil yield estimates in Western Samoa.[65]
Artificial Intelligence	**Papua New Guinea: Raspberry Shake:** In partnership with Geoscience Australia, community centres across Papua New Guinea are using Raspberry Shake for early detection and access to warning of seismic and volcanic activity.	
Internet of Things	**Across Pacific SIDS: Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI):** Regional database for modelling and assessment of earthquake and cyclone risks.[66]	**Fiji: My Kana:** This app allows residents of Fiji to become more nutritionally informed and accountable by monitoring their own eating habits, while promoting sustainable agriculture practices.[67]
Satellite data	**Australia: Satellite data tracking smoke from fires:** Two instruments have been affixed to NASA-NOAA's Suomi National Polar-orbiting Partnership satellite to provide specific data for characterizing and tracking smoke clouds.[68] **Vanuatu: Use of satellite data for damage assessment of buildings:** During Cyclone Harold, satellite data was used by UNITAR to assess damage to buildings in Luganville in Sanma Province, where about 90 per cent of houses and 60 per cent of schools were damaged. **Fiji: Use of satellite data for damage assessment of buildings:** Satellite imagery was used to assess potentially damaged structures in Bua Tikina, Bua Province, after Cyclone Yasa passed through in December 2020.	**Australia: GIS based survey for hospitals:** Geospatial data processing is used to analyse the population most likely to access private health-care services in the state of Victoria. This has offered an invaluable virtual image of residences, private health patients and the facilities available in their immediate neighbourhoods.[69]

62 Data for Change, "Pacific Islands Making the Move to Electronic Data Collection", 2020. Available at https://dataforchange.net/Pacific-islands-making-the-move-to-electronic-data-collection.

63 Quantum Systems, "Use Case - Aerial mapping – Post Cyclone Harold Damage assessment", Fiji, 2020. Available at https://www.quantum-systems.com/project/aerial-mapping-post-cyclone-harold-damage-assessment/.

64 International Institute for Sustainable Development (IISD), "SPREP Reports on Robotic Sensors Deployment for Ocean Research", 11 Junw 2012. Available at http://sdg.iisd.org/news/sprep-reports-on-robotic-sensors-deployment-for-ocean-research/.

65 CGSpace – CGIAR, "Drones for agriculture", 2016. Available at https://cgspace.cgiar.org/bitstream/handle/10568/89779/ICT082E_PDF.pdf.

66 Australian Government (n.d.). "Reducing disaster risk in Papua New Guinea". Available at https://www.ga.gov.au/about/projects/safety/reducingpngrisk.

67 Food and Agricultural Organization of the United Nations (FAO) Regional Office for Asia and the Pacific, "Pacific Small Island Developing States turn to digital technology for better health", 19 August 2021. Available at https://www.fao.org/asiapacific/news/detail-events/en/c/1430417/.

68 NASA, "From Smoke Going Round the World to Aerosol Levels, NASA Observes Australia's Bushfires", 14 January 2020. Available at https://www.nasa.gov/feature/goddard/2020/from-smoke-going-round-the-world-to-aerosol-levels-nasa-observes-australias-bushfires.

