in a warming world:

The latest science
on present-day impacts
and future projections
of sea-level rise

1. The Current State of Sea-Level Rise

Global-mean sea level is rising and accelerating as a direct consequence of human-induced

The magnitude, timing, and rate of SLR within this century and over the next millennia will depend on the long-term temperature at which global warming will stabilize, as well as on the pathways

Table 1.

the IPCC AR6.[21]

the 17th-83rd percentile range. The

1900. **Source:**

Since the publication of the IPCC AR6 WGI in 2021, a growing number of scientifc studies on ice-sheet loss are raising alarm among scientists that future SLR could indeed be much larger and occur sooner (see Annex II for list of studies).[22]

3. Global Impacts and Implications of Sea-Level Rise

Accelerated SLR has the potential to redef ne the coastlines of the 21st century. It can pose major risks to the safety, security, and sustainability of many low-lying islands, populous coastal megacities, large tropical agricultural deltas, and Arctic communities.[27]

The low-elevation coastal zone (LECZ), which comprises continental and island areas connected to the sea no more than 10 meters above mean sea level, **includes a wide diversity of systems, from small islands to megacities, from the Tropics to the Poles, in both the Global North and Global South**

COUNTRY	CITY	OBSERVED SLR FROM 1990 TO 2020 (cm)	PROJECTED SLR FROM 2020 TO 2050 (cm)
Argentina	Buenos Aires	6	15 [12–19]
Australia		8	13 [11–17]
Australia		9	15 [12–20]
Australia		13	15 [12–21]
Australia	Perth	16	16 [15–19]
	Rio de Janeiro	13	16 [12–21]
	Atafona	13	16 [12–21]
Canada	Richmond	4	8 [7–12]
Canada	Vancouver	4	8 [7–12]
Canada		8	14 [12–17]
China		17	24 [20–29]
China		11	13 [9–19]
	Copenhagen	6	17 [13–23]
France		6	14 [9–19]
France		9	15 [11–21]
Germany		7	20 [16–26]
India		10	18 [15–23]
Japan		3	13 [10–18]
Japan		13	
	Incheon	9	
		12	
		8	
		9	
		16	
		14	
	Atlantic City	16	
	Boston	15	
		20	
		26	
		6	
		6	

Climate-driven coastal hazards and risks come not only from SLR itself but also from its amplification of storm surges, tides, and waves. Coastal flood hazards and associated risks are also expected to increase as a result of local land sinking (subsidence) because of human activities such as building dams or groundwater and fossil fuel extraction.[31] Their combined effects can lead to infrastructure damage due to coastal flooding, saltwater intrusion into groundwater and rivers, shoreline retreat, and change to or loss of coastal ecosystems and economic sectors.

Such impacts are already or are likely to create risks to livelihoods, settlements, health and well-being, and food and water security.[32] Impacts can also reach far beyond coastal communities. For example, climate-induced, involuntary displacement and migration from coastal areas may lead to population movements to inland areas, while loss of economic activities such as fisheries or agriculture and damage to ports can severely compromise global food systems, supply chains, and maritime trade, with local-to-global geopolitical, economic, and security ramifications.[33]

Small rises in relative sea-level can disproportionately increase coastal flood frequency.[34] According to the United Nations Development Programme (UNDP) and the Climate Impact Lab (CIL), **the extent of coastal flooding has increased over the past 20 years as a result of SLR, meaning 14 million more people worldwide now live in coastal communities with a 1-in-20-year chance of flooding.**[35]

The frequency of present-day, extreme-but-rare sea-level events is projected to increase substantially in most regions. For example, according to the IPCC AR6, in a globally-averaged sense, the 1-in-100-year extreme sea-level event (in terms of total water level) is projected to occur once every 30 years by 2050 and once every 5 years by 2100 under the Representative Concentration Pathway RCP4.5 (an emissions scenario leading to 2.5°C end-of-century warming, see Annex I for details). Such events are projected to occur more than once a year by 2100 under RCP8.5 (4.4°C of warming).[36] Additionally, a recent study projects that minor flooding events that currently occur annually will occur most days per year worldwide under 0.7m of SLR.[37]

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According to one study,[38] the global annual damage from coastal flooding totalled around USD$_{2005}$ 20 billion/year in 2010. Assuming no further protection measures are implemented, this value could increase by a factor of 150 between 2010 and 2080 under RCP4.5. However, structural adaptation investments show high potential to reduce future coastal flood risk and the benefits would exceed the investments and maintenance costs globally and in most regions. In addition, **SLR can hamper the ability of coastal**

communities to adapt to climate impacts through its destruction of natural coastal defenses and ecosystems. Mangroves, corals, saltmarshes, and seagrass meadows currently protect hundreds of millions of people worldwide against storm surges and waves. Under RCP8.5, a 1m loss in coral reef height is projected to more than double the global area ɲooded during a 100-year event in 2100.[39]

The IPCC AR6 has also highlighted that as sea levels rise and extreme events intensify, “coastal communities face limits due to ɲnancial, institutional, and socioeconomic constraints and a short timeline for adaptation implementation, reducing the e ɜ cacy of coastal protection and aipe0 1ie C70A40,cn 085cm0 0 m18te7ie C70003FjTT2 1 Tf0 125Td

The Pacific SIDS are on the frontline of the climate crisis, facing severe and disproportionate impacts from SLR.

