15

Small Islands

Coordinating Lead Authors: Michelle Mycoo (Trinidad and Tobago), Morgan Wairiu (Solomon Islands)

Lead Authors: Donovan Campbell (Jamaica), Virginie Duvat (France), Yimnang Golbuu (Palau), Shobha Maharaj (Germany/Trinidad and Tobago), Johanna Nalau (Australia/Finland), Patrick Nunn (Australia), John Pinnegar (UK), Olivia Warrick (New Zealand)

Contributing Authors: Giulia Anderson (USA/New Caledonia), Faye Abigail Cruz (Philippines), Eleanor Devenish-Nelson (UK), Kris Ebi (USA), Johanna Loehr (Germany), Roché Mahon (Trinidad and Tobago), Rebecca McNaught (Australia), Meg Parsons (New Zealand), Jeff Price (UK), Stacy-Ann Robinson (Jamaica), Adelle Thomas (Bahamas)

Review Editors: John Agard (Trinidad and Tobago), Mahmood Riyaz (Maldives)

Chapter Scientist: Giulia Anderson (USA/New Caledonia)

This chapter should be cited as:

Mycoo, M., M. Wairiu, D. Campbell, V. Duvat, Y. Golbuu, S. Maharaj, J. Nalau, P. Nunn, J. Pinnegar, and O. Warrick, 2022: Small Islands. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 2043–2121, doi:10.1017/9781009325844.017.

Table of Contents

Executive Summary

Observed Impacts

A sense of urgency is prevalent among small islands in the combating of climate change and in adherence to the Paris Agreement to limit global warming to 1.5°C above pre-industrial levels. Small islands are increasingly affected by increases in temperature, the growing impacts of tropical cyclones (TCs), storm surges, droughts, changing precipitation patterns, sea level rise (SLR), coral bleaching and invasive species, all of which are already detectable across both natural and human systems (*very high confidence*[1]) {15.3.3.1, 15.3.3.2, 15.3.3.3, 15.3.4.1, 15.3.4.2, 15.3.4.3, 15.3.4.4, 15.3.4.5, 15.3.4.7}.

The observed impacts of climate change differ between urban and rural contexts, island types and tropical and non-tropical islands (*high confidence*). Coastal cities and rural communities on small islands have been already impacted by SLR, heavy precipitation events, tropical cyclones and storm surges. Climate change is also affecting settlements and infrastructure, health and well-being, water and food security, and economies and culture, especially through compound events (*high confidence*). As of 2017, an estimated 22 million people in the Caribbean live below 6-m elevation and 50% of the Pacific's population lives within 10 km of the coast along with ≥50% of their infrastructure concentrated within 500 m of the coast {15.3.4.1, 15.3.4.2, 15.3.4.3, 15.3.4.4, 15.3.4.5, 15.3.4.7}.

TCs are severely impacting small islands (*high confidence*). The TC intensity and intensification rates at a global scale have increased in the past 40 years with intensity trends generally remaining positive. Intense TCs including Categories 4 and 5 TCs have threatened human life and destroyed buildings and infrastructural assets in small islands in the Caribbean and the Pacific. Among 29 Caribbean islands, 22 were affected by at least one Category 4 or 5 TC in 2017. TC Maria in 2017 destroyed nearly all of Dominica's infrastructure and losses amounted to over 225% of the annual GDP. Destruction from TC Winston in 2016 exceeded 20% of Fiji's current GDP. TC Pam devastated Vanuatu in 2015 and caused losses and damages to the agricultural sector valued at USD 56.5 million (64.1% of GDP). Coast-focused tourism is already extremely impacted by more intense TCs. {15.2.1, 15.3.3.1, 15.3.3.3, 15.3.4.1, 15.3.4.2, 15,3.4.4, 15.3.4.5}.

Scientific evidence has confirmed that globally and in small islands tropical corals are presently at high risk (*high confidence*). Severe coral bleaching, together with declines in coral abundance, has been observed in many small islands, especially those in the Pacific and Indian oceans (*high confidence*). In the Pacific, median return time between two severe bleaching events has diminished steadily since 1980. The return time is now 6 years and often associated with the warm phase of El Niño–Southern Oscillation (ENSO) events (*high confidence*). In mid-2016, a new ENSO event occurred which reduced living coral cover by 75% in the Maldives {15.3.3.1.3, 15.3.4.8}.

