The IPCC's Fifth Assessment Report

What's in it for Small Island Developing States?

CDKN
Climate & Development Knowledge Network

Image: Américo de Carvalho e Sousa | Aerial view of 'No man's Land' and Buccoo Coral Reef, Tobago

Cover image:
Jocelyn Carlin, Panos Pictures | Poutasi villager surveys the damage on the South Eastern coast of Upolo, Samoa

The IPCC's Fifth Assessment Report offers the following key messages for Small Island Developing States (SIDS)

The IPCC offers some specific messages about the impacts of climate change on small island states – and some of its general findings on climate change adaptation and mitigation are of particular relevance to Small Island Developing States (SIDS):

1. The climate is already changing and SIDS are already feeling the impacts
2. Further climate change is inevitable in the coming decades
3. Climate change is affecting SIDS' growth and development
4. Climate change poses an existential threat to some SIDS
5. Adaptation can reduce the impacts of climate change, but there are limits and risks involved
6. The economic cost of adaptation to climate change is high in SIDS relative to the size of their economies
7. SIDS stand to benefit from further integration of climate adaptation, mitigation and development approaches
8. Transformation to a low-carbon economy implies new patterns of investment
9. International cooperation is vital to avert dangerous climate change and SIDS governments can promote ambitious global action

> **"Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850."**
> IPCC[1]

The climate is already changing and SIDS are already feeling the impacts

The *Fifth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) finds, beyond reasonable doubt that the Earth's climate is warming.[2] Since the 1950s, the rate of global warming has been unprecedented compared to previous decades and millennia.[3]

The *Fifth Assessment Report* presents a long list of changes that scientists have observed around the world.[4] Since the mid-19th century, the average increase in the temperature of the Earth's surface has been 0.85 degrees Centigrade (°C).[5]

Globally, sea levels have risen faster than at any time during the previous two millennia.[6] In many parts of the world, including Small Island Developing States (SIDS), changing rainfall is altering freshwater systems, affecting the quality and quantity of water available.[7]

The IPCC finds that there is 95% scientific certainty (Box 1) that human activity, by increasing concentrations of greenhouse gases in the atmosphere, has been the dominant cause of the observed warming since the mid-20th century.[8] Current science provides the clearest evidence yet that human activity is changing our climate.[9]

The impacts of climate change will affect livelihoods, coastal settlements, infrastructure, ecosystems and economic stability in SIDS, and sea level rise poses an increasing threat to low-lying coastal areas.[10] The following pages explore these impacts in more depth.

Given the interdependence among countries in today's world, the impacts of climate change on resources or commodities in one place will have far-reaching effects on prices, supply chains, trade, investment and political relations in other places. Thus, climate change will progressively threaten food security[11] and economic growth[12] in complex ways, in SIDS and across the world.

Box 1: How the IPCC's *Fifth Assessment Report* defines scientific certainty[13]

The IPCC assigns a degree of certainty to each key finding based on the type, amount, quality and consistency of evidence (e.g., data, theory, models, expert judgment), and the degree of agreement among scientists. The terms to describe evidence are: limited, medium or robust; and to describe agreement: low, medium or high.

When the *Fifth Assessment Report* talks about 'confidence' in a finding, the level of confidence derives from a synthesis of the evidence that exists and the degree of scientific agreement on what the evidence means. The levels of confidence IPCC assigns are: very low, low, medium, high and very high.

IPCC describes the likelihood or certainty of an outcome having occurred or occurring in the future in terms of percentages:

Virtually certain	**99% or more**
Extremely likely	**95% or more**
Very likely	**90% or more**
Likely	**66% or more**
More likely than not	**more than 50%**
About as likely as not	**33–66%**
Unlikely	**33% or less**
Very unlikely	**10% or less**
Extremely unlikely	**5% or less**
Exceptionally unlikely	**1% or less**

On this scale, the world's leading climate scientists consider it extremely likely that human activities have been the dominant cause of observed warming. Scientists consider 95% confidence as the 'gold standard', the standard at which theories are accepted as valid. For example, the theory of evolution, the theory on the age of the Earth and the Big Bang theory all meet this standard of scientific confidence.

It is notable that the IPCC's *Fifth Assessment Report* finds high levels of confidence and robust agreement for many of the impacts of climate change on small islands – in contrast to the agreement and confidence levels for many other developing regions.

It is *virtually certain* that the rate of global average sea level rise is accelerating.[14]

In the western Pacific, rates of sea level rise of up to four times the global average have been reported.[24]

Even today, climate-related risks for SIDS include sea level rise, tropical and extra-tropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns (*high confidence*).[15,16]

The *Fifth Assessment Report* includes a chapter for Small Islands[17] which describes how these drivers of climate change have varying impacts on small islands, depending on the magnitude, frequency and extent of the event, as well as on the bio-physical nature of the island and its social, economic and political setting.[18] Thus, small islands do not have uniform climate change risk profiles (*high confidence*).[19]

The *Fifth Assessment Report* has not provided data for all SIDS. This is because in most small islands, long-term quality-controlled climate data are generally sparse.[20] Below are examples of climate change observations for specific territories, where they are available.

Observed temperature trends. Average temperatures have increased at a rate of between 0.1 and 0.2°C per decade throughout the Pacific islands during the 20th century.[21] Changes in temperature extremes have followed those of average temperatures.[22]

Observed rainfall trends.[23] Rainfall records averaged across the Caribbean region for 100 years (1900–2000) show a consistent reduction in rainfall. In contrast, rainfall data over the past 100 years from the Seychelles has shown substantial variation related to the El Niño Southern Oscillation (ENSO). Nevertheless, an increase in average rainfall from 1959 to 1997 and an increase in temperature of around 0.25°C per decade have occurred in the Seychelles.

Observed sea level rise.[24] Globally, the rate of sea level rise since the 1850s has been larger than the average rate during the previous 2,000 years (*high confidence)* at a rate of 1.3–1.7 millimetres (mm) per year over much of the 20th century but increasing to 2.8–3.6 mm per year since 1993. However, sea level rise varies between regions, and large differences in the rate of sea level rise have been detected in the Indian Ocean and the tropical Pacific.

This has occurred due to a complex set of interactions.[25] Shifting surface winds, the expansion of warming ocean water and the addition of melting ice can alter ocean currents which, in turn, lead to changes in sea level that vary from place to place. Past and present variations in the distribution of land ice affect the shape and gravitational field of the Earth, which also cause regional fluctuations in sea level. Sediment and tectonic movements in the ocean bed cause additional variations in sea level.

In the tropical western Pacific where a large number of small island communities exist, rates of sea level rise of up to four times the global average (approximately 12 mm per year) have been reported between 1993–2009.[26]

Here, the El Niño Southern Oscillation (ENSO) plays a strong role in regional sea level with lower than average sea level during El Niño events and higher than average sea level during La Niña events, by as much as plus or minus 20–30 cm. Large variations in sea level have also been shown between years in the Indian Ocean, for example, in the Chagos Archipelago, and in the Caribbean. In the Caribbean, an observed average rate of sea level rise over the past 60 years was similar to the global average (approximately 1.8 mm per year).[27]

However, there are few long-term sea level records available for individual small island locations and detecting variation caused by climate change, rather than transient conditions such as storm waves and surges, deep ocean swell and tidal cycles, is very difficult.[28]

Where data does exist, a combination of climate-related sea level rise and transient conditions can be shown. For example, at Fongafale Island in the Funafuti Atoll, Tuvalu, high spring tide floods have been well publicised and areas of the central portion of Fongafale Island are already below high spring tide level.[29] However, rates of relative sea level rise at Funafuti between 1950–2009 have been approximately three times higher than the global average; saline flooding of internal low-lying areas occurs regularly, and is expected to become more frequent and extensive over time.[30]

Observed effects of climate change.[31] In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans, including SIDS.[32] The figure below lists the observed impacts for small islands that can be attributed to climate change, and the confidence in this causal link. The observed effects of these environmental changes on economic activity and the implications for future growth and development are explored in more depth from page 12 onwards.

Figure 1: Impacts of climate change on small islands[33]

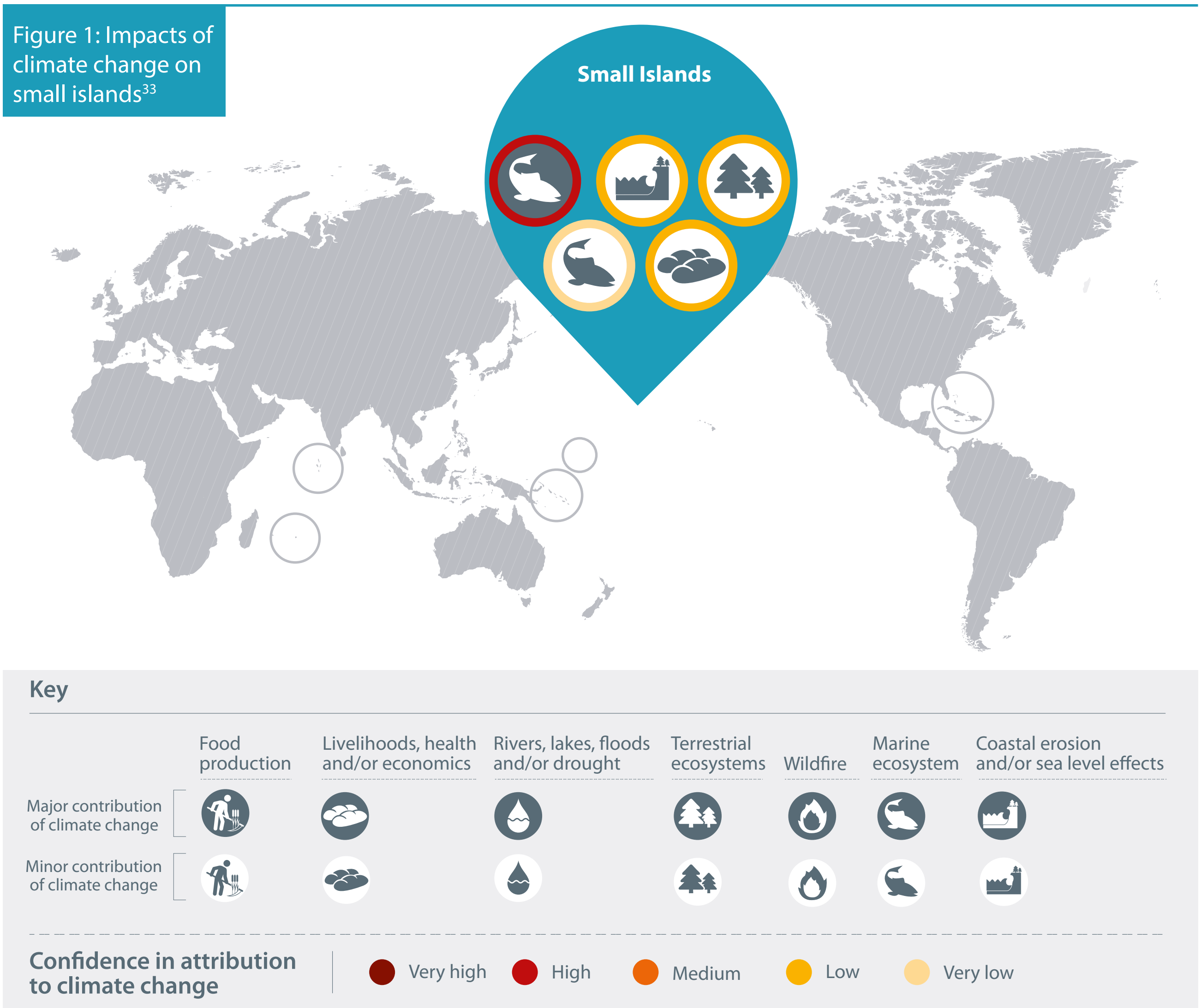
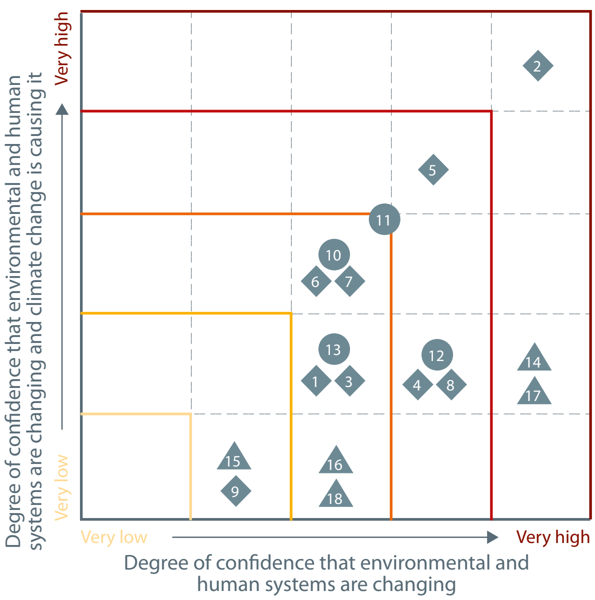


Figure 2: Role of climate change in shaping natural and human systems[34]



Key

Coastal systems

1. Greater rates of sea level rise relative to global average
2. Sea level rise consistent with global average
3. Marine inundation of low-lying areas
4. Shoreline erosion
5. Coral bleaching in small island marine environments
6. Increased resilience of coral reefs and shorelines in the absence of direct human disturbance
7. Acidification of surface waters
8. Degraded coastal fisheries
9. Degradation of mangroves and seagrass