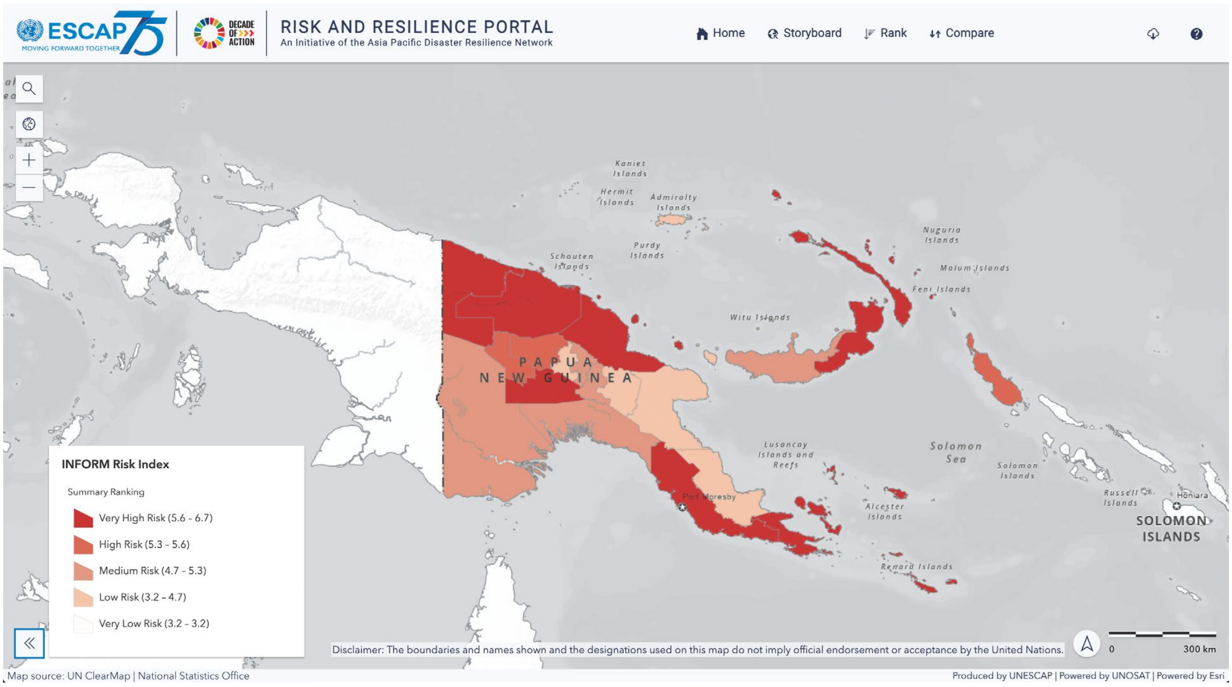
69 Meenal Dhande, "Geospatial Technologies and IoT in Private Healthcare Sector", Geospatial World, 9 November 2016. Available at https://www.geospatialworld.net/article/geospatial-technologies-iot-healthcare/.

Risk analytics

Sound understanding of risk is essential for disaster risk management and building resilience. The Risk and Resilience Portal has been developed by ESCAP and the United Nations Satellite Centre (UNITAR-UNOSAT). The portal is a one-stop shop to ensure that the vast array of scientific information on hazards, climate change, social, economic, and health data can be analysed in a way that can be used by policymakers, decision makers and development researchers to make efficient risk-informed decisions that span across multiple sectors.

This portal is also equipped with a Decision Support System (DSS), which provides contextual analysis of risk based on INFORM Sub-National Risk Index to support informed decision-making of selected countries which scores exposure, vulnerabilities and capacities for each township (Figure 5-2). When the DSS is loaded, users are presented with the risk profile of different subnational units. Users can just click their selected administrative areas to know which factors contribute to the particular risk level of the township. The portal provides information about hazard vulnerability and coping capacity factors that contribute to the risk of the administrative areas, together with various key indicators, and some climate adaptation priorities. By using the rank function within the portal, policymakers at the central government level are able to compare the risk ranking of different administrations in terms of risk exposure to hazard vulnerability, and also lack of coping capacity. Such comparison between administrative units will allow users to understand the risks that need to be prioritized, and the vulnerabilities that need to be addressed.

FIGURE 5-2 **Risk and Resilience Portal: A decision support system for Papua New Guinea**