Freshwater systems on small islands are exposed to dynamic climate impacts and are among the most threatened on the planet. An 11–36% reduction is estimated in the volume of fresh groundwater lens of the small atoll islands (area < 0.6 km²) of the Maldives due to SLR. The El Niño-related 2015–2016 drought in Vanuatu led to reliance on small amounts of contaminated water left at the bottom of household tanks. A Caribbean high-resolution drought atlas spanning 1950–2016 indicates that the region-wide 2013–2016 drought was the most severe event during the multi-decadal period. In Puerto Rico, the island experienced 80 consecutive weeks of moderate drought, 48 weeks of severe drought and 33 weeks of extreme drought conditions between 2014 and 2016. Increasing trends in drought are apparent in the Caribbean although trends in the western Pacific are not statistically significant {15.3.3.2, 15.3.4.3}.

Small islands host significant levels of global terrestrial species diversity and endemism. Due to the large range of insular-related vulnerabilities, almost 50% of terrestrial species presently considered at risk of global extinction also occur on islands (*high confidence*)**.** Despite encompassing approximately 2% of the Earth's terrestrial surface, oceanic and other high-endemicity islands are estimated to harbour substantial proportions of existing species including ~ 25% extant global flora, ~ 12% birds and ~10% mammals {15.3.3.3}.

Projected Impacts

Projected climate and ocean-related changes will significantly affect marine and terrestrial ecosystems and ecosystem services, which will in turn have cascading impacts across both natural and human systems (*high confidence*). Changes in wave climate superimposed on SLR will significantly increase coastal flooding (*high confidence*) and low-coastal and reef island erosion (*limited evidence, medium agreement*). The frequency, extent, duration and consequences of coastal flooding will significantly increase from 2050 (*high confidence*), unless coastal and marine ecosystems are able to naturally adapt to SLR through vertical growth (*low confidence*). These changes are a major concern for small islands given that a high percentage of their population, infrastructure and economic assets are located in the low-elevation coastal zone of below 10-m elevation {15.3.3.1.1, 15.3.3.1.2, 15.3.3.1.3, 15.3.3.1.4}.

Projected changes in the wave climate superimposed on SLR will rapidly increase flooding in small islands, despite highly contrasting exposure profiles between ocean sub-regions (*high confidence*). A 5–10-cm additional SLR (expected for ~2030–2050) will double flooding frequency in much of the Indian Ocean and

1 In this Report, the following summary terms are used to describe the available evidence: limited, medium or robust; and for the degree of agreement: low, medium or high. A level of confidence is expressed using five qualifiers: very low, low, medium, high, and very high, and typeset in italics, e.g., *medium confidence*. For a given evidence and agreement statement, different confidence levels can be assigned, but increasing levels of evidence and degrees of agreement are correlated with increasing confidence.

Tropical Pacific, while TCs will remain the main driver of (rarer) flooding in the Caribbean Sea and Southern Tropical Pacific. Some Pacific atoll islands will *likely*[2] undergo annual wave-driven flooding over their entire surface from the 2060s–2070s to 2090s under RCP8.5, although future reef growth may delay the onset of flooding (*limited evidence, low agreement*) {15.3.3.1.1}.

Modelling of both temperature and ocean acidification effects under future climate scenarios (RCP4.5 and RCP8.5) suggest that some small islands will experience severe coral bleaching on an annual basis before 2040 (*medium confidence*). Above 1.5°C, globally inclusive of small islands, it is projected there will be further loss of 70–90% of reef-building corals, with 99% of corals being lost under warming of 2°C or more above the pre-industrial period. Intact coral reefs, seagrass meadows and mangroves provide a variety of ecosystem services that are important to island communities (*high confidence*). These include provisioning services, regulating services, cultural services and those that support community resilience (*high confidence)*. If coastal ecosystems are degraded and lost, then the benefits they provide cannot be easily replaced (*medium confidence*) {15.3.3.1.3, 15.3.3.1.4}.

