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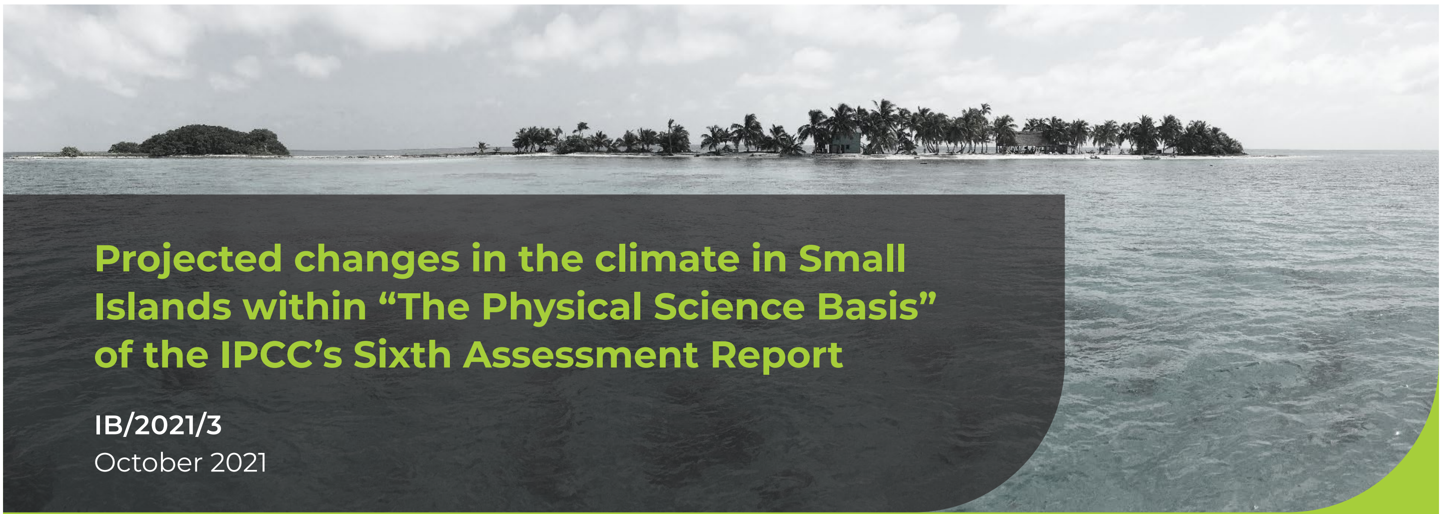
Information Bulletin



Projected changes in the climate in Small Islands within "The Physical Science Basis" of the IPCC's Sixth Assessment Report

IB/2021/3

October 2021

On 9 August 2021, the IPCC Secretariat presented the Summary for Policy Makers (SPM) of the Working Group I (WGI) contribution to the Sixth Assessment Report (AR6), "Climate Change 2021: The Physical Science Basis".

This Information Bulletin provides the underlying basis shaping projections made in IPCC's AR6, followed by a synthesis of claims about projected changes in climate impact drivers on Small Islands.

The basis for climate change projections

With a view to enable an assessment of future impacts of climate change, the IPCC makes use of simplified descriptions of how alternative futures can unpack over time – i.e. hypothetical scenarios, which are described in the AR6 as "Shared Socioeconomic Pathways" (or SSP).

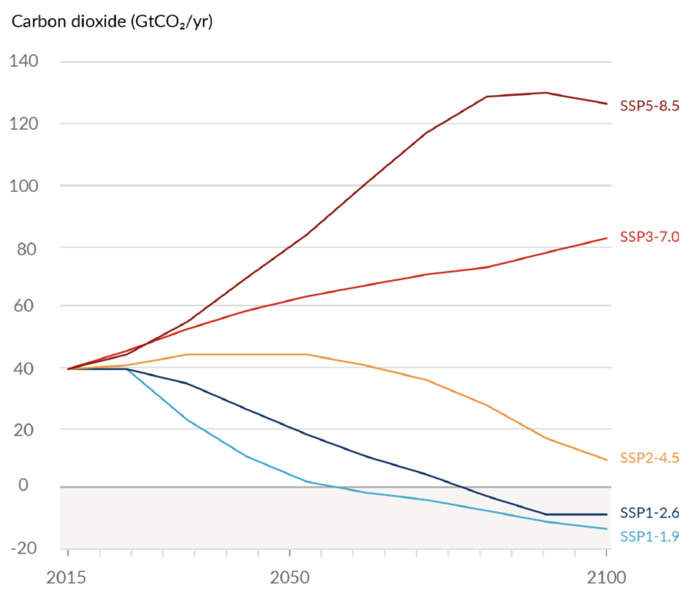
To ensure credibility of those possible futures, these scenarios are based on a set of coherent and internally consistent set of assumptions about key drivers of change, such as: population size, economic processes, technological innovation, governance, lifestyles, as well as the relationships between these driving forces (*Chen et al., 2021*). For instance, the greater the population, the greater the societal needs for food, energy, and mobility, amongst others, therefore the greater the level of emissions of greenhouse gases (GHGs).