Local and regional sea level changes can be larger or smaller than the global average due to many factors.[42] **While the change in global-mean sea level from 1993 to 2023 was 9.4cm [+/- 1cm], sea level change in the South-West Pacific over the same period was greater than 15cm [+/- 3cm] in some locations.**[43] According to one recent study, under RCP4.5, **most of the Pacific SIDS are located in a region where relative SLR is projected to be 10–30% higher than the global-mean SLR arising from Antarctic melt in 2100 relative to 2000.**[44]

According to analysis by the NASA SLCT,[45] under a scenario of 3°C warming, which is roughly consistent with a current-policies pathway, **all locations across the Pacific region can expect to see at least another 15cm of additional SLR between 2020 and 2050 (Table 3). Between 2005 and 2100, the median SLR for the Pacific region ranges from 50–97cm across the five warming scenarios assessed, ranging from 1.5°C to 5°C.** Under a 5°C ‘low-likelihood, high-impact’ storyline accounting

Country	Tide Gauge Name	Observed SLR from
	Penrhyn	
	Rarotonga	
Fiji		
Fiji		
	Pohnpei	
Palau		
	Apia	
Tonga		
Tuvalu	Funafuti	

As also shown in Table 3, future SLR is projected to cause a large increase in the frequency and severity of episodic flooding in almost all locations in the Pacific SIDS in the coming decades. Across all future scenarios and under the assumption of no additional protections, all islands may see an order-of-magnitude increase in potential "flooding" days per year by mid-century, relative to what has been seen in the past decade.[48]

In the 1980s, all Pacific SIDS had fewer than 5 flooding days per year on average. **It is projected that for Nuku'alofa and Apia, the capital cities of Tonga and Samoa respectively, the number of flooding days will increase to 35 days per year during the 2050s for an average year. For a projected "worst year" of flooding, the estimates increase to 70 and 90 days per year for Nuku'alofa and Apia, respectively.** Under the "worst-year" projections, **some locations in the Pacific SIDS could experience floodings for almost half of the entire year**; for instance, Kiribati's Kiritimati atoll could see up to 165 flooding days per year in the 2050s.

The Pacific SIDS, especially those in the western tropical Pacific (e.g., Kiribati, Tuvalu, and the Republic of the Marshall Islands), are particularly vulnerable to SLR because of: (i) high exposure to tropical cyclones and other tropical storms; (ii) high shoreline-to-land area ratios; (iii) high sensitivity to changes in sea level, waves, and currents; and (iv) its many low-lying coral atolls or volcanically-composed islands. Many Pacific islands are atolls fringed with coral reefs and have maximum elevations of 3.5m above sea level, with mean elevations of 1.2m above sea level.[49]

Many Pacific and other SIDS — home to 70 million people combined — are already experiencing loss of human life and significant economic damages, particularly from tropical cyclones and increases in SLR.[50] In the Solomon Islands, 50% of homes have already been lost, along with individual islands, to SLR and coastal erosion.[51] **Tropical cyclones (TCs) account for**

rapid ice-sheet loss could bring impacts forward by decades, and adaptation would need to occur much faster and on a much greater scale than ever performed in the past.[55] **An estimated 90% of Pacific Islanders live within 5km of the coastlines.** In the Solomon Islands and Vanuatu, over 60% of the

5. Surging Seas in a Warming World: The Urgency of Action

Projecting future SLR and quantifying the associated impacts and damages remain a complex challenge involving many geophysical and socioeconomic uncertainties, as our understanding of ice-sheet dynamics and coastal ɳood risks, and changes in urban coastal development and protection measures, continues to evolve. **Nevertheless, one certainty that can be taken away from the latest research is that the climate crisis and SLR are no longer distant threats, especially for the Paci f c SIDS.**

Deep, rapid, and sustained cuts in global greenhouse gas emissions are needed NOW to stay within a 1.5°C long-term warming trajectory. At the same time, effective coastal adaptation and investment in resilience and implementation must be scaled up worldwide, especially in the SIDS, to minimize growing SLR impacts and risks. For example, from 2005 to 2100, the Paciɲc SIDS could see around 18cm higher SLR on average under a current-policies (3°C) pathway instead of a 1.5°C-aligned pathway, with consequential impacts and risks.

Countries' next nationally determined contributions (NDCs) under the Paris Agreement, due in 2025, present an unprecedented opportunity for countries to rally cross-government and non-state actors to take immediate action to cut emissions, chart out 1.5°C-aligned decarbonization pathways, and build resilience to climate impacts. Similarly, the national adaptation plan (NAP) process presents an opportunity for whole-of-economy comprehensive risk management, including actions to prepare for and manage the impacts of sea-level rise.

The outcome of the f rst global stocktake (GST) under the Paris Agreement ? adopted by Parties at

Acknowledgments

This technical brief was written by the UN Secretary-General's Climate Action Team and reviewed by experts from the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO), and Herve Damlamian (The Pacific Community (SPC)), Adjunct Prof. Bill Hare (Murdoch University; Climate Analytics), Prof. Elisabeth Holland (Institute of Strategy Resilience and Security at the University College London; formerly at the University of the South Pacific), Dr. James Kirkham (the International Cryosphere Climate Initiative (ICCI)), Prof. Anders Levermann (the Potsdam Institute for Climate Impact Research), Dr. Rosanne Martyr (Climate Analytics; Humboldt University of Berlin), Pam Pearson (ICCI), Prof. Roshanka Ranasinghe (IHE Delft Institute for Water Education/Deltares), Dr. Ben Strauss (Climate Central), Dr. Moleni Tu'uholoaki (SPC), and Prof. Robert Vautard (IPCC WGI Co-Chair; Centre National de la Recherche Scientifique; Institut Pierre-Simon Laplace).

Annex I: Emissions and socioeconomic scenarios assessed in the IPCC reports

This briefing draws on several IPCC reports which assessed two different sets of future greenhouse-gas emissions and socioeconomic scenarios. The tables below show the different scenarios and associated long-term global warming outcomes assessed in the Sixth Assessment Report and in the Fifth Assessment Report.

Table A.1.