Projected changes in aridity are expected to impose freshwater stress on many small islands, especially SIDS *(high confidence*). It is estimated that with a warming of 1.5°C or less, freshwater stress on small islands would be 25% less as compared to 2.0°C. While some island regions are projected to experience substantial freshwater decline, an opposite trend is observed for some western Pacific and northern Indian Ocean islands. Drought risk projections for Caribbean SIDS aligned with observations from the Shared Socioeconomic Pathway (SSP) 2 scenario indicate that a 1°C increase in temperature (from 1.7°C to 2.7°C) could result in a 60% increase in the number of people projected to experience severe water resources stress from 2043 to 2071. In some Pacific atolls, freshwater resources could be significantly affected by a 0.40-m SLR. Similar impacts are anticipated for some Caribbean countries with the worst-case scenario (RCP8.5) indicating a 0.5-m SLR by the mid-century (2046–2065) and a 1-m SLR by the end-of-century (2081–2100). SIDS with high projected population growth rates are expected to experience the most severe freshwater stress by 2030 under a 2°C warming threshold scenario {15.3.3.2}

The continued degradation and transformation of terrestrial and marine ecosystems of small islands due to human-dominated will amplify the vulnerability of island peoples to the impacts of climate change (*high confidence*). New studies highlight large population reductions with an extinction risk of 100% for endemic species within insular biodiversity hotspots including within the Caribbean, Pacific and Sundaland regions by 2100 for > 3°C warming {15.3.3.3}. This is *likely* to decrease the provision of resources (e.g., potable water) to the millions of people living on small islands, resulting in impacts upon settlements and infrastructure, food and water security, health, economies, culture and migration (*high confidence*) {15.3.3.2, 15.3.3.3, 15.3.4.1, 15.3.4.2, 15.4.3, 15.3.4.4, 15.3.4.5, 15.3.4.6, 15.3.4.7}.

Reef island and coastal area habitability in small islands is expected to decrease because of increased temperature, extreme sea levels and degradation of buffering ecosystems, which will increase human exposure to sea-related hazards (*high confidence*). Climate and non-climate drivers of reduced habitability are context specific. On small islands, coastal land loss attributable to higher sea level, increased extreme precipitation and wave impacts and increased aridity have contributed to food and water insecurities that are *likely* to become more acute in many places (*high confidence*). In the Caribbean, additional warming by 0.2°–1.0°C, could lead to a predominantly drier region (5–15% less rain than present day), a greater occurrence of droughts along with associated impacts on agricultural production and yield in the region. Crop suitability modelling on several commercially important crops grown in Jamaica found that even an increase of less than +1.5°C could result in a reduction in the range of crops that farmers may grow. Most Pacific Island Countries could experience ≥ 50% declines in maximum fish catch potential by 2100 relative to 1980–2000 under both an RCP2.6 and RCP8.5 scenario {15.3.4.3, 15.3.4.4}.

Future Risks

The reduced habitability of small islands is an overarching significant risk caused by a combination of several key risks facing most small islands even under a global temperature scenario of 1.5°C *(high confidence)*. These are loss of marine and coastal biodiversity and ecosystem services; submergence of reef islands; loss of terrestrial biodiversity and ecosystem services; water insecurity; destruction of settlements and infrastructure; degradation of health and well-being; economic decline and livelihood failure); and loss of cultural resources and heritage. Climate-related ocean changes, including those for slow-onset events, and changes in extreme events are projected to cause and/or amplify Keys Risks in most small islands. Identification of key risks facilitates the selection of optimal context-specific adaptation options. Moreover, it can distil the benefits and/or disadvantages and long-term implications of choosing such options (*high confidence*) {15.3.4.9}.

The vulnerability of communities in small islands, especially those relying on coral reef systems for livelihoods, may exceed adaptation limits well before 2100 even for a low greenhouse gas emission pathway (*high confidence*). The impacts of climate change on vulnerable low-lying and coastal areas present serious threats to the ability of land to support human life and livelihood (*high confidence*). Climate-related migration is expected to increase, although the drivers and outcomes are highly context-specific and insufficient evidence exists to estimate numbers of climate-related migrants now and in the future (*medium evidence, high agreement*) {15.3.4.1, 15.3.4.6, CCB7-1}.

2 In this Report, the following terms have been used to indicate the assessed likelihood of an outcome or a result: *virtually certain* 99–100% probability, *very likely* 90–100%, *likely* 66–100%, *about as likely as not* 33–66%, *unlikely* 0–33%, *very unlikely* 0–10%, and *exceptionally unlikely* 0–1%. Additional terms (*extremely likely* 95–100%, *more likely than not* >50–100%, and *extremely unlikely* 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, e.g., *very likely*). This Report also uses the term '*likely* range' to indicate that the assessed likelihood of an outcome lies within the 17–83% probability range.