By assuming varying levels of ambitions in terms of reductions in emissions of GHGs, and combining those assumptions with credible socioeconomic development pathways, IPCC Scenarios examine the evolution of the severity and intensity of impacts of man-made drivers of climate change.

In AR6, five scenarios are assessed, starting with the year 2015 (**Figure 1**):

- *Scenario 1* (represented by SSP 1 - 1.9 in Figure 1) refers to a future corresponding to very low emissions of GHGs, with net-zero CO2 emissions reached around 2050 and that enables holding global average temperature to around 1.5 °C above pre-industrial levels by the year 2100.
- *Scenario 2* (represented by SSP 1 - 2.6 in Figure 1) refers to a future corresponding to low GHG emissions, declining to net-zero after 2050 and that enables staying below the 2 °C threshold.
- *Scenario 3* (represented by SSP 2 - 4.5 in Figure 1) refers to a future corresponding to intermediate GHG emissions and CO_2 emissions remaining around current levels until the end of the century.
    - o *Scenario 3* is the one that is expected to unpack with current levels of ambitions and commitments laid within Nationally Determined Contributions by all nations collectively.

Figure 1: Future annual emissions of CO_2 across five illustrative scenarios of climate change (IPCC 2021b, pg 16)



- *Scenario 4* (represented by SSP 3 - 7.0 in Figure 1) refers to a future with high GHG emissions, with CO_2 levels that roughly double from current levels by the year 2100. This scenario corresponds to a world with no additional climate policy being implemented.
- *Scenario 5* (represented by SSP 5 - 8.5 in Figure 1) refers to a future with very high GHG emissions, with CO_2 levels that roughly double from current levels by the year 2050.

Based on those scenarios, the AR6 assesses results from climate models participating in the World Climate Research Programme, which is a scientific and partnership organisation that coordinates and facilitates international climate research.

Table 1 lists the changes in global surface temperatures for these scenarios at different time periods.

Table 1: Changes in global surface temperatures according to the five illustrative scenarios (Adapted from IPCC 2021b, pg 18)

		Near Term (2021 - 2040)		Mid-term (2041-2080)		Long-term (2081-2100)	
Name	**IPCC term**[2]	**Best Estimate (°C)**	**Very likely range (°C)**	**Best Estimate (°C)**	**Very likely range (°C)**	**Best Estimate (°C)**	**Very likely range (°C)**
Scenario 1	SSP 1-1.9	1.5	1.2 – 1.7	1.6	1.2 – 2.0	1.4	1.0 – 1.8
Scenario 2	SSP 1-2.6	1.5	1.2 – 1.8	1.7	1.3 – 2.2	1.8	1.3 – 2.4
Scenario 3	SSP 2-4.5	1.5	1.2 – 1.8	2.0	1.6 – 2.5	2.7	2.1 – 3.5
Scenario 4	SSP 3-7.0	1.5	1.2 – 1.8	2.1	1.7 – 2.6	3.6	2.8 – 4.6
Scenario 5	SSP 5-8.5	1.6	1.3 – 1.9	2.4	1.9 – 3.0	4.4	3.3 – 5.7

Projected Changes in Small Islands

Using models and scenarios described above, numerous drivers of climate change on Small Islands[3] have been assessed.

The following section details the drivers that were analysed, which, according to authors of the AR6, have the most probability (i.e. with levels of uncertainty that corresponds, at least, to *medium confidence* and *likelihood*– see *Information Bulletin – IB/2021/1*) of occurring in the future.

i. There is *high confidence* of warming over Small Islands, even at 1.5°C global warming level.