Terrestrial systems

10. Saline incursion degrading ecosystems
11. Altitudinal species shift
12. Incremental degradation of groundwater quality
13. Island marine overtopping and rapid salinisation of groundwater

Human systems

14. General environmental degradation and loss of habitat in urban locations
15. Reduced tourism
16. Human susceptibility to climate induced diseases
17. Casualties and damage during extreme events

Table 1: Climate impacts for small islands

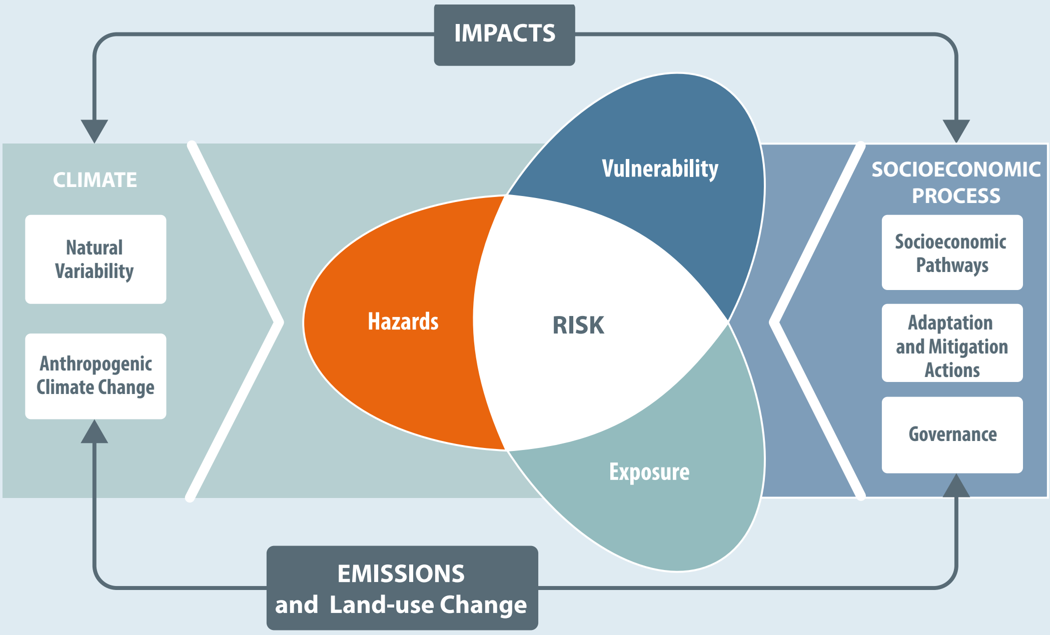
Freshwater resources		• Increased water scarcity in Jamaica, beyond increase due to water use (*very low confidence*, minor contribution from climate change)
Terrestial ecosystems		• Tropical bird population changes in Mauritius (*medium confidence*, major contribution from climate change) • Upward trend in tree-lines and associated fauna on high-elevation islands (*low confidence*, minor contribution from climate change)
Coastal erosion and marine ecosystems		• Increased coral bleaching near many tropical small islands, beyond effects of degradation due to fishing and pollution (*high confidence*, major contribution from climate change) • Degradation of mangroves, wetlands, and seagrass around small islands, beyond degradation due to other disturbances (*very low confidence*, minor contribution from climate change) • Increased flooding and erosion, beyond erosion due to human activities, natural erosion, and accretion (*low confidence*, minor contribution from climate change) • Degradation of groundwater and freshwater ecosystems due to saline intrusion, beyond degradation due to pollution and groundwater pumping (*low confidence*, minor contribution from climate change)
Food production and livelihoods		• Increased degradation of coastal fisheries due to direct effects and effects of increased coral reef bleaching, beyond degradation due to overfishing and pollution (*low confidence*, minor contribution from climate change)

Box 2: Climate change poses risks to human and natural systems[35]

Risks related to climate change arise from climate-related *hazards* (climate trends and extremes) and the *vulnerability* of *exposed* societies, communities or systems (in terms of livelihoods, infrastructure, ecosystem services and governance systems). Effective measures to adapt to climate change and reduce the risks associated with climate change can address all three aspects of risk: hazard, vulnerability and exposure.

The vulnerability and exposure of societies and ecological systems to climate-related hazards vary constantly because of changes in economic, social, demographic, cultural, institutional and governance circumstances.

For example, rapid and unsustainable urban development, international financial pressures, increases in socioeconomic inequality, failures in governance and environmental degradation affect vulnerability. These changes unfold in different places at different times, meaning that strategies to strengthen resilience and reduce exposure and vulnerability need to be locally or regionally specific. For example, countries that are rapidly urbanising are vulnerable to climate change if their economic development is slow. In other countries, urbanisation may present opportunities to adapt to climate change. Poverty is also a critical factor in determining vulnerability to climate change and extreme events.



Regardless of future emissions, we are already committed to further warming.[36]

Further climate change is inevitable in the coming decades

Regardless of future emissions, the world is already committed to further warming, largely due to past emissions and inertia in the climate system. Globally, most greenhouse gas emissions due to human activities have come from few countries. It has long been recognised that greenhouse gas emissions from small islands are negligible in relation to global emissions.[37] But as total emissions since 1970 have continued to rise, and emissions between 2000 and 2010 have been the highest yet,[38] the threats of climate change and sea level rise to small islands are very real.

The IPCC warns that if global society continues to emit greenhouse gases at current rates, the average global temperature could rise by 2.6–4.8°C by 2100, according to the IPCC's highest emissions scenario (see Box 3).[39]

The figure in Box 3, below, illustrates projected warming under a low-emissions scenario, a high-emissions scenario[40] and two intermediate emissions scenarios, and the temperature changes associated with each. Whether global society continues to emit greenhouse gases at today's rate, or cuts greenhouse gas emissions sharply now, does not make a big difference in terms of climate impacts in the next few decades.

Box 3: What are the IPCC scenarios?[43]

In assessing future climate change, the *Fifth Assessment Report* presents four scenarios, known as Representative Concentration Pathways (RCPs – see figure at right). The scenarios show the result of different levels of emissions of greenhouse gases, from the present day to 2100, on global warming. IPCC does not indicate which policy and behavioural choices society could make that would lead to the scenarios.

In all scenarios, carbon dioxide concentrations are higher in 2100 than they are today. The low-emissions scenario (RCP2.6) assumes substantial and sustained reductions in greenhouse gas emissions. The high-emissions scenario (RCP8.5) assumes continued high rates of emissions. The two intermediate scenarios (RCPs 4.5 and 6.0) assume some stabilisation in emissions.

In the next few decades, warming will be the same in all scenarios (see the overlap between the scenarios at right, and in Box 4, overleaf). Regardless of action taken now to reduce emissions, the climate will change until around the middle of this century. In the longer term, in all except the low-emissions scenario, global warming at the end of the 21st century is *likely* to be at least 1.5°C. In the two higher emissions scenarios, global warming is *likely* to be 2°C. In the second lowest emissions scenario, global warming is *more likely than not* to be 2°C. Warming will continue beyond 2100 under all emissions scenarios except the lowest and will continue to vary between years and between decades.

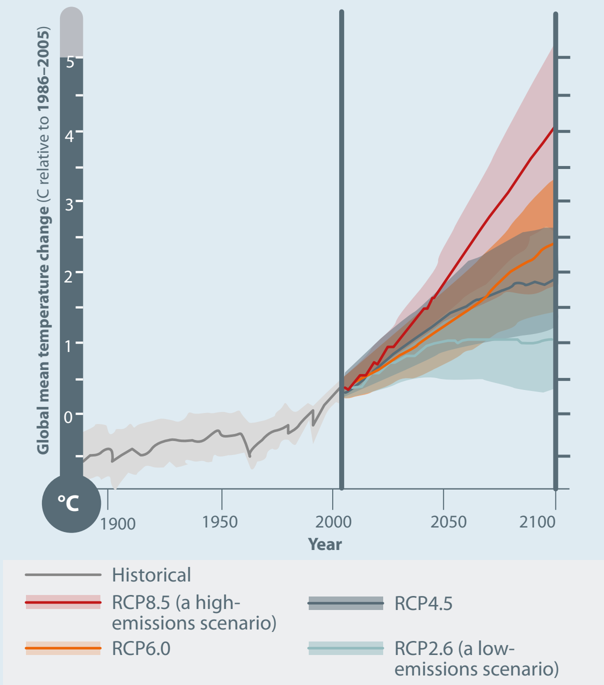


Image: Alex Smailes, Panos Pictures | A home destroyed by Hurricane Ivan, which devastated 90% of the island, Grenada

Curbing emissions to maintain global temperatures below 2°C would need urgent action at global level. However, the benefits to the global climate – and societies and ecosystems that depend on it – will only emerge in the latter half of the century.

The IPCC lists the many reasons why mitigation action must start now and the kinds of immediate benefits it can deliver – one of the immediate benefits of low-carbon development for SIDS, for example, is reduced reliance on costly fossil fuel imports and increased energy security, irrespective of the climate benefits of such actions (see page 27).

Taking action on adaptation today can deliver immediate benefits for dealing with climate change. But, there are limits and risks to adaptation, particularly in SIDS.[41] Both adaptation and mitigation are needed; they each deliver benefits for the climate but over different timeframes;[42] they confer different types of benefits to countries in the present.

Small islands face many challenges in using climate change projections for policy development and decision-making.[44] This difficulty is magnified by the general absence of credible regional socio-economic scenarios relevant at the spatial scale at which most decisions are taken[45] (see Box 4).

Box 4: Climate scenarios for small islands[46]

Climate change scenarios are an important tool for understanding the relationship between climate vulnerability to the direct impacts of climate change, and to changes in socio-economic conditions and governance. However it is incredibly difficult to downscale climate scenarios and projections from global climate change models to the resolution required for SIDS to inform decision-making. The lack of observational climate data for small island states, which is a necessary input for climate modelling, also makes scenario planning difficult. Where observational data is available for at least the last 30 years and at the national, regional and local level, it is possible to generate scenarios and projections at a finer scale. However the climate change scenarios and projections that currently exist for the Caribbean, the Pacific and Indian Ocean tend to apply to the region as a whole.

For these reasons, scenarios for small islands are often constructed on other data from the literature or from local knowledge, rather than model outputs. For example, local data and knowledge of climate from Nauru were used to assess global model outputs, suggesting that Nauru should plan for continued variability in the El Niño Southern Oscillation (ENSO) cycle in the future with dry years during La Niña and an overall increase in average rainfall and extreme rainfall events. In the Caribbean, sea level rise projections have been combined with elevation maps to estimate that 49–60% of tourist resort properties would be damaged, with implications for the economies of the region.

Image: Robin Hammond, Panos Pictures | A home in Nadi, Fiji

Projected temperature trends. Under an intermediate low-emissions scenario (RCP4.5), an average annual increase in surface temperature of 1.2–2.3°C is projected across the Caribbean, Indian Ocean and Pacific Ocean small island regions by the end of the century, compared to 1986–2005 (see Table 2).[47]

Projected rainfall trends. Under the same scenario, a decrease in rainfall of about 5–6% is projected for the Caribbean, signalling a potential future threat to agriculture and water availability, compared to a 1–9% increase projected for the Indian Ocean and Pacific Ocean small island regions.[48]

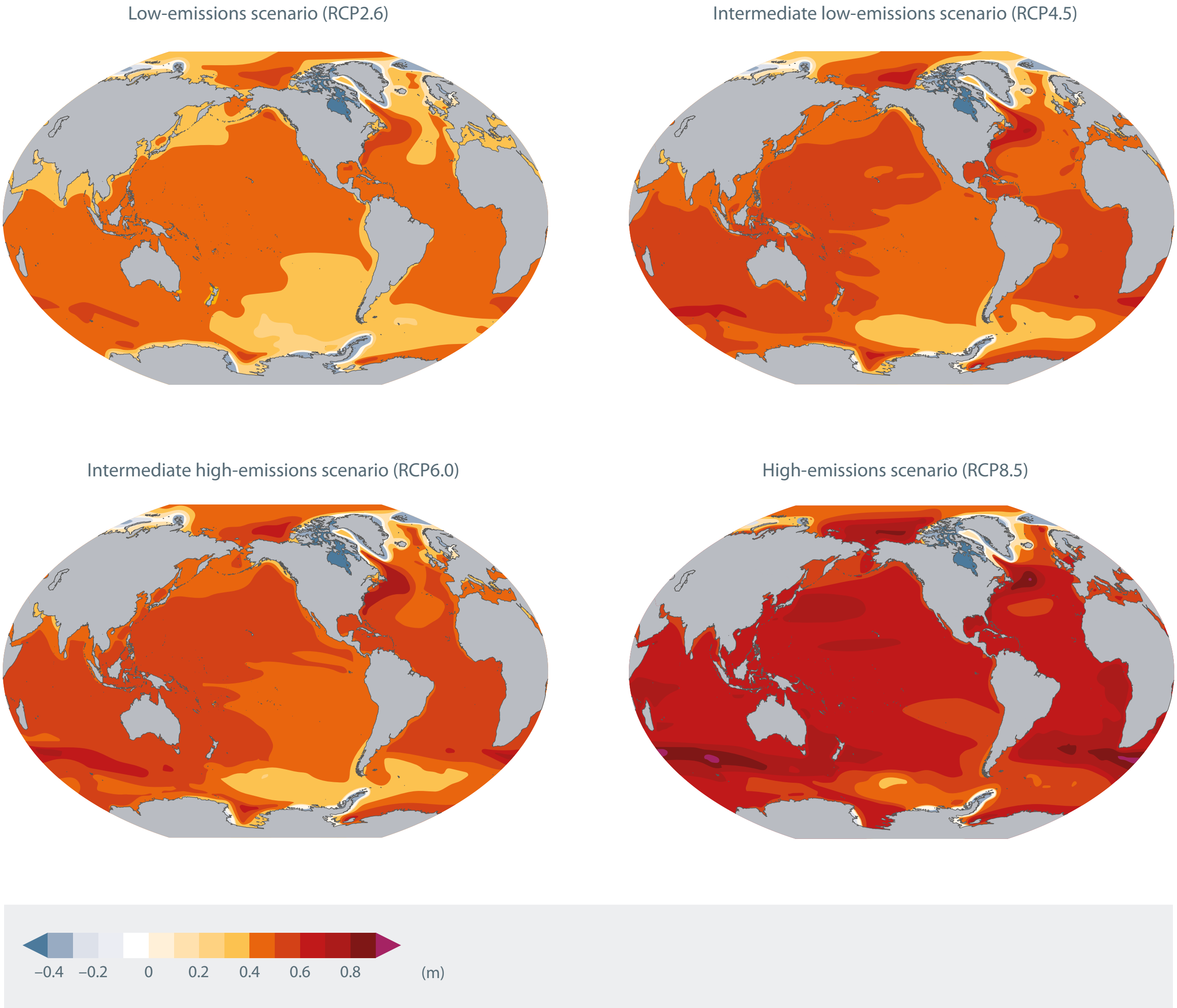
But again, there are large variations within these small island regions. For example, among the more dispersed Pacific islands, the equatorial regions are likely to get wetter, whereas the sub-tropical high pressure belts will likely get drier. In other areas of the Pacific where the trade winds come together, the rainfall outlook is uncertain.[49]