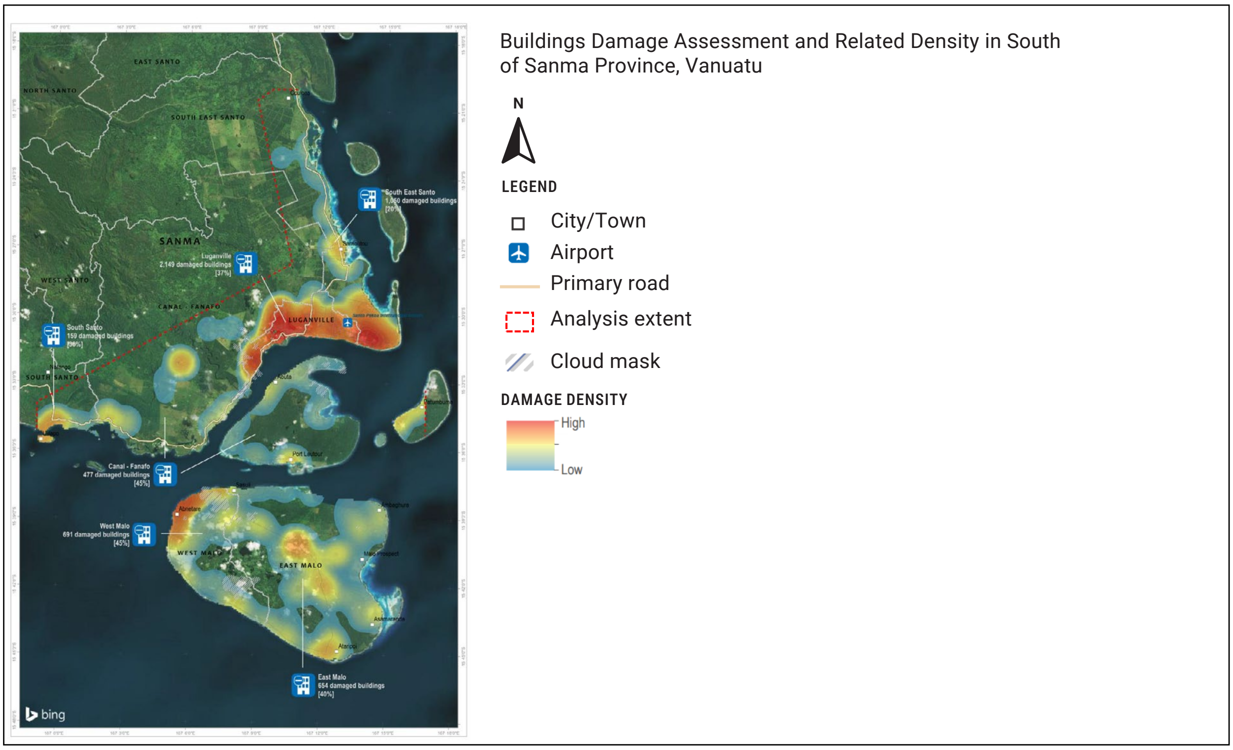
Source : ESCAP, Risk and Resilience Portal, Available at: rrp.unescap.org.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

For example, in 2020, after Fiji was hit by Tropical Cyclone Harold, the United Nations used the One Trinity unmanned aerial vehicle (UAV) to survey the affected regions, assess the damage and direct emergency response.[70] During a flight time of 45 minutes, the drone covered around 400 acres and captured nearly a thousand images of damaged and destroyed rooftops, fallen trees, blocked roads, and river flooding. The volume, variety and velocity of data from the UAV helped to support real-time emergency response. Similarly, in Vanuatu, following Tropical Cyclone Harold, the authorities used satellite data to identify

70 Quantum Systems, "Use Case - Aerial mapping – Post Cyclone Harold Damage assessment", Fiji, 2020. Available at https://www.quantum-systems.com/project/aerial-mapping-post-cyclone-harold-damage-assessment/.

damaged structures and support post-disaster reconstruction with local specific attributes (Figure 5-3).[71] UNITAR-UNOSAT analysis used Pleiades satellite imagery to identify the potentially damaged structures in the cloud-free zones.

FIGURE 5-3 **Damage to buildings in Sanma province Vanuatu, following Cyclone Harold in 2020**



Source: United Nations Satellite Centre, UNITAR Operational Satellite Application Program (UNOSAT), 2020. Available at https://unosat.org/products/2827.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Impact-based forecasting