- Depending on models used, mean temperature is *very likely* to increase by 1°C – 2°C by 2041–2060 and by 2°C – 4°C by 2081–2100.
- Compared with the recent past, it is *likely* that:
    - o the intensity and frequency of hot temperature extremes will increase in Small Islands,
    - o the intensity and frequency of cold temperature extremes will decrease in Small Islands.
- It is *very likely* that the significant recent warming trends observed in the Small Islands will continue in the 21st century, which will likely further increase heat stress in Small Islands.

ii. Relative sea level rise is *very likely* in Small Islands and the oceans around those islands and continues to be a major threat to Small Islands and atolls, since it can exacerbate the impacts of other climate hazards.

- Around Small Islands, regional-mean Sea Level Rise (SLR) projections vary widely, from 0.4 m–0.6 m under ambitious emissions reductions scenarios (*Scenarios 1 and 2*) to 0.7 m–1.6 m in worst case scenarios (*Scenario 5*) for 2081–2100 relative to 1995–2014.
- It is *very likely* that this will result in increased coastal flooding, with the potential to increase salt-water intrusion into aquifers in Small Islands.
- Relative SLR, along with storm surges and waves, will exacerbate coastal inundation in Small Islands.
- Shoreline retreat (relocation) is projected along sandy coasts of most Small Islands (*high confidence*).
    - o In the worst-case scenarios (*Scenario 5*), more than 100 m of median shoreline retreat is projected for all Small Islands (with varying levels depending upon location) by the year 2100; notably in the Caribbean where retreats approaching 200 m (relative to 2010).
- The effects of SLR are *very likely* to be compounded by Tropical Cyclone surge events.

1 *The number coding (e.g. SSP 1-1.9, SSP 1-2.6, etc.) refers to the additional radiative forcing achieved by the year 2100 due to the effects of man-made greenhouse gas emissions (measured in Watts per square meters).*

2 *e.g. warming levels, sea level rise, rainfall trends and their associated impacts such as river flooding, flash floods, landslides, aridity and ecological droughts, wind speed, tropical cyclones, coastal flooding and erosion, and marine heatwaves.*

iii. **Rainfall patterns will vary spatially across Small Islands, with some regions experiencing increases in rainfall, while others will be experiencing decreases in rainfall.**

- The narrowing and strengthening of the Inter Tropical Convergence Zone will result in more rainfall around its core and less towards the southern equatorial region, impacting rainfall patterns in the Western Indian Ocean (*high confidence*).

iv. **Global changes indicate that Small Islands will generally face fewer, but more intense tropical cyclones (*medium confidence*), although large differences exist per region.**

- Future global changes in tropical cyclones include more frequent Category 4-5 storms (*high confidence*) and increased rain rates (*very high confidence*), with relative SLR exacerbating storm surge potential.
- By the late 21st century, tropical cyclones are projected to be less frequent in the basins of the western and eastern North Pacific, Bay of Bengal, Caribbean Sea and in the Southern Hemisphere, but will be more frequent in the subtropical central Pacific.

v. **In the future, increased aridity and decreased freshwater availability are projected in many Small Islands.**

- Increased aridity is projected for the majority of the Small Islands, such as in Caribbean, southern Pacific and Western Indian Ocean, by 2041-2059 relative to 1981-1999, and at 1.5°C and 2.0°C global warming levels, which will further intensify by 2081-2099 (*medium confidence*).
- There is *medium confidence* that agricultural and ecological droughts will increase in frequency, duration, magnitude, and extent in Small Islands.

vi. **It is virtually certain that sea surface temperature will continue to increase in the 21st century at a rate depending on future emissions scenarios, while the global mean ocean surface temperature will continue to increase throughout the 21st century (*very high confidence*)**

- Projections indicate that by 2081 – 2100 (relative to 1995 – 2014), sea surface temperatures will increase by around 0.86°C (likely range: 0.43-1.47°C), under the most conservative scenario (*Scenario 1*). The mean projection increases to 2.89°C (likely range: 2.01 - 4.07°C) under the worst-case scenario (*Scenario 5*).

vii. **There is *high confidence* that marine heatwaves will be more intense and prolonged around all Small Island nations.**

- Projections under models show an increase in marine heatwaves around all Small Island nations by 2081–2100, relative to 1985–2014.
- In the equatorial region,
    - o Maximum annual intensities of up to 1.2°C may be reached over an annual mean duration reaching 100 days at 1.5°C global warming levels.
    - o Maximum annual intensities of up to 1.8°C may be reached over an annual mean duration reaching 200 days at 2.0°C global warming levels.

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Report Citation

Future by Design, 2021. Projected changes in the climate in Small Islands within "The Physical Science Basis" of the IPCC's Sixth's Assessment Report - IB/2021/3. Université des Mascareignes.

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