Projected sea level rise. Sea level rise projections in small island regions under an intermediate low-emissions scenario are similar to global projections of between 0.4 and 0.7 metres, ranging from 0.5 and 0.6 metres in the Caribbean, Pacific and Indian Ocean, and by 0.4 and 0.5 metres in the North Indian Ocean (see Figure 3).[50]

Table 2: Climate change projections for the intermediate low-emissions scenario (RCP4.5) for the main SIDS regions[51]

Small Island Region	RCP4.5 Annual projected change for 2081–2100 (relative to 1986–2005)		
	Average temperature (°C)	Average rainfall (%)	Sea level rise (m)
Caribbean	1.4	-5	0.5–0.6
Northern Tropical Pacific	1.4	1	0.5–0.6
Southern Tropical Pacific	1.2	2	0.5–0.6
North Indian Ocean	1.5	9	0.4–0.5
West Indian Ocean	1.4	2	0.5–0.6

Figure 3: Future average regional sea level change under different emissions scenarios 2081–2100 (relative to 1986–2005)[50]



Caribbean.[53] In the Caribbean, downscaled projections have been generated for some islands. These indicate an increase in temperature of 1–4°C across the Caribbean under the emissions scenarios used in the previous IPCC *Fourth Assessment Report* (SRES A2 and B2, which are respectively relatively high- and low- emissions scenarios). These projections also show increasing rainfall during the latter part of the wet season (November–January) in the northern Caribbean (north of 22°N) and drier conditions in the southern Caribbean, with drying in the traditional wet season (June–October). Lengthening of seasonal dry periods and increasing frequency of drought are expected to increase demand for water across the region.

Indian Ocean.[54] Downscaled projections for the Cocos (Keeling) and Christmas Island show an approximate 1.8°C increase in air temperature by 2070, drier dry seasons and wet seasons, about 40 centimetres sea level rise and a decrease in the number of intense tropical cyclones.

Western tropical Pacific.[55] Extensive projections have been made from downscaled models of Pacific Island Countries. Notably, extreme rainfall events that currently occur once every 20 years on average, are generally shown to occur four times per 20-year period by 2055 and seven times per 20-year period 2090, on average, under a high-emissions scenario. These projections are consistent with increases of 1.2–1.4°C under a more recent intermediate low-emissions scenario (RCP4.5).

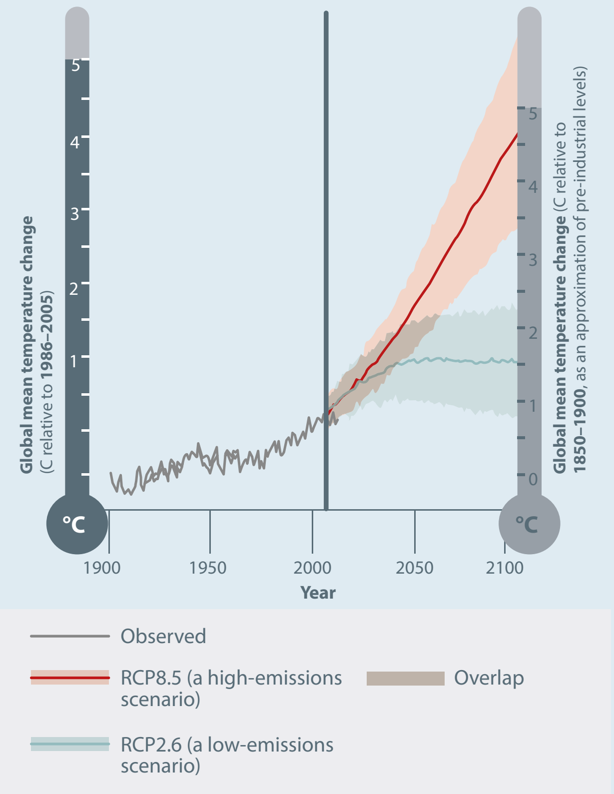
Marine ecosystems have been affected by climate change already.

Box 5: Impacts of global warming[56]

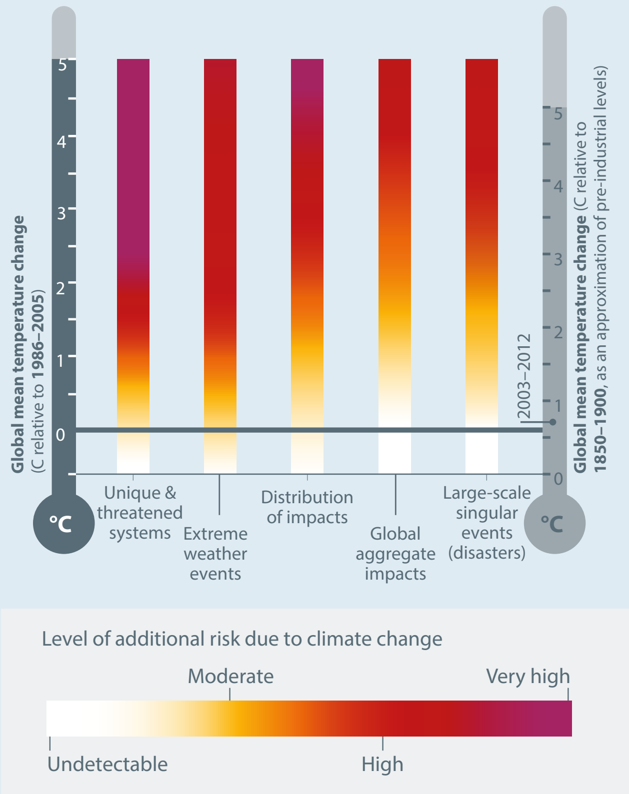
The diagram below shows global warming in the last century, and projected climate global warming to 2100 according to the IPCC's highest and lowest emissions scenarios. The IPCC identifies five main areas of concern as temperatures rise. The diagram on the right indicates the additional climate-related risks when the temperatures reach a certain level, are sustained at that level or exceeded. At even relatively low levels of warming of 1 to 2°C, many unique natural systems are threatened. In SIDS, these include risk of loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions and services they provide for coastal livelihoods, especially for fishing communities in the tropics.

The IPCC concludes that large-scale warming, of around 4°C or above, will increase the likelihood of severe, pervasive and irreversible impacts to which it will be difficult to adapt. Climate change impacts across these areas for concern will increase risk of death, injury, ill-health, or disrupted livelihoods in small island developing states and other small islands, due to storm surges, coastal flooding, and sea level rise.

Observed and projected global annual average temperature



Global risks under increasing levels of climate change



Box 6: Projected warming for SIDS and options for limiting average global temperature rise

During negotiations towards a new multi-lateral climate change agreement, the Alliance of Small Island States (AOSIS) has advocated that the agreement should be based on global average surface temperature increase 'well below' 1.5°C above pre-industrial levels. The average global temperature rise over land and ocean has already been 0.85°C, over the period 1880 to 2012 (see page 2). Global average surface temperatures for the period 2081–2100 (relative to 1986–2005) are projected to rise from 0.3–1.7°C under the lowest emissions scenario, to 2.6–4.8°C under the highest emissions scenario.[57]

In the Caribbean, Indian Ocean and Pacific islands in the tropics, the projected average increase is in the range 0.5–0.9°C by 2100 compared to the baseline period (1986–2005) under the lowest emissions scenario (see Annex 1). By comparison, temperature projections for the intermediate low-emissions scenario (RCP4.5) suggest possible 1.2–1.5°C increases in the Caribbean, Indian Ocean and Pacific SIDS by the end of this century (see Table 2). Associated with this change, the Caribbean region may experience a noticeable decrease in average rainfall, while the Indian and Pacific Ocean SIDS may experience increased rainfall. These trends accelerate steeply for a high-emissions scenario (RCP8.5).[58]

The majority of scenarios reaching long-term concentrations between 430–480 parts per million of carbon dioxide equivalent (ppm CO_2 eq) in 2100 are likely to keep temperature change below 2°C over the course of the century relative to pre-industrial levels. These scenarios are associated with peak concentrations of 530 ppm CO_2 eq.[59]

Only a limited number of studies have explored emissions pathways consistent with limiting long-term temperature change to below 1.5°C. In these scenarios, temperature peaks over the course of the century and is brought back to 1.5°C with a likely chance at the end of the century. These scenarios assume immediate introduction of climate policies as well as the rapid scaling up of the full portfolio of mitigation technologies combined with a development trajectory based on low energy demand.[60]

Geoengineering options that remove carbon dioxide from the atmosphere and store it in forests or oceans carry local or regional risks due to large scale changes in land use, in the case of terrestrial techniques, and significant trans-boundary risks, in the case of maritime techniques. Thus, with currently known technologies, geoengineering could not be deployed quickly on a large scale. Solar radiation management includes various technologies to crudely off-set some warming of the atmosphere. However, these technologies raise questions about costs, risks, governance, and ethical implications.[61]

Table 3: Key characteristics of the scenarios collected and assessed by IPCC[62]

CO_2eq Concentrations in 2100 (CO_2eq)	Relative position of the RCPs	Cumulative CO_2 emission ($GtCO_2$)		Temperature change (relative to 1850–1900)				
		2011–2050	2011–2100	2100 Temperature change (°C)	Likelihood of staying below temperature level over the 21st century			
					1.5°C	2.0°C	3.0°C	4.0°C
<430	Only a limited number of individual model studies have explored levels below 430 pmm CO_2eq							
430-480	*RCP2.6*	550–1300	630–1180	1.5–1.7	More unlikely than likely	Likely	Likely	Likely
480–530		860–1180	960–1430	1.7–1.9	Unlikely	More likely than unlikely		
		1130–1530	990–1550	1.8–2.0		About as likely as not		
530–580		1070–1460	1240–2240	2.0–2.2		More unlikely than likely		
		1420–1750	1170–2100	2.1–2.3				
580–650	*RCP4.5*	1260–1640	1870–2440	2.3–2.6				
650–720		1310–1750	2570–3340	2.6–2.9		Unlikely	More likely than unlikely	
720–1000	*RCP6.0*	1570–1940	3620–4990	3.1–3.7	Unlikely		More unlikely than likely	
>1000	*RCP8.5*	1840–2310	5350–7010	4.1–4.8		Unlikely	Unlikely	More unlikely than likely

The tourism industry and investors are beginning to consider the climate risk of tourism operations including those associated with the availability of freshwater.[65]

Climate change is affecting SIDS' growth and development

Climate change is undermining the essential ecosystems on which the economies of SIDS depend.