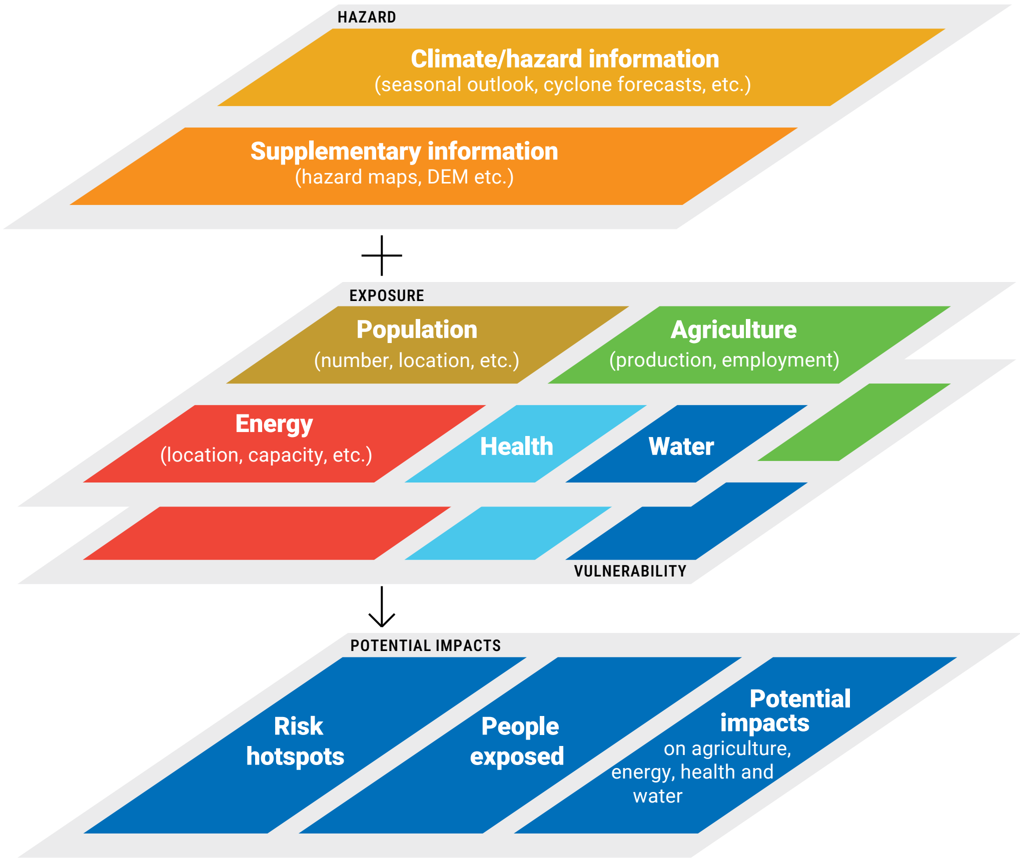
Establishing well-functioning end-to-end early warning systems is critical in responding to, especially climate-related, natural hazards. The importance of early warning information to reduce disaster risks by allowing stakeholders to make early decisions and take early action has been recognized, and the Pacific SIDS have also made efforts in strengthening multi-hazard early warning systems, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030.

Building on the above, further efforts for **operationalizing impact-based forecasting can greatly increase the efficiency of early warning systems.** Moving from broadcasting what the weather will be to what the weather will do by combining hazard, exposure and vulnerability data can better support early action (Figure 5-4).

Impact-based forecasting represents a paradigm shift from "what the weather will be" to "what the weather will do". In Asia and the Pacific this second-generation system is being enabled by the use of AI, Big Data and drones.

71 United Nations Office for Outer Space Affairs, UNITAR Operational Satellite Application Program (UNOSAT), 2020. Buildings Damage Assessment & Related Density in South of Sanma Province, Vanuatu. Available at https://unosat.org/products/2827.

FIGURE 5-4 **ESCAP's approach for impact-based forecasting**



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

Innovation ecosystems

Resilient recovery from the pandemic with utilization of frontier technologies will also require innovation ecosystems that support the implementation of the 2030 Agenda for Sustainable Development. The Pacific SIDS are working towards this goal. This involves, among others, large investments in digital infrastructure, innovation industry, social overhead capital and human resources. In Vanuatu, the Western Santo Conservation and Resilience Program, developed in 2021, has a goal of building new skills, knowledge, awareness and capacity in areas of environment and climate change by 2039 to facilitate the achievement of the Sustainable Development Goals.[72] Examples of joint initiatives with this objective include the Pacific Islands Climate Change Collaboration, Influencing and Learning (PACCCIL) a regional innovation ecosystem.[73]

72 Government of Vanuatu, National Advisory Board on Climate Change and Disaster Risk Reduction, "Western Santo Conservation and Resilience Program", 2022. Available at https://www.nab.vu/project/western-santo-conservation-and-resilience-program.

73 Australian Government, Department of Foreign Affairs and Trade, "Development assistance in the Pacific", n.d. Available at https://www.dfat.gov.au/geo/pacific/development-assistance/climate-change-and-resilience.