Small islands are already reporting losses and damages particularly from tropical cyclones and increases in SLR *(high confidence).* Despite the loss of human life and economic damage, the methods and mechanisms to assess climate-induced loss and damage remain largely undeveloped for small islands. Further, there are no robust methodologies to infer attribution and such assessments are limited. A research gap on losses and damages includes how to assess the economic costs of losses and damages. Specific data on experienced losses and damages across socioeconomic groups and demographics are needed. Monitoring and tracking slow-onset events are equally important and require robust data {15.7, 15.8}.

Options, Limits and Opportunities of Adaptation

Some island communities are resilient with strong social safety nets and social capital that support responses and actions already occurring, but there is limited information on the effectiveness of the adaptation practices and the scale of action needed (*high confidence*). This is in part due to a need for a better understanding of the limits to adaptation and of what constitutes current resilience and/or successful adaptation in small island contexts. Greater insights into which drivers weaken local and indigenous resilience, together with recognition of the sociopolitical contexts within which communities operate, and the processes by which decisions are made, can assist in identifying opportunities at all scales to enhance climate adaptation and enable action towards climate resilient development pathways (*medium evidence, high agreement*) {15.6.1, 15.6.5, 15.7}.

In small islands, despite the existence of adaptation barriers several enablers can be used to improve adaptation outcomes and to build resilience (*high confidence*). These enablers include better governance and legal reforms; improving justice, equity and gender considerations; building human resource capacity; increased finance and risk transfer mechanisms; education and awareness programmes; increased access to climate information; adequately downscaled climate data and embedding Indigenous knowledge and local knowledge (IKLK) as well as integrating cultural resources into decision-making (*high confidence*) {15.6.1 15.6.3, 15.6.4, 15.6.5}.

Small islands present the most urgent need for investment in capacity building and adaptation strategies (*high confidence***) but face barriers and constraints which hinder the implementation of adaptation responses.** Barriers and constraints arise from governance arrangements, financial resources and human resource capacity. Additionally, institutional and legal systems are often inadequately prepared for managing adaptation strategies such as large-scale settlement relocation and other planned and/or autonomous responses to climate risks (*high confidence*). Adaptation strategies are already being implemented on some small islands although barriers are encountered including inadequate up-to-date and locally relevant information, limited availability of finance and technology, lack of integration of IKLK in adaptation strategies, and institutional constraints (*high confidence*) {15.5.3, 15.5.4, 15.6.3, 15.6.4, 15.6.5}.

For many small islands, adaptation actions are often incremental and do not match the scale of extreme or compounding events (*high confidence*). Much of the currently implemented adaptation measures remain small in scale (e.g., community-based adaptation projects), sectoral in focus and do not address the needed structural and system-level adaptations to combat climate impacts and achieve long-term sustainability of adaptation interventions. To address these shortcomings, enablers are being integrated into National Adaptation Plans and Disaster Risk Reduction Plans (*high confidence*) {15.6.3}.

Although international climate finance has increased in magnitude, small islands face challenges in accessing adaptation finance to cope with slow- and rapid-onset events (*high confidence*). In the Caribbean, 38% of flows were concessional loans and 62% were grants, whereas in the Atlantic and Indian oceans nearly 75% of the flows were in the form of concessional loans and 25% were grants. Solutions to these barriers are being explored and some small islands have started adopting enablers such as insurance and microfinance at both the national and local levels in responding to adaptation needs and to facilitate resiliency building. COVID-19 has caused, however, economic shock in many small islands, which will limit adaptation, undermine the attainment of Sustainable Development Goals and slow down climate resilient development transitions {15.8.3}.

The unavailability of up-to-date baseline data and contrasting scenarios/temperature levels continue to impair the generation of local-to-regional observed and projected impacts for small islands, especially those that are developing nations (*high agreement*). Climate model data based on the most recent suite of scenarios (RCPs and especially SSPs) are still not widely available to primary modelling communities in most small island developing nations (high agreement). Coastal sites of small islands are not well represented in global gridded population and elevation data sets, thereby making estimation of population exposure to SLR difficult. The lack of data continues to impede the development of robust impacts-based modelling output (e.g., for terrestrial biodiversity). Downscaling is pivotal for small islands due to their high diversity, which makes generalisation invalid.