Tourism

Tourism is an important weather and climate-sensitive sector on many islands. Climate can impact directly on environmental resources that are major tourism attractions in small islands.[63] Widespread resource degradation, such as beach erosion and coral bleaching has been found to negatively impact the perception of destination attractiveness in various locations. Consequently, some countries have begun to invest in a variety of resource restoration initiatives including artificial beach nourishment, coral and mangrove restoration and the establishment of marine parks and protected areas.[64]

Freshwater is limited on many small islands and changes in its availability and quality during drought events, linked to climate change, have adverse impacts on tourism operations. The increasing use of desalination plants is one adaptation to reduce the risk of water scarcity in tourism operations.[66]

The IPCC finds that marine ecosystems have been affected by climate change already (*very high confidence*). Coral reefs are an important resource in small tropical islands and wellbeing of many island communities is linked to their ongoing function and productivity.[67]

Reefs play a significant role in supplying sediment to island shores and in dissipating wave energy, thus reducing potential shoreline erosion. They also provide habitat for a host of marine species upon which many island communities are dependent for subsistence foods as well as underpinning beach and reef-based tourism and economic activity.[68]

Box 7: Climate change and coral reefs

Coral reefs are shallow-water ecosystems that play an important role in the tropics, housing high levels of biological diversity as well as providing key ecosystem goods and services such as fish breeding grounds, coastal protection and appealing environments for tourism. Communities in tropical small island nations derive benefits including food, livelihoods, construction materials, medicine, cultural value and tourism opportunities from them.[69]

Coral reefs are one of the most vulnerable marine ecosystems (*high confidence)* and more than half the world's reefs are under medium or high risk of degradation. A wide range of climatic and non-climatic drivers affects corals and coral reefs and negative impacts have already been observed. Mass coral bleaching and mortality, triggered by heat stress (*high confidence*), is the most widespread impact of climate change.[70]

Acidification of the ocean reduces biodiversity and coral growth (*high confidence),* while at the same time increasing the rate of dissolution of reefs *(medium confidence).* Ocean warming and acidification have synergistic effects and taken together, these changes will erode habitats that support reef-based fisheries, increase the exposure of coastlines to waves and storms, as well as degrading environmental features important to the tourism industry (*high confidence*).[71]

The abundance of the coral species that build reefs is in rapid decline in many Pacific and South East Asian regions (*very high confidence)* and has decreased by over 80% on many Caribbean reefs.[72]

The importance of reef sensitivity to climate change was recently highlighted in the near-equatorial Indo Pacific, the area of greatest reef diversity in the world. A second highly diverse reef system at risk for warming and ocean acidification has been identified around Micronesia, Mariana Island and Papua New Guinea.[73] For many SIDS, increases in vulnerability due to the loss of such ecosystem services interact with physical impacts of climate change such as sea level rise.[74]

Future impacts of climate-related drivers, including ocean warming, acidification, sea level rise, as well as more intense tropical cyclones and rainfall events, will exacerbate the impacts of non-climate related drivers (*high confidence*). Even under a low-emissions scenario, one third of the world's coral reefs are projected to be subject to degradation in the next few decades. Under an intermediate low-emissions (RCP4.5) scenario, this fraction increases to two-thirds.[75]

Ocean acidification under intermediate low- and high-emissions scenarios (RCPs 4.5 and 6.0) will impact formation and maintenance of coral reefs (*high confidence)* and the goods and services that they provide such as fisheries, tourism and coastal protection.[76]

The annual economic damage of ocean-acidification-induced coral reef loss by the end of the century has been estimated, in 2009, to be US$528–870 billion , depending on the emissions scenario. Although this number is small compared to global Gross Domestic Product (GDP), it can represent a very large GDP loss for the economies of many coastal regions or small islands that rely on the ecological goods and services of coral reefs.[77]

Decreasing rainfall, increasing temperatures and sea-water intrusion threaten already stressed freshwater resources.[85]

Coastal and marine ecosystems and fisheries

Like coral reefs, mangroves and sea grass environments provide a range of ecosystem goods and services and both habits play a significant role in the wellbeing of small island communities. Mangroves, in particular, serve a host of commercial and subsistence uses as well as providing natural coastal protection from erosion and storm events.[78]

Sea level rise is reported as the most significant climate change threat to the survival of mangroves. For example, loss of the seaward edge of mangroves at Hungry Bay, Bermuda has been attributed to sea level rise and the inability of mangroves to tolerate increased water depth.[79] The response of seagrass to climate change is also complex, regionally variable and manifests itself in quite different ways. Temperature stress and reduction in light reaching the seagrass beds may be limiting factors.[80]

A possible 2°C temperature increase by the end of the century has potentially far-reaching consequences for ecosystems such as coral reefs that are important to tropical islands. Even warming in the future caused by the greenhouses gases already in the atmosphere could cause over half the world's coral reefs to experience harmful heat stress by 2080.[81]

Indeed, severe mass coral bleachings have been predicted to be likely to occur in 2074 in the Caribbean, 2088 in the western Indian Ocean, 2082 in the central Indian Ocean, 2065 in Micronesia, 2051 in the central Pacific, 2094 in Polynesia and 2073 in the eastern Pacific small islands regions. Under an intermediate low-emissions scenario (RCP4.5), this could be brought forward as early as 2030.[82]

In some cases, climate change impacts may be positive. For example, projected changes in tuna fisheries and freshwater aquaculture in the Pacific showed positive outcomes, with implications for government revenue and food security. However, these projected changes may favour large international fishing fleets that can shift operations over large distances compared to local, artisanal fishers.[83]

Terrestrial ecosystems

Climate change also impacts on terrestrial biodiversity on islands, frequently interacting with other drivers. Ecosystem and species shifts, decline in range and invasion of exotic and pest species have all been observed. These impacts are generally magnified on islands compared to continental areas due to their limited area and isolation and high level of endemic species. An example is the Mauritius kestrel, which has been affected by changing rainfall conditions over the past 50 years causing a mismatch between the timing of breeding and the abundance of food.[84]

Freshwater

Freshwater supplies in small islands have always presented challenges due to the topography and geology of islands and capacity to store water resources. Rapidly growing demand, land use change, urbanisation and tourism are already placing significant strain on limited freshwater resources e.g. in the Caribbean, and mismanagement has been an issue across SIDS. These issues occur on a backdrop of decreasing rainfall and increasing temperatures.[86]

The intrusion of sea water into fresh groundwater reserves is a risk associated with sea level rise, although there is insufficient evidence about the role of climate change in this effect. But the impacts of saline intrusion are serious, as exemplified by the storm surge on Pukapuka Atoll, Cook Islands in 2005, which caused freshwater to become brackish, taking 11 months to recover for human use. In Fongafale Island, Tuvalu, large areas of the island become inundated with brackish water during extreme high tides.[87]

Box 8: New themes for SIDS in the *Fifth Assessment Report*[88]

The following new themes have emerged for SIDS in the *Fifth Assessment Report:*

- First, the literature appears more sophisticated and does not shirk from dealing with the complexity of small island vulnerability, impacts and adaptation or the differences between islands and island states. In the *Fifth Assessment Report*, the IPCC attempts to strike a balance between identifying the differences between small islands as well as recognising that small islands tend to share a number of common characteristics that have distinguished them as a particular group in international affairs.
- Second, the literature deals with climate change in a multidimensional manner as just one of several stressors on small island nations.
- Third, the literature also critiques some aspects of climate change policy, notably in relation to critical present-day development and security needs of small islands as well as the possibility that some proposed adaptation measures may prove to be maladaptive (please see glossary for definition of maladaptation).
- Fourth, many initiatives have been identified in recent times that will reduce vulnerability and enhance the resilience of small islands to ongoing global change. These include improving risk knowledge and island resource management while also strengthening socio-economic systems and livelihoods.

Infrastructure, settlements and 'coastal squeeze'

Sea level rise poses one of the most widely recognised climate change threats to low-lying coastal areas, particularly in small islands where the majority of human communities and infrastructure is located in coastal zones and with limited island relocation opportunities, especially on atoll islands.[89]

Nowadays, the majority of settlement, infrastructure and development are located on lowlands along the coastal fringe of small islands. In the case of atoll islands, all development and settlement is essentially coastal. It follows then that populations, infrastructure, agricultural areas and fresh groundwater supplies are all vulnerable to extreme tides, wave and surge events and sea level rise.[90]

Population drift and rapid population growth in main centres is driving growing populations into ever more vulnerable locations. At the same time, without adequate resources and planning, engineering solutions such as shoreline reclamation also place communities and infrastructure in positions of increased risk.[91]

For example, on Majuro atoll, Republic of the Marshall Islands, rapid development and abandonment of traditional settlement patterns has resulted in movement from less vulnerable to more vulnerable locations on the island. Likewise, studies of Fongafale Island, capital of Tuvalu, show that engineering works during World War II and rapid development and population growth since independence have led to the settlement of inappropriate shoreline and swampland areas, leaving communities in heightened conditions of vulnerability.[92]

Ascribing direct climate change impacts in such disturbed environments is problematic due to the existing multiple stresses acting on the island's biophysical and social systems. However, it is clear that such pre-existing conditions of vulnerability add to the threat of climate change in such locations.[93]

Increased risk can also result from lack of awareness, particularly in communities in rural areas and outer islands or archipelagic countries such as Cook Islands, Fiji, Kiribati and Vanuatu, whose climate change knowledge often contrasts sharply with that of communities in major centres, where people tend to be better informed and have higher levels of awareness about the complex issues associated with climate change.[94]

The issue of 'coastal squeeze' remains a concern for many small islands as there is a constant struggle to manage the requirements for physical development against the need to maintain ecological balance. Martinique in the Caribbean is a case in point, where physical infrastructure prevents the beach and wetlands from retreating landward as a spontaneous adaptation response to increased rates of coastal erosion.[95]

For island communities, the risks associated with existing and future invasive species and human health challenges are projected to increase in a changing climate.[105]

Moreover, intensive coastal development in the limited coastal zone combined with population growth and tourism has placed great stress on the coast of some islands and has resulted in dense aggregations of infrastructure and people in potentially vulnerable locations.[96]

Box 9: How unsustainable development increases vulnerability to climate change on small islands

Island vulnerability depends on climatic factors but also socio-economic, physical and ecological stressors, and the interactions between them.[97] Socio-economic vulnerabilities are related to the challenges of managing urbanisation, pollution and sanitation, in Kiribati, for example.

Physical characteristics can create inherent vulnerabilities to seismic, landslide and tsunami risks. Ecological stresses, such as habitat loss and degradation, invasive species, pollution and overexploitation, can harm biodiversity and reduce the ability of ecosystems to bounce back after shocks. To understand climate vulnerability on islands, it is necessary to assess all of these dimensions of vulnerability. Islands faced with multiple stressors can be assumed to be at more risk from climate impacts.[98]

Public health

Many small island states currently suffer from climate-sensitive health problems, including morbidity and mortality from extreme weather events and certain vector-, food- and water-borne diseases. Extreme weather and climate events such as tropical cyclones, storm surges, flooding and drought can have both short- and long-term effects on human health, including drowning, injuries, increased disease transmission and health problems associated with deterioration of water quality and quantity.[99]

Tropical small island nations have weather conducive to the transmission of diseases such as malaria, dengue, filariasis and schistosomiasis. In Pacific islands the incidence of diseases such as malaria and dengue fever has been increasing, especially endemic dengue in Samoa, Tonga and Kiribati and a direct link between these diseases and climate variability has been established.[100]

Dengue incidence is also a major concern in Trinidad and Tobago, Cape Verde, Comoros and Mauritius. In Trinidad and Tobago, outbreaks have been significantly correlated with rainfall. Other health risks, such as cholera, are projected to increase as a consequence of climate change.[101]

It has been long established that human health on islands can be seriously compromised by lack of access to adequate, safe freshwater and nutrition. Many anticipated health effects in the Pacific, for example, are expected to be indirect, connected to the increased stress and declining well-being that comes with property damage, loss of economic livelihood and threatened communities.[102]

There is also a growing concern among island communities in the Caribbean, Pacific and Indian oceans, that freshwater scarcity, more intense droughts and storms could lead to a deterioration in standards of sanitation and hygiene. In such circumstances, increased exposure to a range of health risks including communicable diseases would be a distinct possibility.[103]

There is increasing recognition of the risks to small islands from climate-related processes originating well beyond the borders of an individual nation or island. Such trans-boundary processes already have a negative impact on small islands (*high confidence),* including airborne dust from the Sahara and Asia, distant-source ocean swells from mid-high latitudes, invasive plant and animal species and the spread of aquatic pathogens.[104]

Climate change threatens livelihoods, coastal settlements, infrastructure, ecosystem services and the economic stability of SIDS.[113]

Climate change poses an existential threat to some SIDS

The IPCC suggests that the very existence of some atoll nations is threatened by rising sea levels associated with global warming.[106] Owing to higher projections of sea level rise in the *Fifth Assessment Report,* the risk of partial inundation of small island states has increased.[107]

Whilst scenarios are not applicable to all small island nations, the IPCC finds that there is no doubt that, on the whole, the impacts of climate change on small islands will have serious negative effects, especially on socio-economic conditions and bio-physical resources.[108]

Islands face risks from both climate-related hazards that have occurred for centuries, as well as new risks from climate change. Projections of future climate change risks are limited by the capacity to model climatic variables that matter to small islands, such as tropical cyclone frequency and intensity, wind speed and direction, rainfall, sea level, ocean temperature and ocean acidification.[109]

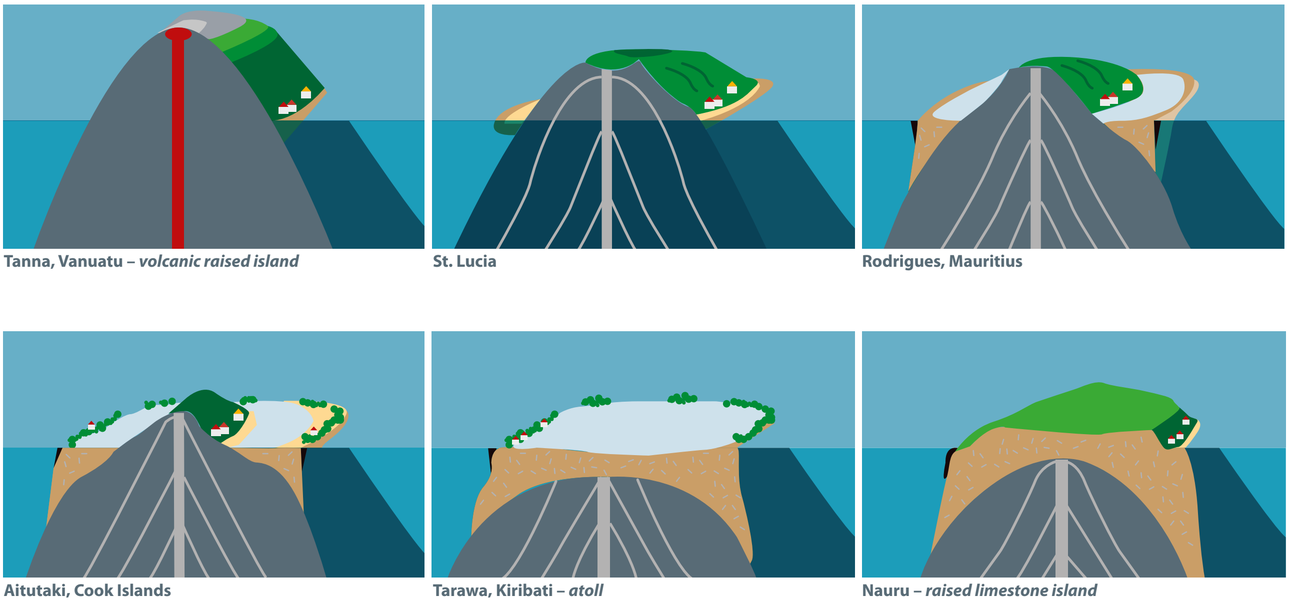
A lack of long term monitoring of baseline conditions is also a constraint when trying to understand risks from saline intrusion, invasive species, biodiversity or large ocean waves, for instance. Thus, while change is occurring, it is not easy to quantify the probability, speed, scale or distribution of future climate risks.[110]