References

Ariyabandu, M. M. (2009). Sex, Gender and Gender Relations in Disasters. In *Women, Gender and Disaster: Global Issues and Initiatives*, Elaine Enarson and P. G. Dhar Chakrabarti, eds. New Delhi: Sage Publications India Pvt. Ltd.

Australian Government, Department of Foreign Affairs and Trade (n.d.). Development assistance in the Pacific. Available at https://www.dfat.gov.au/geo/pacific/development-assistance/climate-change-and-resilience.

Australian Government (n.d.). Reducing disaster risk in Papua New Guinea. Available at https://www.ga.gov.au/about/projects/safety/reducingpngrisk.

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

C40 Cities Climate Leadership Group (2017). C40 Infrastructure Interdependencies + Climate Risks Report. Available at https://assets.locomotive.works/sites/5ab410c8a2f42204838f797e/content_entry5ab410fb74c4833febe6c81a/5ad4fd8574c4837def5d3f8a/files/C40_Interdependencies_TOOL.pdf?1528290641.

Center for Strategic & International Studies (2020). The Pacific Islands Are a Covid-19 Priority". 15 September. Available at: https://www.csis.org/analysis/pacific-islands-are-covid-19-priority.

CGSpace – CGIAR (2016). Drones for agriculture. April. Available at https://cgspace.cgiar.org/bitstream/handle/10568/89779/ICT082E_PDF.pdf.

Data for Change (2020). Pacific Islands Making the Move to Electronic Data Collection. Available at https://dataforchange.net/Pacific-islands-making-the-move-to-electronic-data-collection.

Dhande, Meenal (2016). Geospatial Technologies and IoT in Private Healthcare Sector Geospatial World. 9 November. Available at https://www.geospatialworld.net/article/geospatial-technologies-iot-healthcare/.

EM-DAT - The International Disaster Database. Available at: http://www.emdat.be (accessed on 1 December 2021).

Enarson, E. (2000). Gender and Natural Disasters. Crisis Response and Reconstruction Working Paper No. 1. International Labour Organization, 1 September 2000. Available at https://www.ilo.org/employment/Whatwedo/Publications/WCMS_116391/lang--en/index.htm.

Fijii, Katsunori (n.d.). The Great East Japan Earthquake and Persons with Disabilities Affected by the Earthquake - Why is the Mortality Rate so High? Interim report on JDF Support activities and proposals. Disability Information Resources (DINF). Available at https://www.dinf.ne.jp/doc/english/resource/JDF_201503/1-1-1.html.

Food and Agricultural Organization of the United Nations (FAO) Regional Office for Asia and the Pacific (2021). Pacific Small Island Developing States turn to digital technology for better health. 19 August. Available at https://www.fao.org/asiapacific/news/detail-events/en/c/1430417/.

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

Government of Vanuatu, National Advisory Board on Climate Change and Disaster Risk Reduction (2022). Western Santo Conservation and Resilience Program. Available at https://www.nab.vu/project/western-santo-conservation-and-resilience-program.

Intergovernmental Panel on Climate Change (IPCC) (2021). Working Group I (WGI): Interactive Atlas - Coupled Model Intercomparison Project Phase 6 (CMIP6). Available at https://interactive-atlas.ipcc.ch/ (accessed in November 2021).

International Federation of Red Cross and Red Crescent Societies (2021a). Emergency Plan of Action (EPoA) Tuvalu: Impending Drought. 24 August. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/MDRTV002do.pdf.

__________ (2021b). Fiji TC Yasa: Six months on COVID-19 slows recovery efforts. News and press release. 21 June. Available at https://reliefweb.int/report/fiji/fiji-tc-yasa-six-months-covid-19-slows-recovery-efforts.

International Institute for Sustainable Development (IISD) (2012). SPREP Reports on Robotic Sensors Deployment for Ocean Research. 11 June. Available at http://sdg.iisd.org/news/sprep-reports-on-robotic-sensors-deployment-for-ocean-research/.

International Renewable Energy Agency (IRENA) (2021). Pacific Islands Unite Around Enhanced Renewables Ambition Under Climate Goals. Press release. 28 February. Available at https://www.irena.org/newsroom/pressreleases/2021/Feb/Pacific-Islands-Unite-Around-Enhanced-Renewables-Ambition--Under-Climate-Goals.