Also, differences in exposure to climate hazards vary among islands, depending on their physical form (see Table 4, Figure 4). The culture, ecosystems, populations and hence vulnerabilities are different for each island. It is therefore critical to understand the context-specific conditions for each island when considering risks.[111]

Table 4: Type of island in the Pacific region and implications for hazard[112]

Island type and size	Example	Island elevation, slope and rainfall	Implications for hazard
Continental – large, high biodiversity, well developed soils.	Papua New Guinea	High elevations, river flood plains, rainfall created over mountain ranges.	River flooding more likely to be a problem than in other islands. High elevations expose areas to frost (extreme during El Niño).
Volcanic high islands – relatively small land area barrier reefs, different stages of erosion.	Tanna, Vanuatu	Steep slopes, less well developed river systems, rainfall created over mountain ranges.	Because of size, few areas are not exposed to tropical cyclones. Streams and rivers subject to flash flooding. Barrier reefs may ameliorate storm surge.
Atolls – very small land area, small islets surround a lagoon, larger islets on windward side, shore platforms on windward side, no or minimal soil.	Tarawa, Kiribati	Very low elevations, convectional rainfall, no surface freshwater, freshwater layer resting on salt sea water.	Exposed to storm surge, 'king' tides and high waves. Narrow resource base. Exposed to fresh water shortages and drought. Water problems may lead to health hazards.
Raised limestone islands – concave inner basin, narrow coastal plains, no or minimal soil.	Nauru	Steep outer slopes, sharp topography, no surface water.	Depending on height may be exposed to storm surge. Exposed to fresh water shortages and drought. Water problems may lead to health hazards.

Figure 4: Representative tropical island typologies



Nevertheless, in spite of these uncertainties, the IPCC does find with *high confidence* a set of key risks facing SIDS. These include loss of livelihoods, coastal settlements, infrastructure, ecosystem services and economic stability, driven by extreme rainfall, damaging cyclones, sea level rise, ocean acidification and drying trends. Currently, this risk is judged to be low, rising to medium in the near term (2030–2040). But in the long term (2080–2100), under a 2°C or 4°C world, the risk level could be high or very high respectively.[114]

The other key risk is the interaction of rising global sea level rise with high water level events, such as cyclones, which will threaten low-lying coastal areas. Currently, this risk is medium, rising to high in the near term. But again, in the long term, risk level will be very high in a 2°C or 4°C world.[115]

Due to sea level rise projected throughout the 21st century and beyond, coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding and coastal erosion (*very high confidence*).[116]

Some small island states are expected to face very high impacts that in some cases could have associated damages and adaptation costs of several percentage points of Gross Domestic Product (GDP).[117] With 4°C warming, sea level rise of between 0.5 to 2.0 metres has been projected, which could lead to the displacement of between 1.2 and 2.2. million people from the Caribbean, Indian Ocean and Pacific Ocean.[118]

In conjunction with storm surges and flooding, this creates a threat of temporary and eventually permanent displacement from low-lying coastal areas in SIDS. The distance and permanence of the displacement will depend on whether governments develop strategies such as relocating people from highly vulnerable to less vulnerable areas nearby, and conserving ecosystem services which provide storm surge protection in addition to 'hard' solutions including building sea walls and surge barriers.[119]

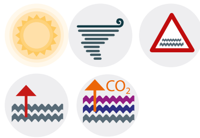
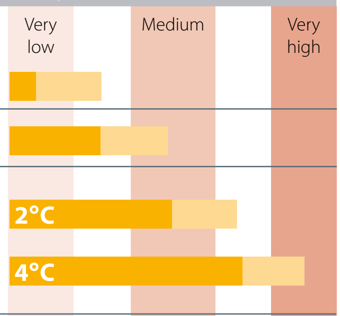
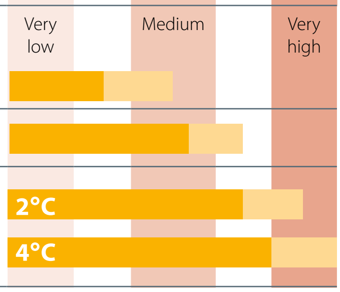
The impacts of climate change on the critical infrastructure and territorial integrity of many states are expected to influence national security policies (*medium evidence, medium agreement*). For example, land inundation due to sea level rise poses risks to the territorial integrity of small-island states with extensive coastlines.[120]

Some trans-boundary impacts of climate change, such as shared water resources, pelagic fish stocks, have the potential to increase rivalry among states, but robust national and intergovernmental institutions can enhance cooperation and manage many of these rivalries.[121]

The most extreme form of erosion of natural assets is the complete disappearance of people's land on islands and in coastal regions, exacerbating livelihood risks due to loss of economic and social assets. Small island states may become uninhabitable.[122]

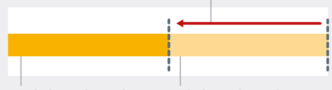
Some climate change projections indicate the possibility of large impacts that may exceed thresholds of detrimental shocks to livelihoods and poverty, unless strong adaptation and/or mitigation responses are implemented in a timely manner. Relocation would represent a critical threshold for indigenous groups, due to sea level rise, for the Torres Strait Islanders between Australia and Papua New Guinea.[123]

Figure 5: Adaptation can reduce risk[124]

Key risk	Adaptation issues and prospects	Climate factors	Time frame	Risk and potential for adaptation
Loss of livelihoods, coastal settlements, infrastructure, ecosystem services, and economic stability *(high confidence)*	• Significant potential exists for adaptation in islands, but additional external resources and technologies will enhance response • Maintenance and enhancement of ecosystem functions and services and of water and food security • Efficacy of traditional community coping strategies is expected to be substantially reduced in the future		Present Near-term (2030–2040) Long-term (2080–2100)	
The interaction of rising global mean sea level in the 21st century with high-water-level events will threaten low-lying coastal areas *(high confidence)*	• High ratio of coastal area to land mass will make adaptation a significant financial and resource challenge for islands • Adaptation options include maintenance and restoration of coastal landforms and ecosystems, improved management of soils and freshwater resources, and appropriate building codes and settlement patterns		Present Near-term (2030–2040) Long-term (2080–2100)	

Climatic factors

Level of risk and potential for adaption



Adaptation can reduce the short-term impacts of climate change, but there are limits and risks involved

Adaptation is the only effective option to manage the impending impacts of climate change that mitigation cannot reduce.[125] The IPCC describes adaptation as "the process of adjustment to actual or expected climate and its effects".[126] Through adaptation, societies and communities can seek to moderate the harm of current and future climate risks or to take advantage of new opportunities.

Adaptation can reduce the risks posed to livelihoods, infrastructure, ecosystem services and economic stability (see Figure 5). For example, restoration of coastal landforms and ecosystems can reduce the risks of sea level rise. The IPCC emphasises that integrating adaptation into planning and decision-making can create many synergies with development (Table 5).

Effective adaptation strategies can, and should, strengthen livelihoods, enhance wellbeing and human security, and reduce poverty today. 'No regrets' or 'low regrets' measures such as safe housing and settlement structures and improved access to education are good for development, irrespective of changes in climate (Table 5).

There are many ways in which climate change adaptation can be undertaken in SIDS, by reducing socio-economic vulnerabilities, building capacities to adapt, enhancing disaster risk reduction, or building longer term resilience to climate change.[127]

Table 5: Action on climate change adaptation can bolster development[128]

Overlapping approaches	Category	Examples
Vulnerability and exposure reduction through development, planning and practices including many low regrets measures; **Adaptation including incremental and transformational adjustments**; **Transformation**	Human development	Improved access to education, nutrition, health facilities, energy, safe housing and settlement structures, and social support structures; reduced gender inequality and marginalisation in other forms.
	Poverty alleviation	Improved access to and control of local resources; disaster risk reduction; social safety nets and social protection; insurance schemes.
	Livelihood security	Income, asset, and livelihood diversification; improved infrastructure; access to technology and decision-making fora; increased decision-making power; changed aquaculture practices; reliance on social networks.
	Disaster risk management	Early warning systems; hazard and vulnerability mapping; diversifying water resources; improved drainage; flood and cyclone shelters; building codes and practices; storm and wastewater management; transport and road infrastructure improvements.
	Ecosystem management	Maintaining wetlands; coastal afforestation; watershed management; reduction of other stressors on ecosystems and community-based natural resource management.
	Spatial or land-use planning	Provisioning of adequate, housing, infrastructure and services; managing development in flood-prone and other high risk areas; urban planning and upgrading programmes; protected areas.
	Structural/physical	Engineered and built environment options: sea walls and coastal protection structures; flood levees; water storage; improved drainage; flood and cyclone shelters; building codes and practices; storm and wastewater management; transport and road infrastructure improvements; floating houses.
		Technological options: indigenous, traditional and local knowledge, technologies, and methods; water-saving technologies; desalinisation; food storage and preservation facilities; hazard and vulnerability mapping and monitoring; early warning systems; technology development, transfer and diffusion.
		Ecosystem-based options: ecological restoration; soil conservation; afforestation and reforestation; mangrove conservation and replanting; controlling overfishing; fisheries co-management; community-based natural resource management.
		Services: social safety nets and social protection; food banks and distribution of food surplus; municipal services including water and sanitation; vaccination programmes; essential public services; enhanced emergency medical services.
	Institutional	Economic options: financial incentives; insurance; catastrophe bonds; payments for ecosystem services; pricing water to encourage universal provision and careful use; microfinance; disaster contingency funds; cash transfers; public-private partnerships.
		Laws and regulations: building standards and practices; water regulations and agreements; laws to support disaster risk reduction; laws to encourage insurance purchasing; protected areas; fishing quotas.
		National and government policies and programmes: national and regional adaptation plans including mainstreaming; sub-national and local adaptation plans; economic diversification; urban upgrading programmes; disaster planning and preparedness; integrated water resource management; integrated coastal zone management; ecosystem-based management; community-based adaptation.
	Social	Educational options: awareness raising and integration into education; gender equity in education; extension services; sharing indigenous, traditional and local knowledge; participatory action research and social learning; knowledge-sharing and learning platforms.
		Informational options: hazard and vulnerability mapping; early warning and response systems; systematic monitoring and remote sensing; climate services; use of indigenous climate observations; participatory scenario development; integrated assessments.
		Behavioural options: household preparation and evacuation planning; migration; soil and water conservation; storm drain clearance; livelihood diversification; changed aquaculture practices; reliance on social networks.
	Spheres of change	Practical: social and technical innovations, behavioural shifts, or institutional and managerial changes that produce substantial shifts in outcomes.
		Political: political, social, cultural, and ecological decision and actions consistent with reducing vulnerability and risk and supporting adaptation, mitigation and sustainable development.
		Personal: individual and collective assumptions, beliefs, values, and worldviews influencing climate change responses.

Small islands do not have uniform climate risk profiles (*high confidence*)[129] and not all adaptations are equally appropriate in all contexts.[130]

Community cohesion, effective leadership and community buy-in can drive successful community adaptation.

The high diversity of small islands in both physical and human attributes, and their response to climate-related drivers means that climate change impacts, vulnerability and adaptation will be variable from one island region to another and among countries in the same region.[131]

On small islands where resources are often limited, recognising the starting point for action is critical to maximising benefits from adaptation.[132] In the past, this diversity in potential response has not always been adequately integrated into adaptation planning.[133]

Traditional knowledge, technologies and skills

Traditional knowledge, technologies and skills have proven to be useful in short-term weather forecasting and disaster risk management. Traditional actions to maintain food security, such as production and storage of food surpluses, maintaining agricultural diversity and growth of famine crops, have been shown to work effectively in the Solomon Islands and Marshall Islands, for example.[134]

Traditional construction methods, such as elevated floors, use of aerodynamic roofing materials and wind-proofed designs have long been identified as means of reducing vulnerability to tropical cyclones and flooding in Pacific SIDS, for example.[135]

However, while there is clear evidence that traditional knowledge networks, technologies and skills can be used effectively to support adaptation in certain contexts, the limits to these tools are not well understood.[136]

Rising risks of loss and damage

Addressing rising risks of damage and associated losses is important for SIDS where effects are disproportionate. Insurance markets has had limited uptake in small islands, as insurance markers do not function as effectively as they do in larger locations, in part due to a small demand for the insurance products, as has been the case in Grenada, Jamaica, Fiji and Vanuatu.[137]

There is potential for index-based insurance schemes that pay out based on rainfall, for example. The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is one such scheme operating since 2007 and the potential for similar schemes in the Pacific is being explored.[138]

Risk can be spread through social networks. In Fiji, after Tropical Cyclone Ami in 2003, households whose homes were not affected increased their fishing effort to support those whose homes were damaged. Changing resource management approach, e.g. establishing marine protected areas to protect habitats and fisheries, can also spread risk.[139]

Avoiding risks through engineered structures has reduced rainfall-driven landslides in Jamaica, for example. Engineering principles to reduce residential damage from hurricanes have been identified, tested, and recommended for decades in the Caribbean. Beach nourishment is increasingly being recommended to reduce erosion risk and support tourism in the Caribbean and western Indian Ocean. However, some island states lack the technical or financial capacity to achieve this.[140]

Community-based adaptation

Community-based adaptation has been shown to generate larger benefits when delivered in conjunction with other development activities.[141] Recent moves towards participatory approaches that link scientific knowledge with local visions of vulnerability offer an important way forward to understanding island vulnerability in the absence of certainty in model-based scenarios.[142]

Collaboration among stakeholders can lessen the occurrence of simple mistakes that can reduce the effectiveness of adaptation actions. Evidence from the Eastern Caribbean suggests that adaptation actions taken by individual households (e.g. building retaining walls) to reduce landslide risk can be ineffective compared to community level responses (e.g. better hillside drainage). In Fiji and Samoa, participatory approaches have been used to help enhance resilience of local residents to the adverse impacts of disasters and climate change.[143]

In Solomon Islands, community cohesion, effective leadership and community buy-in to collective action have been shown to drive successful community adaptation. But buy-in from local and municipal governments is also critical to support community-based disaster risk reduction. Strong local networks and trusting relationships between communities and government appear to be key elements in adaptation, in terms of maintaining sustainable agriculture and in disaster risk reduction.[144]

Limits to adaptation

Barriers to climate adaptation include inadequate access to financial, technological and human resources, issues related to cultural and social acceptability of measures, constraints imposed by the existing political and legal framework, the emphasis on island development as opposed to sustainability, and a preference for 'hard' adaptation measures such as sea walls, instead of 'soft' measures like beach nourishment.[145]

More diversified economies have more robust responses to climate stress, yet most small islands, particularly developing ones, lack economies of scale in production, thus specialise in niche markets and developing monocultures (e.g. bananas or sugar). Due to the peculiarities of islands, in their difference to mainland locations and in their diversity, and due to the limitations of climate models, there are comparatively few assessments of social vulnerability to climate change, adaptation potential or resilience for island communities.[146]

Some limits are 'hard' or time insensitive in that there is no known process to change them. Examples of hard limits include water supply in fossil aquifers, limits to retreat on islands and loss of genetic diversity. Small island states are limited in their ability to adapt to increasing impacts of sea level rise, due to their specific geographies.[147]

While significant potential exists for adaptation in SIDS, effective adaptation will require additional external resources and technologies.[148]

Lack of access to adequate financial, technological and human resources are often cited as the most critical constraints, but experience has shown that factors such as culture, ethics, knowledge and attitudes to risk can be important barriers to adaptation.[149]

For example, the perceived encroachment of new infiltration developments onto traditional land in Kiribati hindered efforts to augment freshwater supplies on Tarawa atoll. The word 'climate' translated into Marshallese implies cosmos, nature and culture as well as weather and climate. Such cultural misunderstandings can create both barriers to action but also novel ways of engaging with climate change.[150]

Lack of knowledge, awareness and understanding of climate change can act as an effective barrier to the implementation and ultimate success of adaptation programmes, critically so in SIDS. This is borne out in Fiji and Kiribati where spiritual beliefs, traditional governance mechanisms and a short-term approach to planning were barriers to community engagement.[151]

Opportunities for effective adaptation can be found by, for example, empowering communities and optimising the benefits of local practices that have proven to be effective through time, and working synergistically to progress development agendas.[152]

'Maladaptation' as a risk in SIDS[153]

As in other regions, adaptation in islands is locally delivered and context specific. Yet, sectors and communities on small islands are often so intricately linked that there are many potential pathways that may lead to maladaptation, be it via increased greenhouse gas emissions, foreclosure of future options or burdensome opportunity costs on local communities.

There is also a concern that some types of interventions may actually be 'maladaptive', and lead to adverse outcomes or increased vulnerabilities now or in the future (see Box 10).

For example, resettlement and migration should be regarded as a last resort on islands, as they may actually discourage viable adaptation initiatives, by fostering over-dependence on external support. Acceptance of adaptation as an effective option for places like the Pacific islands, may also act as a disincentive for reducing greenhouse gas emissions.

Box 10: Avoiding 'maladaptation'[154]

Maladaptation is where an intervention in one location or sector could increase the vulnerability of another location or sector, or increase the vulnerability of the intended beneficiaries to future climate change. Maladaptation is a cause of increasing concern to adaptation planners and the definition used in the *Fifth Assessment Report* has changed to recognise that maladaptation arises not only from inadvertent, badly planned adaptation actions, but also from deliberate decisions. For instance, where wider considerations place greater emphasis on short-term outcomes ahead of longer-term threats, or decision-makers fail to consider the full range of interactions arising from planned actions.

In SIDS, adaptation action runs the risk of adverse outcomes and increasing vulnerabilities so it must be carefully planned.

Role of insurance

Insurance is being promoted as an element of the overall climate change response strategy in some island regions, e.g. the Caribbean, but concerns have been expressed about possible linkages to maladaptation.[155]

The potential consequences include the imposition of exorbitant premiums that are beyond the capacity of resource-scarce governments, as the perception of climate change risks increase, discriminatory coverage of sectors that may not align with local priorities, and tacit encouragement for the state, individual and the private sector to engage in behaviour that is not risk averse.

Consultation processes in bolstering climate resilience

There are opportunities for avoiding maladaptation. For example, decisions about adaptation choices and their implementation are best facilitated where there is constructive engagement with the communities at risk, in a manner that fosters transparency and trust.

Further, adaptation choices are arguably often subjective in nature, and participatory stakeholder involvement can yield valuable information about the priorities and expectation that communities attach to the sector for which adaptation is being sought.

For example, explicitly integrating stakeholders into each step of the process from vulnerability assessment right through to consideration of alternatives measures can provide a sound basis for assisting destinations with the implementation of appropriate adaptation interventions in the tourism sector in Mamanuca islands, Fiji. Vulnerable groups – the poor, elderly, indigenous communities and rural children – may be at greater risk of being marginalised if adaptation is not informed by equitable and participatory frameworks.

Sound adaptation action is emerging across various sectors in island communities. For example, in the area of natural resource management, adoption of adaptive management approaches combined with reduction of greenhouse gas emissions wherever possible may prove to be effective.

Other strategic approaches, including the implementation of multi-sectoral and cross-sectoral measures, also facilitate adaptation in a more equitable, integrated and sustainable manner. Similarly, 'no regrets' measures such as wastewater recycling, trickle irrigation, conversion to non-fossil fuel based energy and transportation which offer collateral benefits with or without the threat of climate change, and 'low regrets' strategies, which may only increase existing operational costs marginally, are becoming increasingly attractive options to island governments.

Together, these constitute valid risk management approaches, as they are designed to assist communities in making prudent, but necessary decisions in the face of an uncertain future.

A concern is that new money being made available for climate change research, policy development and practice, people may place too much emphasis on addressing climate change as an isolated priority to the detriment of other equally pressing social, economic and environmental issues. For example, in small islands, there are concerns that placing adaptation above the critical development needs of the present could inadvertently reduce resilience.[156]

Migration as a long-term adaptation option

Addressing long term climate impacts and migration is a considerable challenge, not least because the cultural, social, and historical ties communities have to their land make the decision to migrate very difficult. There also remains limited evidence as to which regions will experience the largest sea level rise and worst climate impacts. Due to the high costs of adapting on islands, it has been suggested that there will be a need for migration.[157] However, sensitivity needs to be taken to avoid short-term risks, such as depopulation and island abandonment associated with a loss of confidence in an island's future.

Evidence from past migrations due to environmental stress, e.g. in the Caribbean and Cartaret Islands, Papua New Guinea, suggests that under extreme conditions, island communities may consider relocating in the future.[158] In reality, financial and legal barriers are expected to inhibit large-scale migration as an adaptation strategy.

In adapting to poverty, young fishers in the Rodrigues Island periodically resort to temporary migration to the main capital island, Mauritius, where greater employment prospects exist. In the 1950s, residents of Nauru contemplated resettlement in Australia after the collapse of phosphate mining, their only source of revenue. Due to the complex social, economic and cultural challenges associated with environmentally triggered migration, Naurans opted to abandon the proposal to relocate.

Beyond the *Fifth Assessment Report* Building climate resilience: the case of Grenada[159]

Grenada is a Small Island Developing State (SIDS) consisting of three islands: Grenada, Carriacou and Petit Martinique. Historically the country has not been susceptible to the impacts of hurricanes and other extreme weather events, but this has changed drastically in recent years. In September 2004, the country sustained severe damage when it was devastated by Hurricane Ivan, and was further ravaged by Hurricane Emily only 10 months later. It has also been affected by recent storm surges, tropical depressions, flooding and landslides, all leaving trails of destruction in their wake, including considerable damage to roads and other physical infrastructure.

Lacking sufficient resources of its own, it relies heavily on multilateral finance and technical support to design and deliver major climate compatible development policies. Its Strategic Program for Climate Resilience (SPCR) seeks to set the country on a path to mainstream low-carbon and climate resilient poverty reduction and sustainable development, through multilateral finance and technical support. As a relatively low greenhouse gas emitter, Grenada has placed the primary emphasis of its SPCR on climate resilience, while contributing to emission reductions in the forestry sector. This is the first national strategy developed under the Pilot Program for Climate Change Resilience, a donor-funded initiative for Caribbean states.

A study of Grenada's pilot phase of the SPCR found that in SIDS and other developing countries that have high vulnerability to rising sea levels and relatively low potential for emissions reductions, resilience should be the primary focus of climate change responses, while still addressing greenhouse gas limitations through key sectors, such as forestry. A comprehensive approach to reducing climate risk and disaster vulnerability, together with broad-based projects that may be integrated into existing laws, policies, strategies and institutions, are likely to work better than a piecemeal project-by-project approach. While there is still a long way to go, the SPCR signifies a first step towards pursuing an overall climate compatible development strategy for the country.

Synergies with regional programming have proven important: CDKN and the UK's Department for International Development have partnered with the Caribbean Community Climate Change Centre to develop a detailed Implementation Plan for the Regional

Image: Alex Smailes, Panos Pictures | The aftermath of Hurricane Ivan, Grenada

Framework for Achieving Development Resilient to Climate Change. All CARICOM heads of state, including Grenada, endorsed the Implementation Plan in early 2012. To date, the regional and national tracks have advanced in parallel, and there is an opportunity to integrate them further. Additionally, the SPCR specifically recognises the CARICOM Implementation Plan and seeks collaboration to identify synergies and reduce duplications.

The Climate Investment Funds have already addressed some of Grenada's finance challenges by supplementing domestic funds. Funding for other initiatives is limited, but the provision of technical assistance under the SPCR may help attract international or private finance.

Overall however, it is suggested that states contemplating long term, off-island migration may wish to consider early proactive planning as resettlement of entire communities might prove to be socially, culturally and economically disruptive. A related challenge facing small islands is the need to find the middle ground between resettlement and objective assessment of other appropriate adaptation choices.

Image: iStock | A man throws a fishing net during sunset, Fiji

The economic cost of adaptation to climate change is high in SIDS relative to the size of their economies

The IPCC finds that small island economies can be at greater risk from sea level rise in comparison to other geographic areas since most of their population and infrastructure are in the coastal zone. Models show the costs of sea level rise impacts as a percentage of GDP to be highest for the small islands from the Pacific (Federated States of Micronesia, Palau, Marshall Islands, Nauru) and Caribbean (Bahamas).[160]

The damage costs for these small islands is enormous in relation to the size of their economies and, together with deltaic areas, they will find it most difficult to locally raise the finances necessary to implement adequate coastal protection.[161]

Cost of adaptation to climate change is high in small island states. This is because adaptation to climate change that involved infrastructural works generally require large up-front overhead costs, which in the case of small islands cannot be easily downscaled in proportion to the size of the population or territory.[162]

This is a major socio-economic reality that confronts many SIDS, notwithstanding the benefits that could accrue to island communities through adaptation. Referred to as 'indivisibility' in economics, the problem can be illustrated by the cost of shore protection works aimed at reducing the impact of sea level rise. The unit cost of shoreline protection per capita in small islands is substantially higher than the unit cost for a similar structure in a larger territory with a larger population.[163]

This reality of scale applies throughout much of a small island economy including the indivisibility of public utilities, services and all forms of development. Moreover, the relative impact of an extreme event such as a tropical cyclone that can affect most of a small island's territory has a disproportionate impact on that state's GDP, compared to a larger country where an individual event generally affects a small proportion of its total territory and it's GDP.[164]

The result is relatively higher adaptation and disaster risk reduction costs per capita in countries with small populations and small areas, especially those that are already geographically isolated, have a poor resource base and high transport costs.[165]

Adaptation and mitigation on small islands are not always trade-offs, but can be regarded as complementary components in the response to climate change (*medium confidence*).