Joint Appeal and Food Response Plan Towards Recovery: Timor-Leste (2021). May. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/2021%20TL%20Flood%20Response%20Plan%20FINAL%20210528%20%28rev%29.pdf.

Kitara, Taukiei and others (2020). Reducing COVID-19 risk through population relocation and closed borders: effects of pandemic measures in a small island state. Blog. International Organization for Migration (IOM). 1 June. Available at https://environmentalmigration.iom.int/blogs/reducing-covid-19-risk-through-population-relocation-and-closed-borders-effects-pandemic-emergency-measures-small-island-state.

Kuku, Rebecca (2020). Flooding leaves 60,000 homeless. *The National*, 7 April. Available at https://reliefweb.int/report/papua-new-guinea/flooding-leaves-60000-homeless.

Marsh & McLennan Advantage (2020). Global Risks for Infrastructure: The climate challenge. Available at https://www.mmc.com/content/dam/mmc-web/insights/publications/2020/august/Global-Risks-for-Infrastructure_The-Climate-Challenge_Final.pdf.

NASA (2020). From Smoke Going Round the World to Aerosol Levels, NASA Observes Australia's Bushfires. 14 January. Available at https://www.nasa.gov/feature/goddard/2020/from-smoke-going-round-the-world-to-aerosol-levels-nasa-observes-australias-bushfires. 14 January 2020.

Null, Jan (2021). El Niño and La Niña Years and Intensities. March-April-May. Available at: https://ggweather.com/enso/oni.htm.

Ober, Kayly and Stefan Bakumenko (2020). A New Vulnerability: COVID-19 and the Tropic Cyclone Harold Create the Perfect Storm in the Pacific. Issue brief. Refugees International. 3 June. Available at https://www.refugeesinternational.org/reports/2020/6/1/a-new-vulnerability-covid-19-and-tropical-cyclone-harold-create-the-perfect-storm-in-the-pacific.

Osborne, Kira (2021). Localisation for who? Pacific resilience in the wake of the COVID-19 pandemic. Blog. Australia Pacific Security College. 10 June. Available at https://pacificsecurity.net/localisation-for-who-pacific-resilience-in-the-wake-of-the-covid-19-pandemic/.

Pacific Disability Forum (2018). From Recognition to Realisation of Rights: Furthering Effective Partnership for an Inclusive Pacific 2030. Pacific Disability Forum SDG-CRPD Monitoring Report 2018. Fiji. Available at https://www.internationaldisabilityalliance.org/sites/default/files/pdf_sdg.crpd_report_.pdf.

Sustainabledevelopment.un.org. 2014. *SIDS Accelerated Modalities of Action (SAMOA) Pathway*. Available at: https://sustainabledevelopment.un.org/sids2014/samoapathway (accessed 14 November 2014).

2022. [online] Available at: https://reports.unocha.org/en/country/asia-pacific/card/5KF8hCc5Aq/ (accessed 9 August 2022).

2022. Tonga eruption: a reminder of the cascading risks and vulnerabilities of SIDS. Available at: https://reports.unocha.org/en/country/asia-pacific/card/5KF8hCc5Aq/ (accessed 9 August 2022).

Government of Vanuatu (2020) Post-Disaster Needs Assessment, TC Harold & COVID-19, Vanuatu. Available at: https://www.preventionweb.net/publication/vanuatu-tropical-cyclone-harold-and-covid-19-post-disaster-needs-assessment.

Quantum Systems (2020). Use Case - Aerial mapping – Post Cyclone Harold Damage assessment. Fiji. Available at: https://www.quantum-systems.com/project/aerial-mapping-post-cyclone-harold-damage-assessment/.

Republic of Kiribati (n.d.). Climate change. Available at https://www.climate.gov.ki/effects/fresh-water-supply/.

Sohrabizadeh, Sanaz and others (2021). A systemic review of health sector responses to the coincidence of disasters and COVID-19. BMC Public Health, vol. 21, No. 709 (20 November). Available at https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10806-9.

Sustainable Development Solutions Network, "The Decade of Action and Small Island Developing States: Measuring and addressing SIDS' vulnerabilities to accelerate SDG progress", 12 July 2021, Available at: https://resources.unsdsn.org/the-decade-of-action-and-small-island-developing-states.