SIDS stand to benefit from further integration of climate adaptation, mitigation and development approaches

Adaptation to climate change generates larger benefits to small islands when delivered in conjunction with other development activities, such as disaster risk reduction and community-based approaches to development (*medium confidence*).[166]

Addressing the critical social, economic and environmental issues of the day, raising awareness and communicating future risks to local communities will likely increase human and environmental resilience to the longer-term impacts of climate change.[167]

There is growing evidence about the benefits and possibilities of mainstreaming or integrating climate change policies in development plans. Various mechanisms through which development agencies as well as donor and recipient countries can seek to capitalise on the opportunities to mainstream are beginning to emerge.[168]

For example, in Fiji and elsewhere, synergies and trade-offs can be found in integrating climate change adaptation into development cooperation activities around disaster risk reduction, community-based approaches to development and building capacity.[169]

Although there are synergies and benefits to be derived from the integration of climate change and development policies, care is needed to avoid institutional overlaps, and differences in language and approach which can give rise to conflict.[170]

Overall, there appears to be an emerging consensus that climate change and development strategies should be considered to be complementary, and that some elements such as land and water management and urban, peri-urban and rural planning provide important adaptation, development and mitigation opportunities.[171]

While the potential to deliver such an integrated approach may be reasonably strong in urban centres on islands, there appears to be limited capacity to mainstream climate change adaptation into local decision-making in out-lying islands or peripheral areas.[172]

If this approach is not purposefully incorporated into the implementation process, it is possible that maladaptation and inappropriate mitigation may result. It is therefore necessary to carefully assess the risk profile of each individual island so as to ensure that any investments in adaptation and mitigation are context-specific. The varying risk profiles between individual small islands and small island regions have not always been adequately acknowledged in the past.

Examples of adaptation-mitigation inter-linkages in small islands include energy supply and use, tourism infrastructure and activities, and functions and services associated with coastal wetlands. The alignment of these sectors for potential emission reductions together with adaptation, offer co-benefits and opportunities in some small islands.[173]

Making the most of mitigation-adaptation synergies in the energy sector

The exploitation of renewable energy is vital to the sustainable development of small islands, although more attention is needs to be paid to the development of energy storage technologies, if rapid transition from conventional fuels is to be achieved in an efficient manner. This is especially important in the case of intermittent energy sources (e.g. solar and wind), as the cost of current storage technologies can frustrate achievement of full conversion to renewable energy. Thus to avoid the possibility of maladaptation in the sector, countries may wish to engage in comprehensive planning, including considerations relating to energy storage.

Sharing learning among island nations

Lessons learned from adaptation and mitigation experiences in one island may offer some guidance to other small island states, though there is low confidence in the success of wholesale transfer of adaptation and mitigation options when the local lenses through which they are viewed differ from one island state to the next, given the diverse cultural, socio-economic, ecological and political values.[174]

While lessons learned from adaptation and mitigation experiences in one island or island region may offer some guidance, caution must be exercised to ensure that transfer of such experiences is appropriate to local biophysical, social, economic, political and cultural contexts.[175]

Beyond the *Fifth Assessment Report*: Going after adaptation co-benefits – a REDD+ programme in Fiji[176]

Image: iStock | Bay of Botaira Island Beach, Yasawa Group, Fiji

Climate change adaptation is a policy priority for Pacific Island Countries (PICs). A CDKN-supported study focused on Fiji found it is difficult for smaller PICs to justify the costs of developing 'readiness' to participate in international mitigation mechanisms. However, while Reduced Emissions from Deforestation and Degradation (REDD+) is often considered primarily as a mitigation mechanism; this study found that it can also help build countries' resilience to the effects of climate change. REDD+ may provide financial and other benefits that strongly support climate compatible development – thereby justifying the high costs of achieving 'REDD+ readiness'.

Forest conservation in PICs can be viewed as a climate change adaptation effort, supported by both adaptation and mitigation funding channels and technical expertise. This dual role of forests is being recognised in REDD+ initiatives at the national and regional scale in the Pacific. Most REDD+ stories that make the headlines are about countries with very large threatened forests. But while the scale of carbon savings will be small in most PICs, a well-structured REDD+ programme can provide finance and other ancillary benefits that are highly meaningful to climate compatible development. With funding and technical support from the international community, even small countries can make significant progress in creating policies and strategies for REDD+.

The international support available for REDD+ means that finance for readiness and eventual REDD+ activities can also contribute to a range of sustainable land management priorities, such as watershed protection, flood mitigation, water security, drought mitigation, mitigating land degradation, coastal forest management (including the protection and enhancement of mangroves) and biodiversity conservation. Seen in this light, the high costs of developing REDD+ readiness can become justifiable for more developing countries and donor agencies.

Good process is key to policy adoption and strategy development. REDD+ initiatives across the globe have shown the importance of multi-stakeholder consultation. This must not be rushed or exclude important parts of the community. REDD+ programmes in Fiji and other PICs point to the need for structured consultations that are inclusive from the outset, when countries must grapple with the tough issues like who owns the forests, what tenure systems exist, how secure is the tenure of households that depend on the forests, and how will benefits be shared. Resolving such issues will be the acid test of Fiji's process.

International support plays a crucial role. In the case of these REDD+ initiatives in the Pacific, GIZ and SPC have helped to fund effective multi-stakeholder processes that provide clear mandates for moving this sector forward at a pace in line with the needs, interests and capabilities of participating countries. Including international experts has accelerated progress on technically and politically complex issues.

The Pacific example can act as a model to other countries. The national circumstances of PICs may be unique. However, many other developing countries that are at an earlier stage of their REDD+ thinking and readiness efforts may find PICs' experience illuminating. In particular, the framing of the elements of a REDD+ programme's policies and strategies, and the use of multi-stakeholder process to develop the initial texts can serve as examples to build upon.

In the absence of significant mitigation efforts globally, adaptation interventions could become very costly and difficult to implement.[179]

Transformation to a low-carbon economy implies new patterns of investment

Potential for low-carbon development

Overall, the potential for mitigation and emissions reductions in SIDS depends to a large extent on their size and stage of economic development. In the small and less developed islands, key mitigation sectors including energy, transport, industry, built environment, agriculture, forestry or waste management, are generally relatively small.[177]

Hence, opportunities for emissions reductions are usually quite limited and are mostly associated with electricity generation and utilisation of vehicles. More mitigation opportunities should exist in more economically advanced and larger islands that rely on forms of production that utilise fossil fuels, including manufacturing, and where vehicle usage is extensive and electricity driven home appliances, such as air conditioners, are used more extensively.[178]

Linkages with energy security

Renewable energy resources on small islands have only recently been considered within the context of long-term energy security. The lack of uptake of renewables to date might be due to historical commitments to fossil fuel-based infrastructure, and a lack of resources to undertake research and development of alternatives.[180]

Those islands that have introduced renewable energy technologies have often done so with support from international development agencies. But significant barriers remain. Potential benefits exist in creating the opportunity for Energy Service Companies, which enter into medium-to-long term, performance-based contracts with energy users, in small islands.[181]

Evidence from Fiji suggests that if incentive mechanisms can be resolved, and information shared between service providers and users, Energy Service Companies could provide an opportunity to expand renewable technologies. In its *Special Report on Renewable Energy Sources and Climate Change Mitigation published in 2011*,[182] the IPCC presents examples of opportunities for renewable energy.

The transition towards renewable energy sources and away from fossil fuel dependence has been partly driven by economic motives, for instance, to avoid oil price shocks. The development of hydro-power in Fiji, for example, promotes protection and management of the water catchment zones, and thus could lead to improved management of water resources.[183]

This is a critical adaptation concern for areas expected to see a decrease in average rainfall due to climate change. Whilst the cost effectiveness of renewable technologies is critical, appraising them in the context of water availability could enhance project viability.[184]

Energy prices in small islands are among the highest anywhere in the world, mainly due to their dependence on imported fossil fuel, and limited ability to reap the benefits of economies of scale including bulk buying. Energy sectors in small islands may be transformed into sustainable growth entities mainly through sensible exploitation of renewable energy sources, combined with implementation of energy efficiency measures.[185]

Realising the potential for such transformation, the countries comprising the Alliance of Small Island States (AOSIS) launched SIDS Dock. This is intended to function as a 'docking station' to connect the energy sector in SIDS with the international finance, technology and carbon markets to pool and optimise energy efficiency goods and services for the benefit of the group. This initiative seeks to decrease energy dependence in SIDS, while generating financial resources to support low-carbon growth and adaptation interventions.[186]

Energy sectors in small islands may be transformed through exploitation of renewable energy sources combined with implementation of energy efficiency measures.

Beyond the *Fifth Assessment Report*: Solar water heating: The case of Barbados[187]

For the Caribbean SIDS, renewable energy technologies will become increasingly important in the face of high fossil fuel costs. Many countries now recognise the need to move towards low-carbon, climate-resilient economies, as set out in the Caribbean Community (CARICOM) implementation plan for climate change-resilient development. Many nations rely heavily on imported fossil fuels, spending an ever-larger proportion of their GDP on energy imports. Along with air conditioning, refrigeration and transportation, water heating is one of the most energy-intensive domestic activities, using roughly 2 megawatt-hours (MWh) of energy per household per year. Fortunately, the islands have access to one source of energy that is not in short supply, receiving over 3,000 hours of sunshine in a year. Barbados has capitalised on this, replacing gas and electric water heaters with solar water heaters (SWHs) at both domestic and commercial sites.

The SWH industry in Barbados has been very successful. It boasts over 50,000 installations that have saved consumers as much as US$137 million since the early 1970s. Governments must create a framework to support the development of SWHs and ensure long-term fiscal and regulatory certainty for manufacturers and customers. Fiscal incentives are good value: government support for the Barbados SWH industry was approximately US$550,000 in 2002. Estimates suggest SWHs save consumers between US$11.5 and US$16 million per year.

Governments can play a major role in establishing a commercial market by installing SWHs on public buildings and social housing. Persuasive champions who are able to speak to communities, together with effective marketing strategies, are vital for consumer acceptance of the technology. Public recognition of the personal, financial and quality of life benefits of SWHs provides a springboard to acceptance of other renewable energy technology programmes. The Barbados experience could be easily replicated in other countries with high fossil fuel imports and abundant sunshine.


Image: Kate Shifman | Barbados, Solar Water Heater

Sustainable tourism as a potential growth area

Many small islands rely heavily on the foreign exchange from tourism to expand and develop their economies, including the costs of adaptation and mitigation. Tourism, particularly in small islands, often relies on coastal and terrestrial ecosystems to provide visitor attractions and accommodation space.[188]

Where the relationship between ecosystem services and tourism has been recognised, as in Jamaica, sustainable tourism planning should include activities undertaken by the industry, including tertiary treatment of waste and reuse of water, as well as composting organic material and investing in renewable energy.[189]

Linkages have been made between greenhouse gas emissions and sustainable tourism, which imply that the tourism sector (including operators and tourists) should pay more to promote sustainable tourism, especially where they benefit directly from environmental services sustained by those investments.[190]

Role of international assistance

The ability of small islands to undertake adaptation and mitigation programmes, and their effectiveness, can be substantially strengthened through appropriate assistance from the international community (*medium confidence*).[191]

However, caution is needed to ensure such assistance is not driving the climate change agenda in small islands, as there is a risk that critical challenges confronting island governments and communities may not be addressed.[192]

Donor-led initiatives may unintentionally cause enhanced vulnerability by supporting adaptation strategies that are externally derived, rather than optimising the benefits of local practices that have proven to be effective through time.[193]

Image: iStock | Underwater nature, Caribbean sea

Beyond the *Fifth Assessment Report*: Experience with direct access to climate finance from Jamaica[194]

Developed countries have pledged to make more climate finance available to developing countries via the Green Climate Fund and other funding institutions and mechanisms. Jamaica's experiences with accessing finance from the Adaptation Fund offers relevant lessons for other SIDS.

Different types of organisation can become National Implementing Entities (NIEs) to manage money from the Adaptation Fund. International climate finance received under this model is refered to as 'direct access' because it is managed directly by a national institution as opposed to being disbursed via international, multilateral agencies.

The NIE in Jamaica faced the challenge of managing large sums of money and meeting the fiduciary standards of the Adaptation Fund.

Including civil society early in the NIE accreditation process is beneficial for later phases of project implementation.

Once accredited, this NIE found it difficult to access adaptation finance because of its range of core responsibilities.

Working with multilateral agencies to develop internationally-accepted accreditation standards would allow wider access to adaptation finance for NIEs.

Nations with limited institutional capacity may not be able to establish NIEs; in such cases Regional and Multilateral Implementing Entities can provide access to finance.

Image: Vinicius Tupinamba, Shutterstock | Jamaica Currency

The Green Climate Fund is likely to channel even larger amounts of finance than the AF. Institutions that qualify as NIEs may not automatically qualify for direct access to this new Fund.To avoid uneven access, vulnerable countries will need help to build their institutional capacity.

"International cooperation is required to effectively mitigate greenhouse gas emissions and address other climate change issues… outcomes seen as equitable can lead to more effective cooperation." IPCC[195]

International cooperation is vital to avert dangerous climate change and SIDS governments can promote ambitious global action

Since the IPCC's formation in 1992, its work has given us a better understanding of climate science and has provided us with a better picture of vulnerabilities in different parts of the world. The IPCC has reviewed the range of potential policy options and their implementation in a range of country contexts. The *Fifth Assessment Report* provides the strongest scientific evidence of climate change yet. The report also indicates that waiting or doing nothing is no longer an option and makes a compelling case for immediate global action on climate change.

Political processes need to reflect this. Ensuring the right choices now requires every government to participate in global climate negotiations towards a collective solution. Recognising that everyone must share the effort, and making financial resources available for investment in adaptation programmes and low-emissions infrastructure are important in reaching global agreement.

To this end, developed countries have committed to jointly mobilising US$100 billion a year from various sources by 2020 for adaptation and mitigation in developing countries. As yet, there is no agreed understanding on how to allocate funds between mitigation and adaptation, or between developing countries and regions. What is clear is that SIDS needs resources to build viable adaptation frameworks and capabilities, and critical infrastructure for development. Provision of climate finance through the Global Climate Fund or other schemes is one way of mobilising resources to support adaptation and mitigation action in SIDS.

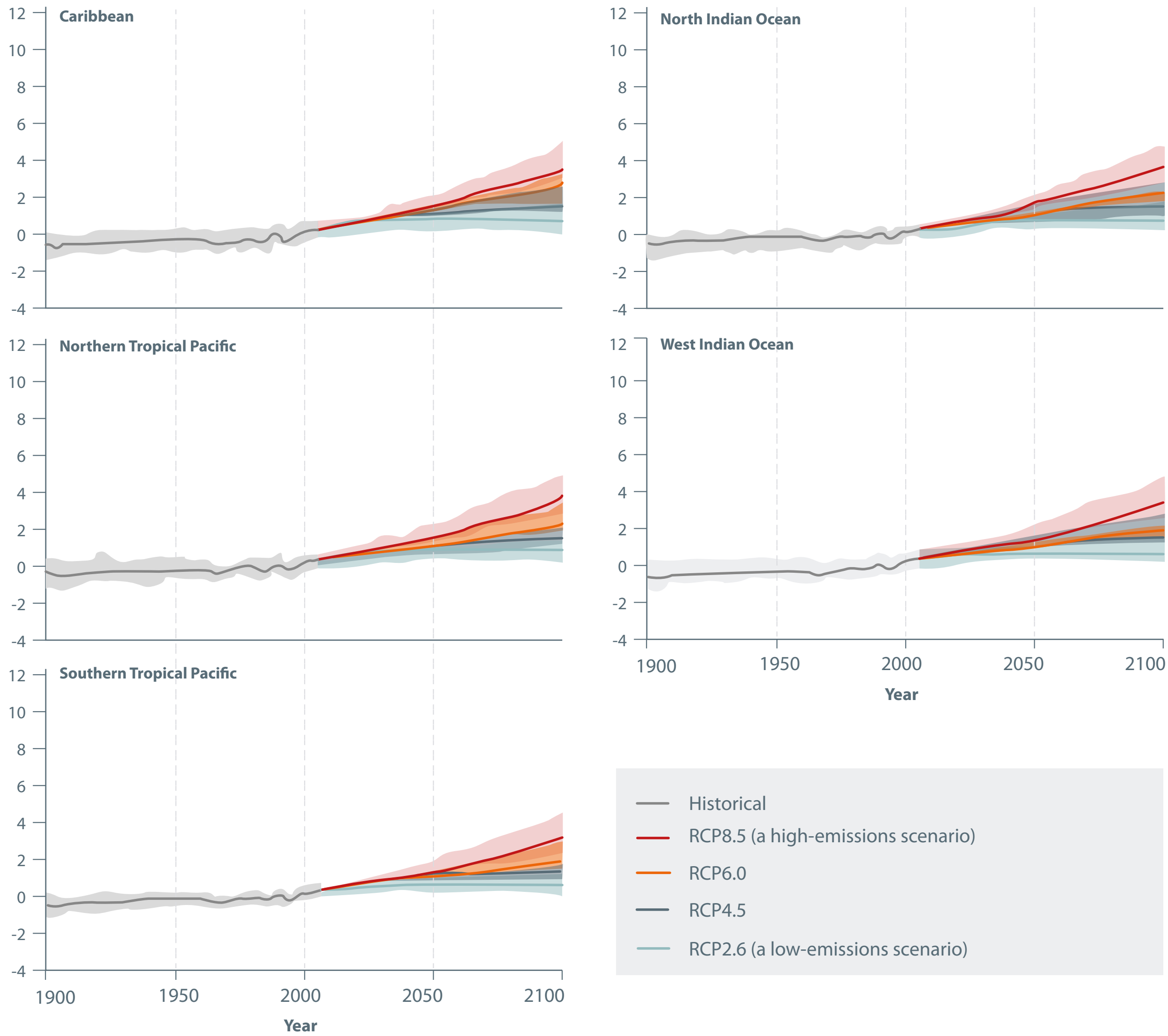
The IPCC's key messages provide crystal clear implications for the global climate negotiations process. As mentioned above, the IPCC states categorically that the Cancun pledges for emissions reduction by 2020 are insufficient,[196] but could be the basis for something more ambitious. This is what the international process must deliver.

The leaders of SIDS have an important part to play – with all other international leaders – in forging this commitment to ambitious, collective action. An important part of reaching a global agreement is ensuring that the cooperative spirit is in place, effort-sharing is recognised and financial resources are made available to invest in adaptation programmes and low-emissions development pathways.

Annex 1:

Future temperature trends for SIDS regions up to 2100 relative to 1986–2005[197]

Figure 6: Temperature trends for SIDS



About the IPCC's *Fifth Assessment Report*

The Intergovernmental Panel on Climate Change (IPCC) has produced the most comprehensive assessment of climate change ever. The *Fifth Assessment Report* (http://www.ipcc.ch), which IPCC is releasing in four parts between September 2013 and November 2014, is the work of 830 expert authors, from 85 countries. The report reviews the scientific evidence on the trends and causes of climate change, the risks to human and natural systems, and options for adaptation and mitigation. The IPCC aims to be – in its own words – "policy relevant but not policy prescriptive". Its findings further our understanding of humankind's interaction with our environment: how we are affecting the global climate and what we can do about it.

The IPCC Working Groups publish the reports comprising the *Fifth Assessment Report* (see figure: How the IPCC works). These groups are: Working Group I (physical science of climate change), Working Group II (impacts, adaptation and vulnerability) and Working Group III (climate change mitigation). The fourth report is a synthesis of findings. Although the collected reports total many thousands of pages, each Working Group produces a *Summary for Policymakers,* which presents key findings in a more succinct form. Representatives of more than 190 governments review and negotiate the summaries in detail during a week-long event. Once governments have signed off on each *Summary*, the IPCC publishes it, together with the full scientific report.

You may find the *Fifth Assessment Report* on the following websites:

Working Group I: The Physical Science Basis
www.climatechange2013.org

Working Group II: Impacts, Adaptation, and Vulnerability
www.ipcc.ch/report/ar5/wg2/

Working Group III: Mitigation of Climate Change
www.ipcc.ch/report/ar5/wg3/

About this report

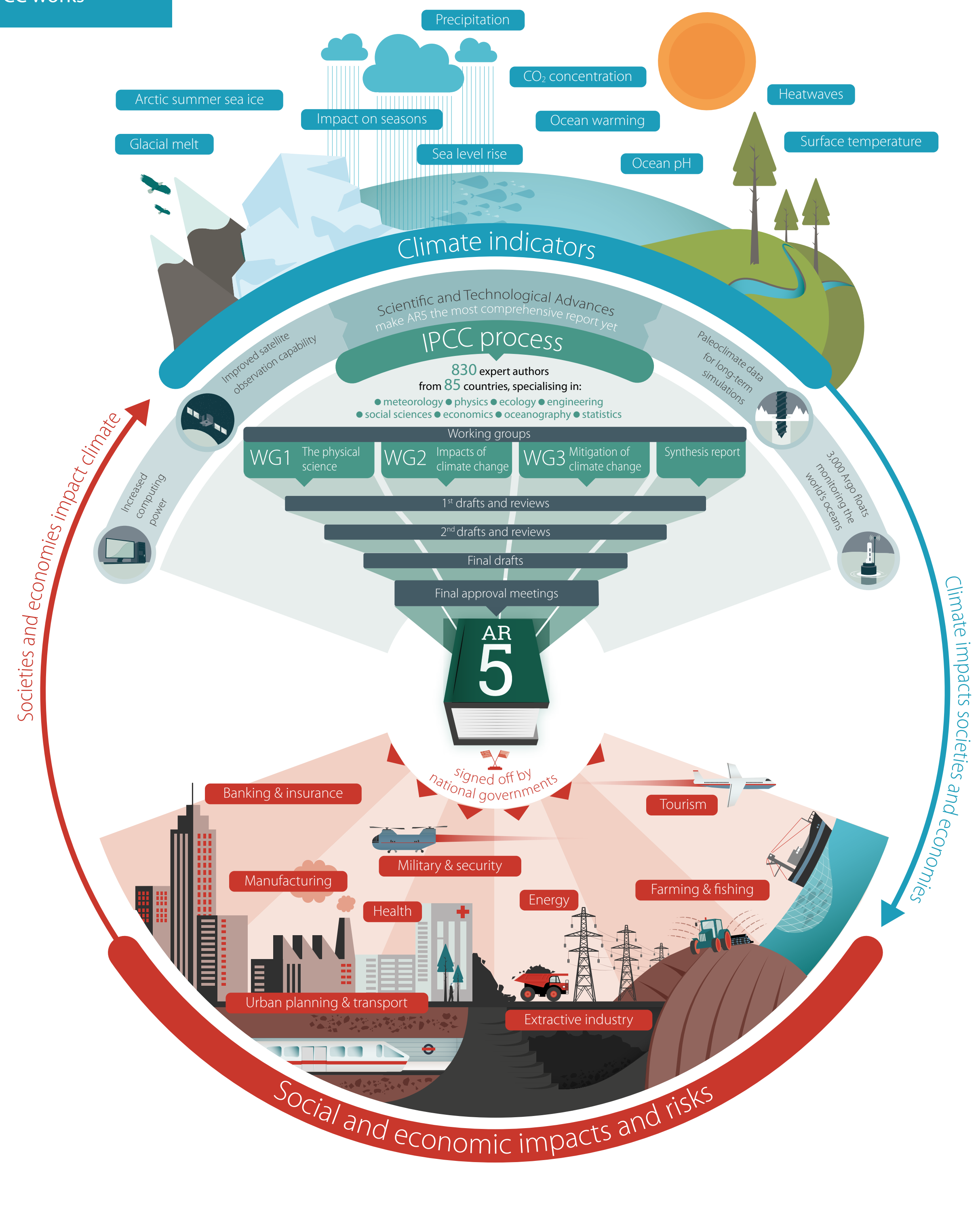
This report is a guide to the IPCC's *Fifth Assessment Report* prepared for decision-makers in Small Island Developing States by the Climate and Development Knowledge Network (CDKN) and Overseas Development Institute (ODI). The IPCC *Summaries for Policymakers* focus principally on global issues and trends. This report distils the richest material on Small Island Developing States' experiences in adaptation and mitigation, from the thousands of pages of the *Fifth Assessment Report*. The publication has not been through the comprehensive governmental approval process that IPCC endorsement requires.

The research team has extracted the Small Island Developing States-specific data, trends and analysis, as available, directly and solely from the *Fifth Assessment Report* for this short volume. In so doing, we hope to make the IPCC's important material more accessible and usable to Small Island Developing States audiences. This report responds to wide demand among CDKN's Small Island Developing States partner networks for such information.

Our publication is part of a suite of materials to aid understanding of the IPCC's *Fifth Assessment Report*. Companion volumes provide a digest of IPCC findings for: Africa; Latin America; and South Asia.

Please visit www.cdkn.org/ar5-toolkit

How the IPCC works[198]



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Glossary

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Greenhouse gas: Greenhouse gases are those gaseous constituents of the atmosphere, both natural and caused by human activity. Greenhouse gases trap energy from the sun in the atmosphere causing it to warm. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere; while hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) are also of concern. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as halocarbons and other chlorine- and bromine-containing substances.

Maladaptive actions (or maladaptation): Actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.

Mitigation (of climate change): A human intervention to reduce the sources of greenhouse gases or enhance the sinks (those processes, activities, or mechanisms that remove a greenhouse gas from the atmosphere).

Representative concentration pathways (RCPs): Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use and land cover. The word 'representative' signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics (i.e., greenhouse gas-related warming). The term 'pathway' emphasises that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome.

Resilience: The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganising in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are useful to provide a view of the implications of developments and actions.

Social protection: In the context of development aid and climate policy, social protection usually describes public and private initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of the marginalised, with the overall objective of reducing the economic and social vulnerability of poor, vulnerable, and marginalised groups.

Transformation: A change in the fundamental attributes of a system, often based on altered paradigms, goals, or values. Transformations can occur in technological or biological systems, financial structures, and regulatory, legislative, or administrative regimes.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Endnotes

1 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Headline Statements from the Summary for Policymakers.*
2 Ibid.
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4 These are summarised at a global level in IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers.*
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11 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability.* Chapter 7 (p3).
12 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Chapter 10* (p4).
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17 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Chapter 29.*
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35 IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Technical Summary* (Figure TS.1, p60).
36 IPCC (2013). *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (p27).
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38 During the decade 2000–2010, emissions have been higher "than any previous decade since 1750" and "between 2000–2010, greenhouse gas emissions grew on average 2.2% per year compared to 1.3% per year over the entire period 1970–2000". IPCC (2014). *Climate Change 2014: Mitigation of Climate Change. Technical Summary* (pp9–10).
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198 Information is Beautiful. Graphic adapted from Information is Beautiful graphic, from a project developed and released by the European Climate Foundation and the Cambridge Institute for Sustainability Leadership.

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IPCC, 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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