Tavola, H. (2018). Tuvalu Study on People with Disability. DFAT/Pacific Women Shaping Pacific Development. Available at https://pacificwomen.org/wp-content/uploads/2018/08/Tuvalu-Study-on-People-With-Disability-Full-Report-July-2018.pdf.

United Nations Children's Fund (UNICEF) (2019). Poor diets damaging children's health in Pacific, warns UNICEF. 15 October. Available at https://www.unicef.org/pacificislands/press-releases/poor-diets-damaging-childrens-health-pacific-warns-unicef.

United Nations Department of Economic and Social Affairs (UN DESA), Division For Public Institutions and Digital Government, and United Nations Office of Disaster Risk Reduction Global Education and Training Institute (2020). Risk-informed Governance and Innovative Technology for Disaster Risk Reduction and Resilience. Training Module.

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). Risk and Resilience Portal. Available at rrp.unescap.org.

__________ (2019). *Asia-Pacific Disaster Report 2019: The Disaster Riskscape across East and North-East Asia*. United Nations publication.

__________ (2021a). *Asia-Pacific Disaster Report 2021*. United Nations publication.

__________ (2021b). Asia and the Pacific SDG Progress Report 2021. United Nations publication.

United Nation Framework Convention on Climate Change. Vulnerability and Adaptation to Climate Change in Small Island Developing States. Background paper for the expert meeting on adaptation for small island developing States. Available at https://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200702_sids_adaptation_bg.pdf.

United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2014). Solomon Islands: Worst flooding in history. 30 April. Available at: https://www.unocha.org/story/solomon-islands-worst-flooding-history.

__________ (2020). Pacific Humanitarian Team – Tropical Cyclone Harold Situation Report #12 (final). Situation report. 7 May. Available at https://reliefweb.int/report/vanuatu/pacific-humanitarian-team-tropical-cyclone-harold-situation-report-12-final-7-may.

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

United Nations Office for Outer Space Affairs (2020). UNITAR Operational Satellite Application Program (UNOSAT). Available at https://www.un-spider.org/unitar-operational-satellite-applications-programme-unosat.

University of Melbourne (2017). Disability Inclusion in Disaster Risk Reduction: Experiences of people with disabilities in Vanuatu during and after Tropical Cyclone Pam and recommendations for humanitarian agencies. July. Available at https://mspgh.unimelb.edu.au/__data/assets/pdf_file/0011/2567576/WEB-DIDRR-Report-14112017.pdf.

Williams, Megan (2020). Tropical Cyclone Harold Rapid Gender Analysis. CARE International. 14 April. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/TC%20Harold%20Rapid%20Gender%20Analysis%2014.04.20.pdf.

World Bank. Climate Change Knowledge Portal. Available at https://climateknowledgeportal.worldbank.org.

World Bank (2019). In Small Island States, Resilient Transport is Providing a Lifeline Against Disasters. 11 June. Available at https://www.worldbank.org/en/news/feature/2019/06/11/in-small-island-states-resilient-transport-is-providing-a-lifeline-against-disasters.

World Food Programme (2016). Food Assistance to El-Niño affected populations in Papua New Guinea. Available at: https://www.wfp.org/operations/200966-food-assistance-el-nino-affected-populations-papua-new-guinea and https://documents.wfp.org/stellent/groups/internal/documents/projects/wfp284301.pdf?_ga=2.28499260.1853860904.1642045876-120962107.1642045876.

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

__________ (2003). Climate change and human health: risks and responses. Technical report. 4 December. Available at https://www.who.int/publications/i/item/climate-change-and-human-health—-risks-and-responses.

__________ Western Pacific Region (2015). Human health and climate change in Pacific island countries. Meeting report. 4 November. Available at https://www.who.int/publications-detail-redirect/human-health-and-climate-change-in-pacific-island-countries.

__________ WHO Coronavirus (COVID-19) Dashboard. Available at https://covid19.who.int.

World Meteorological Organization and others (2019). 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. Available at https://reliefweb.int/sites/reliefweb.int/files/resources/climsci.pdf.

World Meteorological Organization (2021). State of the Climate in South-West Pacific, 2020. WMO-No. 1276. Geneva. Available at https://library.wmo.int/doc_num.php?explnum_id=10900.

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

Pathways to Adaptation and Resilience in Pacific SIDS demonstrate how the Pacific 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 the Pacific 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.